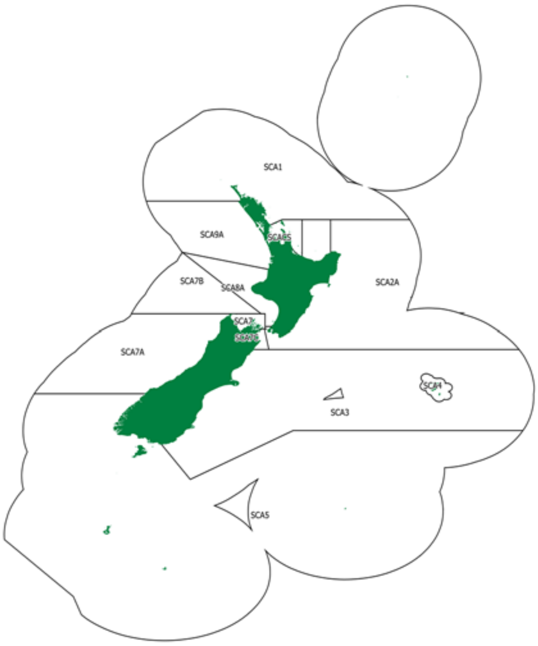
SCALLOPS (SCA)

(*Pecten novaezelandiae*)
Kuakua



1. INTRODUCTION

Scallops are important shellfish both commercially and to non-commercial (customary and recreational) fishers.

For each stock, the Total Allowable Catch (TAC), allowances for recreational and customary fisheries and other sources of mortality, and Total Allowable Commercial Catch (TACC) can be found in Table 1 (all values in meatweight – muscle plus attached roe).

Table 1: TAC, customary allowance, recreational allowance, other sources of mortality allowance and TACC (t) for all scallop stocks.

Fishstock	TAC	Customary allowance	Recreational allowance	Other mortality	TACC
SCA 1 (Northland)	75	7.5	7.5	20	40
SCA 1A (Eastern Bay of Plenty)	8	3	3	1	1
SCA CS (Coromandel)	81	10	10	11	50
SCA 2A (part Central (East))	4	1	1	1	1
SCA 3 (South-East and part Chatham Rise)	4	1	1	1	1
SCA 4 (Chatham Islands)	26	1	1	1	23
SCA 5 (Southland and Sub-Antarctic)	8	3	3	1	1
SCA 7 (Nelson/Marlborough)	520	40	40	40	400
SCA 7A (West Coast)	4	1	1	1	1
SCA 7B (North and West of Farewell Spit)	2	0	0	1	1
SCA 7C (Clarence Pt to West Head, Tory Channel)	4	1	1	1	1
SCA 8A (part Central (Egmont))	4	1	1	1	1
SCA 9A (part Auckland (West))	26	12	12	1	1

Specific Working Group reports are given separately for SCA 1, SCA CS and SCA 7.

1.1 Commercial fisheries

All scallop stocks are managed under the QMS using individual transferable quotas (ITQ). In October 1995, legislation was passed in which annual quotas were determined as a fixed proportion of the Total Allowable Commercial Catch (TACC) rather than being allocated as a fixed tonnage.

All scallop stocks, other than SCA 7, are 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.

In 1996, because of the rotational fishing and stock enhancement management strategy being used to manage the stocks in SCA 7, the fishery was placed on the Third Schedule of the Fisheries Act 1996, and was, therefore, able to have an alternative TAC set under s14 of the Act.

Some harbours and enclosed waters are closed to commercial dredging but remain open to recreational fishers. Closures by area have a considerable history of use in New Zealand scallop fisheries, for both allocation issues and more general issues in scallop management.

The fishing year for scallops is from 1 April to 31 March. The commercial fishing seasons and minimum legal sizes can be found in Table 2. The period of fishing within the season may vary from year to year depending on when the industry decides to operate.

Table 2: Commercial fishing seasons and minimum legal sizes (MLS).

Fishstock	Commercial fishing season	MLS (mm)
SCA 1 (Northland)	15 July to 14 February	100
SCA CS (Coromandel)	15 July to 21 December	90
SCA 7 (Nelson/Marlborough)	15 July to 14 February	90

Historical landings for the three major commercial fisheries are shown in Figure 1.

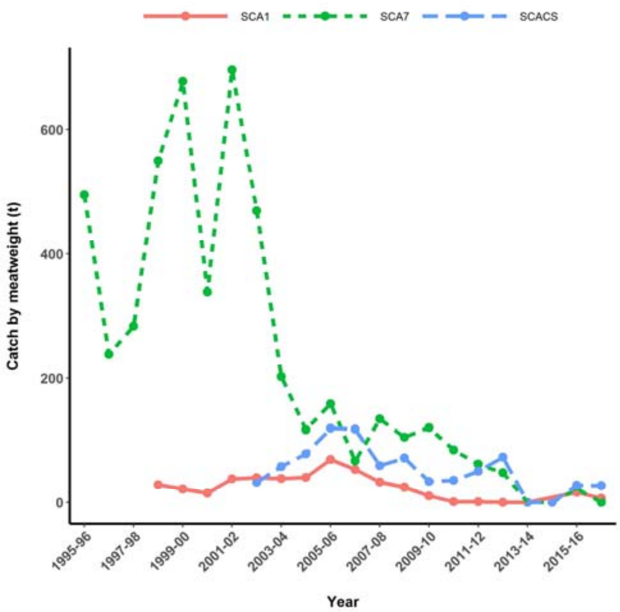


Figure 1: Historical landings for Northland, Coromandel and Nelson/Marlborough scallop fisheries.

All commercial fishing is by dredge. In the Northland and Coromandel fisheries, fishers use a self-tipping ‘box’ dredge (up to 2.4 m wide, fitted with a rigid tooth bar on the leading bottom edge). Vessels in the SCA 7 fishery tow one or two ring-bag dredges up to 2.4 m in width with heavy tickler chains (there are no teeth or tines on the leading bottom edge of the dredges, unlike those of the fixed tooth bars used on dredges in the northern fisheries).

1.2 Recreational fisheries

There is a strong non-commercial interest in scallops in suitable areas throughout the country, mostly in enclosed bays and harbours. Scallops are usually taken by diving using snorkel or scuba, although the use of small dredges is also common practice. 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 beaches in large numbers.

Some harbours and enclosed waters are closed to commercial dredging but remain open to recreational fishers in the Northland and Coromandel scallop fisheries. Closures by area have a considerable history of use in New Zealand scallop fisheries, for both scallop allocation issues and more general issues in scallop management.

Regulations governing the recreational harvest of scallops include a minimum legal size, a restricted daily harvest (bag limit) and a recreational fishing season (Table 3). A change to the recreational fishing regulations in 2005 allowed 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.

Table 3: Recreational scallop fishing regulations.

Fishstock	Minimum legal size (mm)	Daily bag limit (# of scallops per person)	Recreational fishing season
SCA 1 (Northland)	100	20	1 September to 31 March
SCA CS (Coromandel)	100	20	1 September to 31 March
SCA 5 (Stewart Island: Fiordland Paterson Inlet and Port Pegasus)	100	10	1 October to 15 March
SCA 7 (Nelson/Marlborough)	90	50	15 July to 14 February

1.3 Customary fisheries

Scallops were undoubtedly used traditionally as food by Maori. Limited quantitative information on the level of customary take is available from the Ministry for Primary Industries (MPI). Details are provided in the respective chapters.

1.4 Illegal catch

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

1.5 Other sources of fishing mortality

Dredging results in incidental mortality of scallops.

An experimental study conducted on predominantly sandy substrates in the Coromandel fishery found that a box dredge (with teeth or ‘tines’) caused more breakage and incidental mortality in scallops than a ring-bag dredge, although the ring-bag dredge showed poor efficiency on this substrate type in comparison with the box dredge (Cryer & Morrison 1997). Scallops retained by dredges were more likely to be killed than those that were left on the seabed, and there was increasing mortality with increasing scallop size. Total mortality was 20–30% but potentially as high as 50% for scallops that were returned to the water, i.e., those just under the MLS. 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 (Talman et al. 2004) and modelling (Cryer et al. 2004) 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 (Cryer & Parkinson 2006).

The applicability of these findings to the use of the ring-bag dredge in the sand/silt substrates in the SCA 7 fishery is unknown.

The extent of other sources of fishing mortality is unknown. Dredging results in incidental mortality of scallops.

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 worldwide; most scallop populations undergo large fluctuations. *Pecten novaezelandiae rakiura* is a sub-species found around Stewart Island.

Scallops are found in a variety of coastal habitats, but particularly in semi-enclosed areas where circulating currents are thought to retain larvae.

Scallops are functional hermaphrodites and become sexually mature at a size of about 70 mm shell length (Williams & Babcock 2005). They are extremely fecund and may spawn several times each year. They breed most prolifically in early summer (although partial spawning can occur from at least August to February). Most scallops mature by the end of their first year, but they contribute little to the spawning pool until the end of their second year. Year 1 scallops contain about 500 000 eggs, whereas year 4 and 5 scallops can contain over 40 million. Like other broadcast spawning marine invertebrates, scallops need to be in close proximity during spawning to ensure that sperm concentrations are sufficiently high to fertilise the eggs released; high density beds of scallops are disproportionately more important for fertilisation success during spawning. Scallop veliger larvae spend about three weeks in the plankton. They then attach to algae or some other filamentous material with fine byssus threads. When the spat reach about 5 mm they detach and take up the free-living habit of adults, usually lying in depressions on the seabed and often covered by a layer of silt. Although adult scallops can swim, they appear to move very little (based on underwater observations, the recovery of tagged scallops, and the persistence of morphological differences between adjacent sub-populations). They may, however, be moved considerable distances by currents and storms and are sometimes thrown up in large numbers on beaches.

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

For more specific information on individual stocks, please refer to the relevant scallop chapters.

3. STOCKS AND AREAS

Scallops inhabit waters of up to about 60 m deep (apparently up to 85 m at the Chatham Islands), but are more common in depths of 10 to 50 m on substrates of shell gravel, sand or, in some cases, silt. Scallops are typically patchily distributed at a range of spatial scales. Some of the beds are persistent and others are ephemeral. The extent to which the various beds or populations are reproductively or functionally separate is not known.

Some work has been conducted on the spatial and temporal genetic structure of the New Zealand scallop. Samples were collected from 15 locations to determine the genetic structure across the distribution range of scallops. The low genetic structure detected was expected given the recent evolutionary history, the large reproductive potential and the pelagic larval duration of the species (approximately 3 weeks). A significant isolation by distance signal and a degree of differentiation from north to south was apparent, but this structure conflicted with some evidence of panmixia. A latitudinal genetic diversity gradient was observed that might reflect colonisation and extinction events and insufficient time to reach migration-drift equilibrium during a recent range expansion (Silva 2015, Silva & Gardner 2015).

A seascape genetic approach was used to test for associations between patterns of genetic variation in scallops and environmental variables (three geospatial and six environmental variables). Although the geographic distance between populations was an important variable explaining the genetic variation among populations, it appears that levels of genetic differentiation are not a simple function of distance. Evidence suggests that some environmental factors such as freshwater discharge and suspended particulate matter can be contributing to the patterns of genetic differentiation of scallops (Silva 2015, Silva & Gardner 2016).

For more specific information on individual stocks, please refer to the relevant scallop chapters.

4. STOCK ASSESSMENT

The stock assessments of scallop stocks SCA 1, SCA CS and SCA 7 are provided in the relevant Working Group reports.

5. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

5.1 Role in the ecosystem

Scallops (*Pecten novaezelandiae*) are subtidal, benthic, epifaunal, sedentary, bivalve molluscs, which have a pelagic larval dispersal phase. They are found patchily distributed at a range of scales in particular soft sediment habitats in inshore waters of depths generally to 50 m and exceptionally up to 85 m. They exhibit relatively fast growth, high mortality, and variable recruitment. The rates of these processes probably vary in relation to environmental conditions (e.g., temperature, water flow, turbidity and salinity), ecological resources (e.g., food, oxygen and habitat), and with intra- and inter-specific interactions (e.g., competition, predation, parasitism and mutualism), and the combination of these factors determines the species distribution and abundance (Begon et al. 1990). Scallops are considered to be a key component of the inshore coastal ecosystem, acting both as consumers of primary producers and as prey for many predators. Scallops themselves can also provide structural habitat for other epifauna (e.g., sponges, ascidians and algae).

5.1.1 Trophic interactions

Scallops are active suspension feeders, consuming phytoplankton and other suspended material (benthic microalgae and detritus) as their food source (Macdonald et al. 2006). Their diet is the same as, or similar to, that of many other suspension-feeding taxa, including other bivalves such as oysters, clams and mussels.

Scallops are prey to a range of invertebrate and fish predators, whose dominance varies spatially. Across all areas, reported invertebrate predators of scallops include starfish (*Astropecten polyacanthus*, *Coscinasterias muricata* and *Luidia maculata*), octopus (*Pinnoctopus cordiformis*) and hermit crabs (*Pagurus novaezelandiae*), and suspected invertebrate predators include various carnivorous gastropods (e.g., *Cominella adspersa* and *Alcithoe arabica*); reported fish predators of scallops include snapper (*Pagrus auratus*), tarakihi (*Nemadactylus macropterus*) and blue cod (*Parapercis colias*), and suspected fish predators include eagle rays (*Myliobatis tenuicaudatus*) and stingrays (*Dasyatis* sp.) (Morton & Miller 1968, Bull 1976, Morrison 1998, Nesbit 1999). Predation varies with scallop size, with small scallops being generally more susceptible to a larger range of predators.

5.2 Incidental catch (fish and invertebrates)

A range of non-target fish and invertebrate species are caught and discarded by dredge fisheries for *P. novaezelandiae* scallops. No data are available on the level or effect of this incidental catch (bycatch) and discarding by the fisheries. Bycatch data are available, however, from various dredge surveys of the scallop stocks, and the bycatch of the fisheries is likely to be similar to that of the survey tows conducted in areas that support commercial fishing.

Species or groups that have been caught as incidental catch in the box dredges and ring-bag dredges used in surveys of commercial scallop (*P. novaezelandiae*) fishery areas in New Zealand are shown in Table 4. Catch composition varies among the different fishery locations and through time.

In the Coromandel scallop stock (SCA CS), a photographic approach was used in the 2006 dredge survey to provisionally examine bycatch groups (Tuck et al. 2006), but a more quantitative and comprehensive study was conducted using bycatch data collected in the 2009 dredge survey (Williams et al. 2010), with survey catches quantified by volume of different component categories. Over the whole 2009 survey, scallops formed the largest live component of the total catch volume (26%), followed by assorted seaweed (11%), starfish (4%), other live bivalves (4%), coralline turfing algae (1%) and other live components not exceeding 0.5%. Dead shell (identifiable and hash) formed the largest overall component (45%), and rock, sand and gravel formed 8%. Categories considered to be sensitive to dredging were caught relatively rarely. Data on the bycatch of the 2010 and 2012 surveys of SCA CS were also collected but not analysed; those data have been loaded to the MPI database 'scallop' for potential future analysis (Williams & Parkinson 2010, Williams et al. 2013b).

In the Northland scallop stock (SCA 1), analysis of historical survey bycatch from a localised deep area within Spirits Bay showed an unusually high abundance and species richness of sponges (Cryer et al. 2000), and led to the voluntary and subsequent regulated closure of that area to commercial fishing.

In the Southern scallop stock (SCA 7), data on the bycatch of the 1994–2013 surveys have been collected but not analysed, except for preliminary estimation of the 1998–2013 bycatch trajectories (Williams et al. 2013a).

Table 4: Species or groups categorised by bycatch type caught as incidental catch in dredge surveys of commercial scallop (*P. novaezelandiae*) fishery areas in New Zealand.

Type	Species or groups
Habitat formers	sponges, tubeworms, coralline algae (turf, maerl), bryozoa
Starfish	*Astropecten*, *Coscinasterias*, *Luidia*, *Patiriella*
Bivalves	dog cockles, horse mussels, oysters, green-lipped mussels, *Tawera*
Other invertebrates	anemones, crabs, gastropods, polychaetes, octopus, rock lobster
Fish	gobie, gurnard, John dory, lemon sole, pufferfish, red cod, sand eel, snake eel, stargazer, yellowbelly flounder
Seaweed	*Ecklonia,* other brown algae, green algae, red algae
Shell	whole shells, shell hash
Substrate	mud, sand, gravel, rock
Other	rubbish

5.3 Incidental catch (seabirds, mammals and protected fish)

There is no known bycatch of seabirds, mammals or protected fish species from *P. novaezelandiae* scallop fisheries.

5.4 Benthic interactions

It is well known that fishing with mobile bottom contact gears such as dredges has impacts on benthic populations, communities and their habitats (e.g., Kaiser et al. 2006, Rice 2006). The effects are not uniform, but depend on at least: 'the specific features of the seafloor habitats, including the natural disturbance regime, the species present, the type of gear used, the methods and timing of deployment of the gear and the frequency with which a site is impacted by specific gears; and the history of human activities, especially past fishing, in the area of concern' (Department of Fisheries and Oceans 2006). The effects of scallop dredging on the benthos are relatively well studied, and include several New Zealand studies carried out in areas of the northern fisheries (SCA 1 and SCA CS) (Thrush et al. 1995, Thrush et al. 1998, Cryer et al. 2000, Tuck et al. 2009, Tuck & Hewitt 2012) and the Golden/Tasman Bays region of the southern fishery (SCA 7) (Tuck et al. 2017). The results of these studies are summarised in the Aquatic Environment and Biodiversity Annual Review (Ministry for Primary Industries 2016), and are consistent with the global literature: generally, with increasing fishing intensity there are decreases in the density and diversity of benthic communities and, especially, the density of emergent epifauna that provide structured habitat for other fauna.

5.5 Other considerations

5.5.1 Spawning disruption

Scallop spawning occurs mainly during spring and summer (Bull 1976, Williams & Babcock 2004). Scallop fishing also occurs during these seasons, and is particularly targeted in areas with scallops in good condition (reproductively mature adults ready to spawn). Fishing also concentrates on high density beds of scallops, which are disproportionately more important for fertilisation success during spawning (Williams 2005). Fishing may therefore disrupt spawning by physically disturbing scallops that are either caught and retained (removal), caught and released, not caught but directly contacted by the dredge, or not caught but indirectly affected by the effects of dredging (e.g., suspended sediments).

5.5.2 Habitat of particular significance to fisheries management

Habitat of particular significance for fisheries management (HPSFM) does not have a policy definition (Ministry for Primary Industries 2016) although work is currently underway to define one. Certain features of the habitats with which scallops are associated are known to influence scallop productivity by affecting the recruitment, growth and mortality of scallops, and therefore may in the future be useful in terms of identifying HPSFM. Scallop larval settlement requires the presence of fine filamentous emergent epifauna on the seabed, such as tubeworms, hydroids and filamentous algae, hence the successful use of synthetic mesh spat bags held in the water column as a method for collecting scallop spat. Survival of juveniles has been shown to vary with habitat complexity, being greater in more complex habitats (with more emergent epifauna) than in more homogeneous areas (Talman et al. 2004). The availability of suspended microalgae and detritus affects growth and condition (Macdonald et al. 2006). Suspended sediments can reduce rates of respiration and growth, the latter by 'diluting' the food available. Scallops regulate ingestion by reducing clearance rates rather than increasing pseudofaeces production. Laboratory studies have demonstrated that suspended sediments disrupt feeding, decrease growth and increase mortality in scallops (Stevens 1987, Cranford and Gordon 1992, Nicholls et al. 2003).

6. STATUS OF THE STOCKS

The status of scallop stocks SCA 1, SCA CS and SCA 7 are given in the relevant Working Group reports.

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