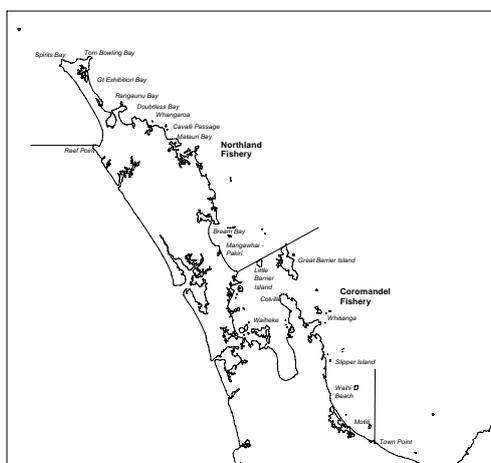


SCALLOPS NORTHLAND (SCA 1)

(*Pecten novaezelandiae*)



1. FISHERY SUMMARY

(a) Commercial fisheries

Scallops support regionally important commercial fisheries off the northeast coast of the North Island between Reef Point (Ahipara) and Cape Rodney, the limits of the Northland fishery (SCA 1). 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 Northland commercial scallop season runs from 15 July to 14 February, and 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 two lowest recorded landings were in 1999 and 2000.

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. 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. 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, landed catch (t meatweight), and estimated catch (t greenweight) from the Northland fishery since 1980. The Northland commercial scallop season runs from 15 July to 14 February, inclusive. Data before 1986 are from Fisheries Statistics Unit (FSU) forms. Landed catch figures come from 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" 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).

Season	Catch limits (t)		Landed catch (t,		Estimated catch (t green)			
	Meat	"Green"	LFRR	CELR	Total	Whangarei	Far North	Spirits
1980	-	-	-	-	238	*	*	*
1981	-	-	-	-	560	*	*	*
1982	-	-	-	-	790	*	*	*
1983	-	-	-	-	1 171	78	1 093	-
1984	-	-	-	-	541	183	358	-
1985	-	-	-	-	343	214	129	-
1986	-	-	114	-	675	583	92	-
1987	-	-	183	-	1 625	985	640	-
1988	-	-	171	-	1 121	1 071	50	-
1989	-	-	164	-	781	131	650	-
1990	-	-	115	-	519	341	178	-
1991	-	-	158	-	854	599	255	-
1992	-	-	135	-	741	447	294	-
1993	-	-	114	-	862	75	787	1
1994	-	-	205	-	1 634	429	1 064	142
1995	-	-	208	214	1 469	160	810	499
1996	188	1 504	129	132	954	55	387	512
1997	188	1 504	136	126	877	22	378	477
1998	106	848	31	32	233	0	102	130
1999	106	785	18	18	132	0	109	23
2000	60	444	17	17	128	0	88	40
2001	40	320	38	38	291	14	143	134
2002	40	320	40	40	296	42	145	109
2003	40	320	39	39	309	11	228	70
2004	40	320	40	40	319	206	77	37
2005	70	320	69	70	560	559	1	0
2006	70	320	53	53	382	382	0	0

(b) Recreational fisheries

There is an intense non-commercial (recreational and Maori) interest in scallops throughout the Coromandel and Northland fisheries. Non-commercial fishing for scallops occurs in suitable areas throughout the two fisheries, 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. To some extent, management of northern scallop fisheries has concentrated on spatial separation of commercial and amateur fisheries through the closure of harbours and enclosed waters to commercial dredging. However, areas of contention and conflict have existed in the past, some of which have been addressed using additional voluntary or regulated closures. Recreational regulations restrict the daily harvest (bag limit) to 20 per person, with a minimum legal size of 100 mm shell length. 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 Coromandel or Northland fisheries. 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). The 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 2000/2001 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 (number and greenweight, t) of scallops taken by recreational fishers in Coromandel and Northland (QMA 1) from the telephone-diary surveys conducted in 1993/94, 1996, 1999/2000, and 2000/01. The Marine Recreational Fisheries Technical Working Group considered that these estimates may be very inaccurate.

Year	Coromandel			QMA 1 (Northland)			Reference
	No. of scallops	CV	Weight (t, green)	No. of scallops	CV	Weight (t, green)	
1993/94	626 000	0.14	60.0–70.0	374 000	0.17	40.0–60.0	Bradford (1997)
1996	614 000	0.12	62.0	272 000	0.18	32.0	Bradford (1998)
1999/2000	257 000	1.01	30.1	634 000	0.34	69.8	Boyd & Reilly (2002)
2000/01	472 000	0.47	55.3	820 000	0.31	90.3	Boyd et al. (2004)

(c) Maori customary fisheries

Scallops were undoubtedly used traditionally as food by Maori, although quantitative information on the level of Maori customary take is not available.

(d) Illegal catch

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

(e) Other sources of mortality

Scallops encountered by box dredges in the Coromandel scallop fishery 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).

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 undergo large population 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 60–70 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 very 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. STOCK ASSESSMENT

(a) Estimates of fishery parameters and abundance

Catch rates are variable both within and among seasons, but the relationship between biomass and CPUE is complex and (declines in) CPUE cannot be used to estimate biomass within a season (Cryer, 2001b). Effort data are, therefore, not presented.

(b) 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.

There have been almost annual assessments of Northland scallops since 1992, 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 used throughout the fishery between 1992 and 1998, except in 1993 when only divers were used and 1998 when only dredges were used (Table 2). The Northland fishery was not surveyed in 1999, 2000, or 2004 but dredge surveys were conducted in 2001, 2002, 2003, 2005, and 2006. 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 five 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 in 2005 and 2006 calculated using historical average dredge efficiency (Table 2) suggest that the biomass in Bream Bay was substantially higher than in 2003 (following good fishery performance, but no survey, in 2004). The beds in Rangaunu Bay seem more consistent between years, although the 2006 biomass estimate was the highest on record. In contrast, biomass in Spirits/Tom Bowling Bay in 2006 was the lowest on record.

Table 2: Estimated recruited biomass (at the time of surveys) of scallops of 95 mm or more shell length 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)					Total
	Bream Bay	Whangaroa	Doubtless	Rangaunu	Spirits Bay	
1992	1733	–	78	766	–	3092 †
1993	569	172	77	170 *	–	1094 *
1994	428	66	133	871	–	1611 †
1995	363	239	103	941	–	1984 †
1996	239	128	32	870	3 361	5098
1997	580	117	50	1038	1 513	3974
1998	18	45	37	852	608	1654
1999	–	–	–	–	–	–
2000	–	–	–	–	–	–
2001	110	8	0	721	604	1451
2002	553	10	–	1 027	1 094	2900
2003	86	33	3	667	836	1554
2004	–	–	–	–	–	–
2005	2945	–	–	719	861	4676
2006	5315	–	–	1275	261	7539

Diver surveys of scallops were conducted in June 2006 at selected scallop beds in Northland and Coromandel recreational fishing areas (Williams et al., 2006a). For the four small beds (total area of 4.35 km²) surveyed in the Northland fishery, start-of-season biomass of scallops over 100 mm shell length was estimated to be 49.7 t greenweight (6.2 t meatweight) with a CV of 23%.

(c) 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.

(d) Estimation of Current Annual Yield (CAY)

Management of Northland scallops is based on a CAY approach. Since 1998, catch limits have been adjusted in line with estimated start-of-season recruited biomass and an estimate of CAY made using the version of the Baranov catch equation given by Cryer & Morrison (1997).

Cryer & Morrison (1997) modelled yield-per-recruit in the Coromandel fishery, but their model was modified to incorporate growth parameters more suited to the Northland fishery and estimate reference fishing mortality rates. For an assumed rate of natural mortality of $M = 0.50$, $F_{0.1}$ was estimated as 0.550 and F_{max} as 0.700. $F_{40\%}$ was not estimated. Yield estimates based on $F_{0.1}$ should probably be preferred as targets over that based on F_{max} (which is usually considered a limit reference point). The following modified version of the Baranov equation given by Cryer & Morrison (1997) should be used in their application:

$$CAY = \frac{F_{ref}}{F_{ref} + \frac{7M}{12}} * \left[1 - e^{-\left(F_{ref} + \frac{7M}{12}\right)} \right] * B_{jul} \quad (1)$$

where B_{jul} is the estimate of recruited biomass in July. Natural mortality is assumed to act in tandem with fishing mortality for the first 7 months of the year, the length of the current Northland commercial scallop season. 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. CAY estimates are derived for one scenario: the ‘average outlook’, which includes incidental effects on adults but excludes putative habitat effects.

Average outlook, including incidental effects on adults

The recruited biomass of scallops 100 mm or more in shell length at the start of the 2006 season in the Northland fishery was predicted to be 7280 t (greenweight, median projected value using constrained historical dredge efficiency) and 984 t (meatweight, median project value). CAY was calculated using the two reference fishing mortality rates $F_{0.1}$ and F_{max} as follows:

For $F_{0.1}$ (0.550), CAY = 0.6535 * 0.5690 * 7280 (984) = 2707 t (green) or 366 t (meat)

For F_{max} (0.700), CAY = 0.7059 * 0.6290 * 7280 (984) = 3232 t (green) or 437 t (meat)

These estimates of CAY would have a CV at least as large as that of the estimate of start-of-season recruited biomass (43–44%), 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 excluding areas of low density has not been calculated, but excluding stations with density < 0.04 m² reduced the time of survey biomass estimate by 24%. The level of risk to the putative Northland scallop stock of fishing at the estimated CAY level cannot be determined.

(e) 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.

5. STATUS OF THE STOCKS

Estimates of current biomass for the Northland fishery are available (from a 2006 survey) but there are no estimates of reference biomass with which to compare them. Estimates of biomass in 2005 were much higher than those in 2003 for some beds, but similar or lower in others. The 2006 survey results suggest a continued increase in biomass in all areas except Spirits / Tom Bowling Bay, where the biomass has declined since 2005. Bream Bay continues to contribute most (about 70%) to the overall estimated biomass. There seems to have been a “shift” in biomass away from the Far North and towards Bream Bay and Mangawhai/Pakiri Beach. An opposite shift towards the Far North occurred in the early 1990s. We do not understand the processes that have resulted in such large fluctuations in scallop abundance. Given these dramatic changes, it is not known if landings at the level of CAY are sustainable, and the biomass that will support the maximum sustainable yield is probably not an appropriate reference point for a stock with highly variable recruitment and growth such as scallops.

Yield estimates, TACC, ACE, and reported landings for the 2005/06 fishing year are summarised in Table 3.

Table 3: Yield estimates, TACC, ACE, and reported landings, for the 2005/06 fishing year, for scallops SCA 1.

Fishstock	QMA	MCY	2006		2006	
			CAY ($F_{0.1}$)	TACC	ACE	Landings
SCA 1	Northland	N/A	366	40	70	53

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