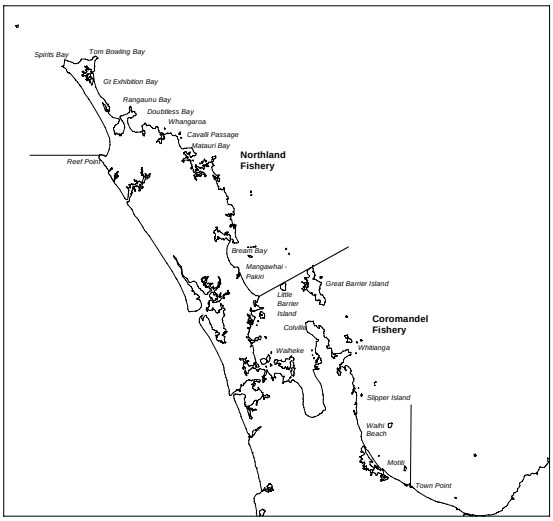
SCALLOPS NORTHLAND (SCA 1)

(*Pecten novaezelandiae*)
Kuakua, Tipa



1. FISHERY SUMMARY

1.1 Commercial fisheries

Scallops support regionally important commercial fisheries off the north-east coast of the North Island between Reef Point (Ahipara) and Cape Rodney, the limits of the Northland fishery. Fishing is conducted within discrete beds in Spirits Bay, Tom Bowling Bay, Great Exhibition Bay, Rangaunu Bay, Doubtless Bay, Stevenson's Island, the Cavalli Passage, Bream Bay, and the coast between Mangawhai and Pakiri Beach. All commercial fishing is by dredge, with fishers preferring self-tipping "box" dredges to the "ring bag" designs used in Challenger and Chatham Island fisheries.

The fishing year applicable to this fishery is from 1 April to 31 March. The Northland commercial scallop season runs from 15 July to 14 February. The minimum legal size (MLS) is 100 mm. Since 1980, landings have varied more than 10-fold from less than 150 t to over 1500 t (greenweight). The lowest recorded landings were in 1999–2000, 2000–01, and 2009–10 (lowest on record).

Northland scallops were introduced into the QMS on 1 April 1997. The Northland TAC is 75 t, comprised of a TACC of 40 t, allowances of 7.5 t for recreational fisheries and 7.5 t for customary fisheries, and an allowance of 20 t for other sources of mortality (values all in meatweight). Northern scallop fisheries are managed under the QMS using individual transferable quotas (ITQ) that are proportions of the Total Allowable Commercial Catch (TACC). Catch limits and landings from the Northland fishery are shown in Table 1. Figure 1 shows the per-stock catch composition for the main SCA stocks, and also the historical landings and TACC for SCA1. Both northern scallop fisheries have been gazetted on the Second Schedule of the Fisheries Act 1996 which specifies that, for certain "highly variable" stocks, the Annual Catch Entitlement (ACE) can be increased within a fishing season. The TACC is not changed by this process and the ACE reverts to the "base" level of the TACC at the end of each season.

Table 1: Catch limits and landings (t meatweight or greenweight) from the Northland fishery since 1980. Data before 1986 are from Fisheries Statistics Unit (FSU) forms. Landed catch figures come from Monthly Harvest Return (MHR) forms, Licensed Fish Receiver Return (LFRR) forms, and from the landed section of Catch Effort and Landing Return (CELR) forms, whereas estimated catch figures come from the effort section of CELRs and are pro-rated to sum to the total CELR greenweight. "Whangarei" includes beds south of Cape Brett, "Far North" includes beds from Cape Brett to North Cape, and "Spirits" includes beds to the west of North Cape. Catch limits for 1996 were specified on permits in meatweight, and, since 1997, were specified as a formal TACC in meatweight (Green[1] assumes the gazetted meatweight recovery conversion factor of 12.5% and probably overestimates the actual greenweight taken in most years). In seasons starting in 1999 and 2000, voluntary catch limits were 40 and 30 t, respectively. *, split by area not available; –, no catch limits set, or no reported catch (Spirits).

			Landings (t)						
	Catch limits (t)		MHR	LFRR	CELR		Scaled estimated catch (t green)		
Season	Meat	Green[1]	Meat	Meat	Meat	Green	Whangarei	Far North	Spirits
1980-81	–	–	–	–	–	238	*	*	*
1981-82	–	–	–	–	–	560	*	*	*
1982-83	–	–	–	–	–	790	*	*	*
1983-84	–	–	–	–	–	1 171	78	1 093	–
1984-85	–	–	–	–	–	541	183	358	–
1985-86	–	–	–	–	–	343	214	129	–
1986-87	–	–	–	114	–	675	583	92	–
1987-88	–	–	–	183	–	1 625	985	640	–
1988-89	–	–	–	171	–	1 121	1 071	50	–
1989-90	–	–	–	164	–	781	131	650	–
1990-91	–	–	–	115	–	519	341	178	–
1991-92	–	–	–	158	–	854	599	255	–
1992-93	–	–	–	135	–	741	447	294	–
1993-94	–	–	–	114	–	862	75	787	1
1994-95	–	–	–	205	–	1 634	429	1 064	142
1995-96	–	–	–	208	214	1 469	160	810	499
1996-97	188	1 504	–	129	132	954	55	387	512
1997-98	188	1 504	–	136	126	877	22	378	477
1998-99	106	848	–	31	32	233	0	102	130
1999-00	106	785	–	18	18	132	0	109	23
2000-01	60	444	–	17	17	128	0	88	40
2001-02	40	320	26	38	38	291	14	143	134
2002-03	40	320	40	40	40	296	42	145	109
2003-04	40	320	38	39	39	309	11	228	70
2004-05	40	320	40	40	40	319	206	77	37
2005-06	70	560	69	69	70	560	559	1	0
2006-07	70	560	53	53	51	405	404	1	0
2007-08	40	320	33	33	30	242	9	197	35
2008-09	40	320	25	25	25	197	0	171	26
2009-10	40	320	10	10	10	80	0	80	0

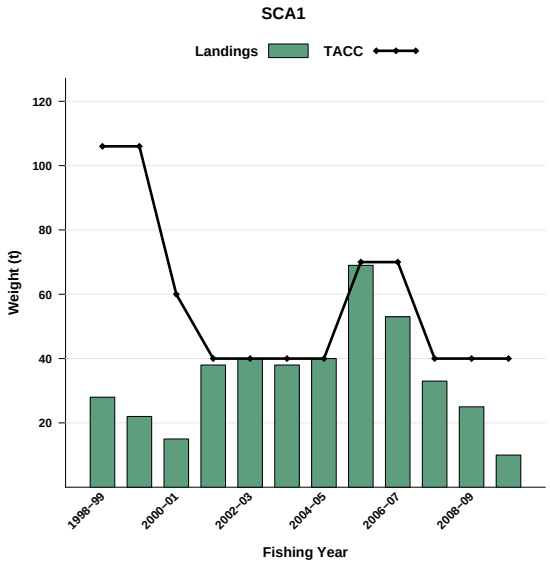


Figure 1: Landings and catch limits (I.e. TACC of 40t plus additional ACE) for SCA 1 (Northland) from 1997–98 to 2009–10. Note that this figure does not show data prior to entry into the QMS. TACC refers to catch limits and 'Weight' refers to Meatweight.

1.2 Recreational fisheries

There is a strong non-commercial (recreational and Maori customary) interest in scallops in suitable areas throughout the Northland fishery, mostly in enclosed bays and harbours. Scallops are usually taken by diving using snorkel or scuba, although considerable amounts are also taken using small dredges. In some areas, especially in harbours, scallops can be taken by hand from the shallow subtidal and even the low intertidal zones (on spring tides), and, in storm events, scallops can be cast onto lee beaches in large numbers. One management tool for northern scallop fisheries is the general spatial separation of commercial and amateur fisheries through the closure of harbours and enclosed waters to commercial dredging. There remain, however, areas of contention and conflict, some of which have been addressed using additional voluntary or regulated closures. Regulations governing the recreational harvest of scallops from SCA CS include a minimum legal size of 100 mm shell length and a restricted daily harvest (bag limit) of 20 per person. A change to the recreational fishing regulations in 2005, allows divers operating from a vessel to take scallops for up to two nominated safety people on board the vessel, in addition to the catch limits for the divers. Until 2006, the recreational scallop season ran from 15 July to 14 February, but in 2007 the season was changed to run from 1 September to 31 March.

Currently, there are no reliable estimates of non-commercial harvest of scallops from the Northland fishery. Estimates of catch by recreational fishers from the two northern scallop fisheries have been made on four occasions as part of recreational fishing (telephone and diary) surveys (Table 2). A Marine Recreational Fisheries Technical Working Group (FTWG) reviewed these surveys and recommended "that the telephone-diary estimates be used only with the following qualifications: 1) they may be very inaccurate; 2) the 1996 and earlier surveys contain a methodological error; and 3) the 1999–2000 and 2000–01 estimates are implausibly high for many important fisheries."

Given the above concerns about the reliability of non-commercial harvest estimates, it is difficult to make comparisons between the levels of commercial and non-commercial harvest. However, recreational catch in 1993–94 from the area shared with the Northland commercial fishery was estimated as 40–60 t (Bradford 1997). Commercial landings from the Northland fishery in the most comparable period (July 1994 to February 1995 scallop season) were 1634 t, suggesting that, in that year, the recreational catch of scallops was probably 2–4% of total removals.

Table 2: Harvest estimates (numbers, and equivalent greenweight) of scallops taken by recreational fishers in Northland (QMA 1) from the telephone-diary surveys conducted in 1993–94, 1996, 1999–2000, and 2000–01. A Marine Recreational Fisheries Technical Working Group considered that these estimates may be very inaccurate.

	QMA 1 (Northland)			
Year	No. of scallops	CV	Weight (t, green)	Reference
1993–94	374 000	0.17	40.0–60.0	Bradford (1997)
1996	272 000	0.18	32.0	Bradford (1998)
1999–00	634 000	0.34	69.8	Boyd and Reilly (2002)
2000–01	820 000	0.31	90.3	Boyd *et al*. (2004)

1.3 Customary non-commercial fisheries

Scallops were undoubtedly used traditionally as food by Maori, and some limited quantitative information on the level of customary non-commercial take is available from MFish (Table 3).

Table 3: MFish records of customary harvest of scallops (reported as numbers or greenweight, or units unspecified) taken from the Coromandel scallop fishery, 2003–04 to 2008–09. –, no data.

SCACS	Quantity approved, by unit type			Actual quantity harvested, by unit type		
Fishing year	Weight (kg)	Number	Unspecified	Weight (kg)	Number	Unspecified
2006–07	–	1650	–	–	1650	–
2007–08	–	1780	–	–	1780	–
2008–09	120	–	300	120	–	300

1.4 Illegal catch

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

1.5 Other sources of mortality

There is no quantitative information on other sources of mortality for Northland scallops. In field studies conducted in the Coromandel fishery, scallops encountered by box dredges showed modest reductions in growth rate compared with scallops collected by divers, and their mortality was high (up to about 50% for larger size classes). Stochastic modelling suggested that, of the three dredge designs tested, box dredges would generate the greatest yield-per-recruit and catch rates. The incidental mortality caused by dredging substantially changed the shape of yield-per-recruit curves for Coromandel scallops, causing generally asymptotic curves to become domed, and decreasing estimates of F_{max} and $F_{0.1}$. More recent field experiments and modelling suggest that dredging reduces habitat heterogeneity, increases juvenile mortality, makes yield-per-recruit curves even more domed, and decreases estimates of F_{max} and $F_{0.1}$ even further.

2. BIOLOGY

Pecten novaezelandiae is one of several species of "fan shell" bivalve molluscs found in New Zealand waters. Others include queen scallops and some smaller species of the genus *Chlamys*. *P. novaezelandiae* is endemic to New Zealand, but is very closely related to the Australian species *P. fumatus* and *P. modestus*. Scallops of various taxonomic groups are found in all oceans and support many fisheries world-wide; most scallop populations undergo large fluctuations.

Scallops are found in a variety of coastal and intertidal habitats, but particularly in semi-enclosed areas where circulating currents are thought to retain larvae. After the planktonic larval phase and a relatively mobile phase as very small juveniles, scallops are largely sessile and move actively mainly in response to predators. They may, however, be moved considerable distances by currents and storms and are sometimes thrown up in large numbers on beaches.

Scallops are functional hermaphrodites, and become sexually mature at a size of about 70 mm shell length. They are extremely fecund and may spawn several times each year. Fertilisation is external and larval development lasts for about 3 weeks. Initial settlement occurs when the larva attaches via a byssus thread to filamentous material or dead shells on or close to the seabed. The major settlement of spat in northern fisheries usually takes place in early January. After growth to about 5 mm, the byssus is detached and, after a highly mobile phase as a small juvenile, the young scallop takes up the relatively sedentary adult mode of life.

The very high fecundity of this species, and likely variability in the mortality of larvae and pre-recruits leads to great variability in annual recruitment. This, combined with variable mortality and growth of adults, leads to scallop populations being highly variable from one year to the next, especially in areas of rapid growth where the fishery may be supported by only one or two year classes. This variability is characteristic of scallop populations world-wide, and often occurs independently of fishing pressure.

Little detailed information is available on the growth and natural mortality of Northland scallops, although the few tag returns from Northland indicate that growth rates in Bream Bay are similar to those in the nearby Coromandel fishery (see the report for SCA CS). The large average size of scallops in the northern parts of the Northland fishery and the consistent lack of small animals there suggests that growth rates may be very fast in the far north.

3. STOCKS AND AREAS

Little is known of the stock structure of New Zealand scallops. It is currently assumed for management that the Northland fishery is separate from the adjacent Coromandel fishery and from the

various west coast harbours, Golden Bay, Tasman Bay, Marlborough Sounds, Stewart Island and Chatham Island fisheries.

4. ENVIRONMENTAL EFFECTS OF FISHING

This section is new for the May 2010 Plenary and has been considered by the Aquatic Environment Working Group (AEWG). It includes only a summary of the incidental bycatch of marine mammals and seabirds in this fishery and does not consider other potential environmental effects. A more detailed assessment of environmental effects across all fisheries will be available in the Ministry's Aquatic Environment Plenary that is under development.

4.1 Role in the ecosystem

Not discussed by the AEWG.

4.2 Incidental catch (fish and invertebrates)

Not discussed by the AEWG.

4.3 Incidental catch (seabirds and mammals)

Scallops are taken commercially using dredges. Seabirds and mammals are not known to be caught in these fisheries.

4.4 Benthic interactions

Not discussed by the AEWG.

4.5 Other considerations

Not discussed by the AEWG.

5. STOCK ASSESSMENT

Northland scallops are managed using a TACC of 40t meatweight which can be augmented with additional ACE based on a Current Annual Yield (CAY) calculation using $F_{0.1}$ as a reference point. Pre-season research (dredge) surveys are used to estimate recruited biomass.

5.1 Estimates of fishery parameters and abundance

At the fishery-wide level, estimated fishing mortality on scallops 100 mm or more in the Northland fishery was in the range F_{est} = 0.33–0.78 y^{-1} (mean F_{est} = 0.572 y^{-1}) between 1997–98 and 2003–04, but was lower in the period 2005–07 (mean F_{est} = 0.203 y^{-1}) (Table 4). The level of fishing mortality in more recent years is unknown because of the lack of surveys to estimate biomass. There is no known stock-recruit relationship for Northland scallops.

CPUE is not presented for this fishery because it is not a reliable index of abundance (Cryer 2001b). However, recent simulation studies in the Coromandel scallop fishery have shown that CPUE can be used as a basis for some management strategies (Haist 2010). This may or may not apply to the Northland scallop fishery.

5.2 Biomass estimates

Virgin biomass, B_0, and the biomass that will support the maximum sustainable yield, B_{MSY}, have not been estimated and are probably not appropriate reference points for a stock with highly variable recruitment and growth such as scallops.

Table 4: Estimated start of season abundance and biomass of scallops of 100 mm or more shell length in the Northland fishery since 1997 using historical average dredge efficiency; for each year, the catch (reported on the 'Landed' section of CELRs), exploitation rate (catch to biomass ratio), and the estimated fishing mortality (F_{est}) are also given. F_{est} was estimated by iteration using the Baranov catch equation where t = 7/12 and M = 0.50 spread evenly through the year. Abundance and biomass estimates are mean values up to and including 2003, and median values from 2005, when the analytical methodology for producing the estimates was modified. This, together with changes to survey coverage each year, make direct comparisons among years difficult. –, no data. There were no surveys in 1999, 2000, 2004, 2008, and 2009.

Year	Abundance		Biomass				Exploitation rate	F_{est}
	(millions)	c.v.	(t green)	c.v.	(t meat)	c.v.	(catch/biomass)	≥100 mm
1997	34.9	0.22	3520	0.22	475	0.22	0.27	0.62
1998	13.9	0.13	1547	0.13	209	0.13	0.15	0.33
1999	–	–	–	–	–	–	–	–
2000	–	–	–	–	–	–	–	–
2001	8.9	0.27	871	0.27	118	0.27	0.32	0.78
2002	13.2	0.19	1426	0.19	193	0.19	0.21	0.46
2003	9.3	0.19	1031	0.19	139	0.19	0.28	0.66
2004	–	–	–	–	–	–	–	–
2005	51.3	0.72	5565	0.70	753	0.71	0.09	0.19
2006	66.6	0.45	7280	0.43	984	0.44	0.05	0.11
2007	15.1	0.47	1637	0.45	208	0.46	0.14	0.31
2008	–	–	–	–	–	–	–	–
2009	–	–	–	–	–	–	–	–

There have been reasonably regular assessments of Northland scallops since 1992 (Table 4 and Table 5), in support of a CAY management strategy. Assessments are based on pre-season biomass surveys conducted by diving and/or dredging. Composite dive-dredge surveys were conducted annually from 1992 to 1997, except in 1993 when only divers were used. From 1998, surveys were conducted using dredges only. The Northland fishery was not surveyed in 1999, 2000, 2004, 2008, or 2009. Where dredges have been used, absolute biomass must be estimated using scalars (multipliers) to correct for the efficiency of the particular dredges used. Previously, these scalars were estimated by comparing dredge counts with diver counts in experimental areas (e.g., Cryer & Parkinson 1999). However, different vessels have been used in the most recent surveys and no trials were conducted on the efficiency of the particular dredges used. Estimating start-of-season biomass and yield is, therefore, difficult and contains unmeasurable as well as measurable uncertainty. For some years, the highest recorded estimate of dredge efficiency has been used, but more recent surveys have had a range of corrections applied from no correction (the most conservative) to historical average across all studies (the least conservative).

Estimates for the Northland fishery calculated using historical average dredge efficiency are shown for scallops 95 mm or more in Table 5. Estimates of current biomass for the Northland fishery are not available (the most recent biomass survey of the Northland fishery was in 2007; there was no survey in 2008 or 2009), and there are no estimates of reference biomass with which to compare historical estimates of biomass. A substantial increase in biomass was observed between 2003 and 2006, which resulted in the 2006 biomass estimate being the highest recorded for Northland. In 2005 and 2006, estimates of biomass were considerably higher than those in 2003 for some beds (notably Bream Bay), but similar or lower in others. There appeared to have been a "shift" in biomass away from the Far North and towards Bream Bay and Mangawhai/Pakiri Beach. This was the "reverse" of the shift towards the Far North that occurred in the early 1990s. However, the 2007 survey results suggested the biomass in Bream Bay and Mangawhai/Pakiri had declined markedly since 2006, and, consequently, the overall fishery biomass was far lower in 2007 than in previous years. The beds in Rangaunu Bay seem more consistent between years, although the 2007 biomass estimate was the highest on record. The biomass in Spirits/Tom Bowling Bays was higher in 2007 than 2006 but remains low compared with historical levels.

Table 5: Estimated recruited biomass (t greenweight) of scallops of 95 mm or more shell length at the time of the surveys in various component beds of the Northland scallop fishery since 1992, assuming historical average dredge efficiency. – indicates no survey in a given year. Estimates of biomass given for 1993 are probably negatively biased, especially for Rangaunu Bay (*), by the restriction of diving to depths under 30 m, and all estimates before 1996 are negatively biased by the lack of surveys in Spirits Bay (†). Totals also include biomass from less important beds at Mangawhai, Pakiri, around the Cavalli Passage, in Great Exhibition Bay, and Tom Bowling Bay when these were surveyed. Commercial landings in each year for comparison can be seen in Table 1, wherein "Far North" landings come from beds described here as "Whangaroa", "Doubtless", and "Rangaunu".

Year	Biomass (t)					
	Bream Bay	Whangaroa	Doubtless	Rangaunu	Spirits Bay	Total
1992	1 733	–	78	766	–	3 092 †
1993	569	172	77	170 *	–	1 094 *
1994	428	66	133	871	–	1 611 †
1995	363	239	103	941	–	1 984 †
1996	239	128	32	870	3 361	5 098
1997	580	117	50	1 038	1 513	3 974
1998	18	45	37	852	608	1 654
1999	–	–	–	–	–	–
2000	–	–	–	–	–	–
2001	110	8	0	721	604	1 451
2002	553	10	–	1 027	1 094	2 900
2003	86	33	3	667	836	1 554
2004	–	–	–	–	–	–
2005	2 945	–	–	719	861	4 676
2006	5 315	–	–	1 275	261	7 539
2007	795	–	–	1 391	432	2 694
2008	–	–	–	–	–	–
2009	–	–	–	–	–	–

Substantial uncertainty stemming from assumptions about dredge efficiency during the surveys, rates of growth and natural mortality between survey and season, and predicting the average recovery of meatweight from greenweight remain in these stock assessments. The findings of current MFish-funded research to model scallop dredge efficiency using existing data should help to reduce this uncertainty, as should future research projects aimed at collecting more data on scallop growth and mortality. Managing the fisheries based on the number of recruited scallops at the start of the season as opposed to recruited biomass (the current approach) could remove the uncertainty associated with converting estimated numbers of scallops to estimated meatweight.

Diver surveys of scallops were conducted in June 2006 and June–July 2007 at selected scallop beds in Northland recreational fishing areas (Williams et al. 2008, Williams 2009). For the four small beds (total area of 4.35 km^2) surveyed, start-of-season biomass of scallops over 100 mm shell length was estimated to be 49.7 t greenweight (CV of 23%) or 6.2 t meatweight in 2006, and 42 t greenweight (CV of 25%) or 5 t meatweight (CV of 29%) in 2007.

5.3 Estimation of Maximum Constant Yield (MCY)

MCY is not normally estimated for scallops and, given the highly variable nature of most wild scallop fisheries, is likely to be close to zero.

5.4 Estimation of Current Annual Yield (CAY)

Yield estimates are generally calculated using reference rates of fishing mortality applied in some way to an estimate of current or reference biomass. Cryer & Parkinson (2006) reviewed reference rates of fishing mortality and summarised modelling studies by Cryer & Parkinson (1997) and Cryer et al. (2004). The Ministry of Fisheries Shellfish Working Group recommend $F_{0.1}$ as the most appropriate reference rate (target) of fishing mortality for scallops.

Management of Northland scallops is based on a CAY approach. Since 1998, in years when biomass surveys have been conducted, catch limits have been adjusted in line with estimated start-of-season recruited biomass and an estimate of CAY made using the Baranov catch equation:

$$CAY = \frac{F_{ref}}{F_{ref} + M} * \left[1 - e^{-(F_{ref}+M)t}\right] * B_{jul}$$

where t = 7/12 years, F_{ref} is a reference fishing mortality ($F_{0.1}$) and B_{jul} is the estimated start-of-season (15 July) recruited biomass (scallops of 90 mm or more shell length). Natural mortality is assumed to act in tandem with fishing mortality for the first 7 months of the fishing season, the length of the current Northland commercial scallop season. B_{jul} is estimated assuming historical average dredge efficiency at length, average growth (from previous tagging studies), M = 0.5 spread evenly through the year, and historical average recovery of meatweight from greenweight. Because of the uncertainty over biomass estimates, growth, and mortality in a given year, and appropriate reference rates of fishing mortality, yield estimates must be treated with caution.

Modelling studies for Coromandel scallops (Cryer & Morrison 1997, Cryer et al. 2004) indicate that $F_{0.1}$ is sensitive not only to the direct incidental effects of fishing (reduced growth and increased mortality on essentially adult scallops), but also to indirect incidental effects (such as additional juvenile mortality related to reduced habitat heterogeneity in dredged areas). Cryer & Morrison's (1997) yield-per-recruit model for the Coromandel fishery was modified to incorporate growth parameters more suited to the Northland fishery and estimate reference fishing mortality rates. Including direct incidental effects of fishing only, and for an assumed rate of natural mortality of M = 0.50, $F_{0.1}$ was estimated as $F_{0.1}$ = 0.943 y^{-1} (reported by Cryer et al., 2004, as 7/12 * $F_{0.1}$ = 0.550) for SCA 1, but estimates of $F_{0.1}$ including direct and indirect incidental effects of fishing were not estimated.

Consequently, the most recent CAY estimates were derived in 2007 for one scenario only:

CAY including direct effects on adults
By including only the direct incidental effects of fishing on scallops, Cryer et al. (2004) derived an estimate of $F_{0.1}$ = 0.943 y^{-1} (reported by Cryer et al., 2004, as 7/12 * $F_{0.1}$ = 0.550). Using this value and the 2007 start of season biomass estimates (median projected values), CAY for 2007–08 was estimated to be 609 t greenweight or 77 t meatweight.

These estimates of CAY would have a CV at least as large as that of the estimate of start-of-season recruited biomass (50–51%), are sensitive to assumptions about dredge efficiency, growth, and expected recovery of meatweight from greenweight, and relate to the surveyed beds only. The sensitivity of these yield estimates to excluding areas of low density has not been calculated, but excluding stations with scallop density less than 0.02 m^{-2} and 0.04 m^{-2} reduced the fishery-wide time of survey biomass estimate by 95 and 100%, respectively. It should be noted that these low-density exclusions were calculated before correcting for average historical dredge efficiency, so these estimates are conservative. However, even if corrections for dredge efficiency were applied and no exclusions were made, the density of scallops 100 mm or more was low in all areas of the fishery surveyed in 2007. There is also additional uncertainty associated with using a point estimate of $F_{0.1}$ (i.e., variance associated with the point estimate of $F_{0.1}$ was not incorporated in the analysis).

5.5 Other yield estimates and stock assessment results

The estimation of Provisional Yield (PY) is no longer accepted as appropriate, and assessments since 1998 have used a CAY approach.

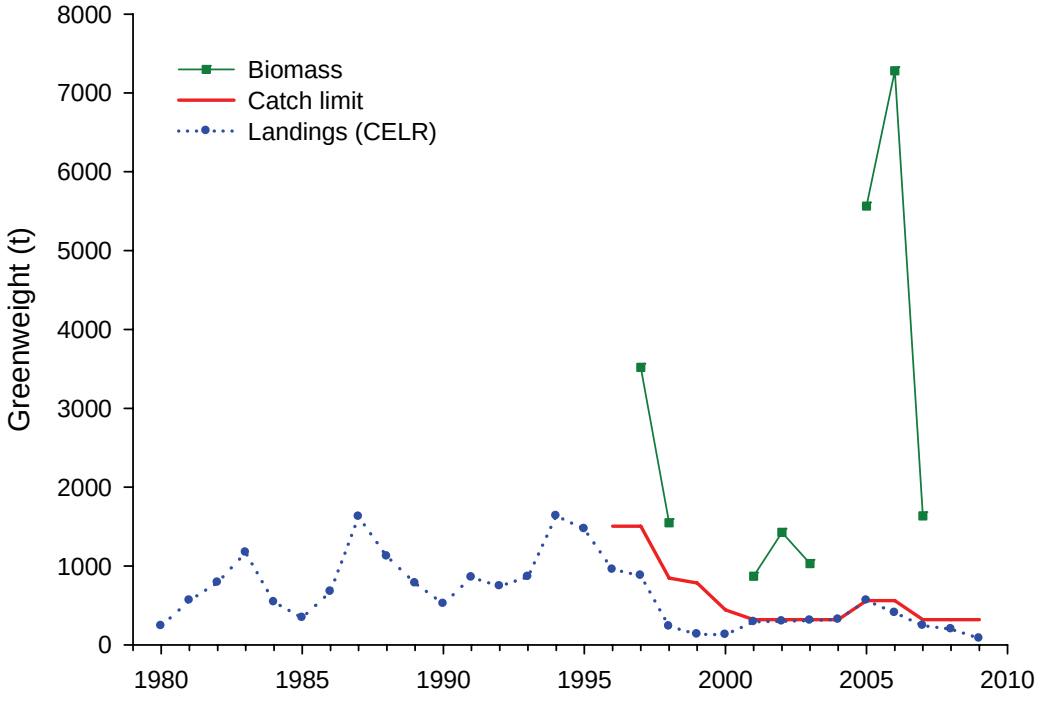
6. STOCK STATUS

Stock Structure Assumptions
Current management assumes the Northland fishery is separate from the other New Zealand scallop fisheries (i.e., Coromandel, the various west coast harbours, Golden Bay, Tasman Bay, Marlborough Sounds, Stewart Island and Chatham Islands). The stock structure of this fishery is assumed to be a single biological stock, although the extent to which the various beds or populations are separate reproductively or functionally is not known.

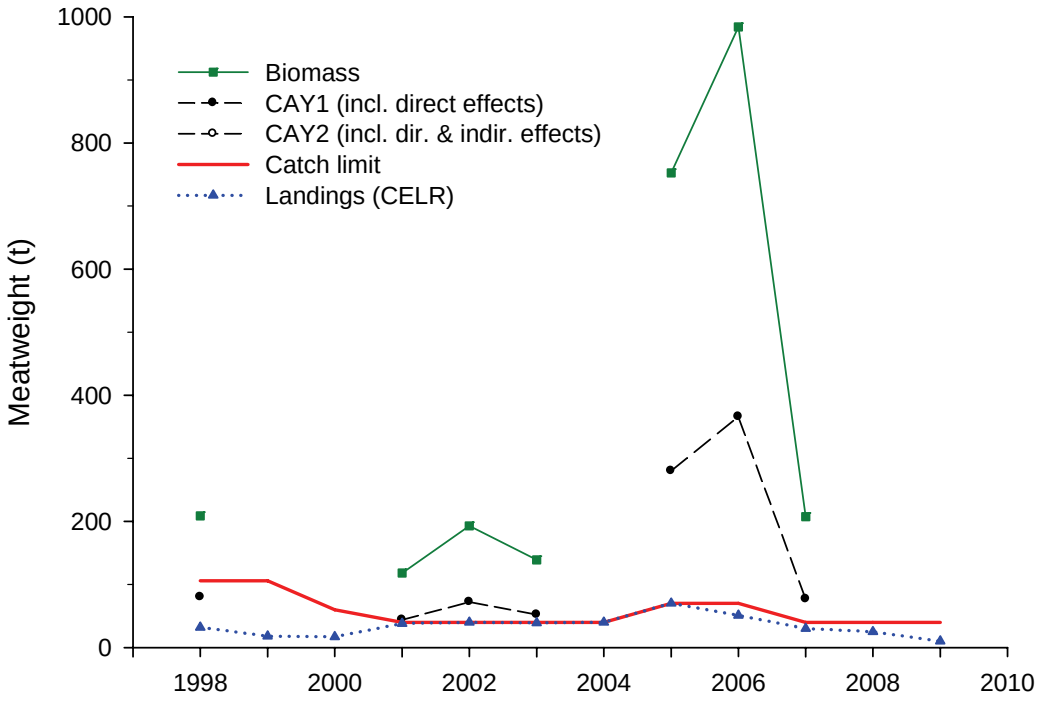
- **Northland scallops, SCA 1**

Stock Status	
Year of Most Recent Assessment	2007
Assessment Runs Presented	Estimate of CAY for 2007
Reference Points	Target: Fishing mortality at or below $F_{0.1}$ ($F_{0.1}$ = 0.943 y^{-1} including direct incidental effects of fishing only) Soft Limit: 20% B_0 Hard Limit: 10% B_0
Status in relation to Target	Unknown
Status in relation to Limits	Unknown

Historical stock status trajectory and current status



Recruited biomass estimates (scallops 100 mm or more shell length), catch limits, and reported landings (CELR) in t greenweight for the SCA 1 fishery since 1980.



Recruited biomass estimates (scallops 100 mm or more shell length), CAY estimates, catch limits, and reported landings (CELR) in t meatweight for the SCA 1 fishery since 1998.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The recent (2008 to present) trend in biomass is unknown.
Recent Trend in Fishing Mortality or Proxy	F_{est} in recent years cannot be estimated for this fishery. Catch in 2009–10 was the lowest on record.
Other Abundance Indices	CPUE is not a reliable index of abundance (Cryer 2001b). However, recent simulation studies in the Coromandel scallop fishery have shown that CPUE can be used as a basis for some management strategies (Haist 2010). This may or may not apply to the Northland scallop fishery
Trends in Other Relevant Indicator or Variables	None

Projections and Prognosis	
Stock Projections or Prognosis	Stock projections are not available.
Probability of Current Catch / TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology		
Assessment Type	Level 2: Partial quantitative stock assessment	
Assessment Method	Dredge surveys and CAY management strategy	
Main data inputs	Abundance and length-frequency data from surveys	
Period of Assessment	Latest assessment: 2007	Next assessment: ???
Changes to Model Structure and Assumptions	Current model has been in use since 2005	
Major Sources of Uncertainty	These include assumptions about: dredge efficiency during the survey, growth rates and natural mortality between the survey and the start of the season, predicting the average recovery of meatweight from greenweight and the extent to which dredging causes incidental mortality and affects recruitment.	

Qualifying Comments
In the Northland fishery some scallop beds are persistent and others are ephemeral. The extent to which the various beds or populations are reproductively or functionally separate is not known. Currently this fishery is managed with a CAY management strategy with a base TACC. However, the management strategy currently resembles a constant catch strategy because there have been no surveys since 2007.

Fishery Interactions
A bycatch survey was conducted in the Coromandel fishery in 2009 under project SCA2007-01B. The results are summarised below and may or may not be relevant to the Northland scallop fishery Bycatch composition Live components • Scallops 26% • Seaweed 11% • Starfish 4% • Other bivalves 4% • Corraline turf 1% Dead components • Dead shell 45% • Rock and gravel 8%

7. FOR FURTHER INFORMATION

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