The Ecology of Poole Harbour
John Humphreys and Vincent May (editors)

13. The Manila Clam in Poole Harbour

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The Manila Clam *Tapes philippinarum* was introduced to Poole Harbour in 1989 as a novel species for aquaculture. Contrary to expectations this species has become naturalized in the harbour, probably the northernmost location in Europe for this to occur. The chapter discusses possible reasons why this should have happened. The naturalized clam is now fished extensively in the western part of the harbour and preliminary data suggest that the pump-scoop method of fishing does not increase the degree of infaunal community disturbance (as measured by an ABC plot), but may have some effect on the sediment character.

Introduction

The Manila Clam *Tapes philippinarum* (Adams and Reeve 1850) is a sediment dwelling, bivalve mollusc of the family Veneridae. It is indigenous to western Pacific coastal seas (Goulletquer, 1997) and has over the years generated a good deal of taxonomic confusion. Consequently its scientific name has been volatile. It has at one time or another been located in seven different genera. Synonyms include *Tapes semidecussatus, Ruditapes philippinarum, Venerupis semidecussatus, Venerupis phillipinarum* and *Venerupis semidecussata* (Howson and Picton, 1997), among the 30 binomials used since 1791. Common names include the Littleneck Clam and the Japanese Palourde. The closest taxonomically related species native to UK waters is the Palourde or Carpet Shell *Tapes decussatus* (Canapa *et al*., 1996), generically these two species are very different (Passamonti *et al*., 1997).

Tapes philippinarum lives in fine sediments in the intertidal and upper sub-littoral zones. Relatively short inhalant and exhalent siphons are fused along much of their length – a feature, which in the UK distinguishes the Manila Clam from its indigenous taxonomic relative. It is commonly found 3–5 cm below the mud surface. The adult Manila Clam is tolerant of salinities down to 15 and the species distribution consequently extends into estuaries.

In the twentieth century, the distribution of the Manila Clam has been extended beyond its native coasts by human agency, occasionally inadvertently, but usually commercially motivated as the clam has considerable economic significance in terms of both fisheries and aquaculture (clam farming). Initial introductions were from Japan, the first in the 1920s to the Hawaiian Islands (Yap, 1977). In the 1930s, Manila Clams were accidentally introduced to the Pacific coast of North America (Quayle, 1964), mixed in with Pacific Oyster seed. They now range from California to Northern British Columbia (Magoon and Vining, 1981), being one of the principal commercially harvested clam species in Washington State. In the 1960s, they were imported to France for cultivation on both the Mediterranean and Atlantic coasts (Flassch and Leborgne, 1992). They have also been imported to Tahiti, the Adriatic coast of Italy, Germany and Spain. Since 1982, they have been cultivated in Ireland (Quishi Xie and Burnell, 1994).

The farming of clams commonly involves the laying of juvenile 'spat' under netting on an otherwise natural coastal or estuarine mudflat. Since spat can be grown and supplied commercially from hatcheries, successful clam farming can be achieved outside the range at which a natural breeding population can establish. Consequently, despite the presence of successful clam aquaculture enterprises in northern European waters, the capacity of the species to naturalize in the UK remains to be finally elucidated. Whilst Manila Clams have been found to mature and spawn in natural conditions in south-western Ireland (Qiushi Xie and Burnell, 1994), there does not appear to be a naturalized population in Ireland. In contrast Robert *et al.* (1993) reported on the growth, reproduction and gross biochemical composition of a naturalized Manila Clam population in the Bay of Arcachon, France. The first occurrence of a naturalized population in the UK has since been reported from Poole Harbour (Jensen *et al*., 2004).

Naturalization in Poole Harbour

In 1980, the clam was introduced into the UK by the Ministry of Agriculture, Fisheries and Food (MAFF) in order to investigate the economic potential of the species in the UK. Whilst field trials demonstrated good potential, by 1992, the commercial production of the clam was still less than 50 tonnes per year. The slow growth of the industry was attributed in part to the activities of conservation groups including English Nature (the statutory nature conservation agency for England) who were concerned that the Manila Clam might naturalize and displace indigenous species (Utting, 1995). At that time, it was thought in MAFF that clams could not reproduce successfully in UK waters (Laing and Utting, 1994). Despite some evidence to this effect, conservation groups remained unconvinced and in this context MAFF initiated a programme of research at Conway to produce sterile triploid clams for farming.

Triploidy can be induced in bivalves by chemical or physical (heat or pressure) interventions during meiosis. The anticipated effect was sterility and improved meat production as a consequence of reduced resource-expensive gonad activity, as had earlier been reported for oysters. In the event, whilst triploid clams demonstrated reduced fecundity, sterilization was not reliably achieved.

In the context of this and other research programmes, MAFF conducted field trials at a number of locations including the Menai Straits in Wales, the estuary of the River Exe in Devon, and in Poole Harbour (Spencer *et al*., 1996; Shpigel and Spencer 1996). The Manila Clam was introduced to Poole Harbour in 1988 by Othneil Shellfisheries following MAFF trials. By 1994, local fishers were exploiting the species, although it was not clear initially whether the clam had naturalized outside the aquaculture beds or if the spat fall was dependent on hatchery reared stock. It is now clear that both the stock on the aquaculture beds and in other areas of the harbour reproduce annually (Grisley, 2003).

The intertidal distribution of the clam in Poole Harbour was established in late 2002, during a systematic survey of 80 sampling stations along with additional sites sampled as part of a fisheries study (Figure 1). The figure also shows the sites of the original MAFF trials and the current Othneil Shellfisheries operation. It is clear from this pattern of distribution along with other studies, that a naturalized population of clams has achieved widespread distribution within the harbour, including Wareham Channel, Lytchett and Holes Bays, from Arne Bay south-east to Brands Bay, and on the northern coast at Parkstone Bay.

The Poole Harbour Environment

The existence of a naturalized population in Poole Harbour raises questions about the harbour environment and its compatibility with the needs of the Manila Clam: what is it about the harbour that has enabled this alien species to get established? Is the harbour unique in some respect or might this species colonize other parts of the UK coastline? In the light of the clams' natural distribution in sub-tropical and low boreal latitudes, water temperature is an obvious factor to examine.

Commonly limits to distribution are determined by environmental constraints on reproduction and recruitment. The physiological and other challenges of reproductive and early growth processes are more sensitive to environmental circumstances than is the physiology of mature individuals. It is well established that temperature is one of the most important environmental factors that influence reproductive activity in molluscs. Key processes in this respect are gametogenesis, spawning and larval growth. In the Manila Clam there is evidence that while gonad activity is possible down to 8 ˚C, the maturation of gametes does not occur below 12 ˚C. Spawning and larval growth requires temperatures of 14 ˚C while the growth of metamorphosed juveniles can occur at 10 ˚C. (Laing *et al*., 1987; Laing and Utting, 1994).

Thus in UK waters, the processes of gamete production, spawning and larval growth are vulnerable. Since these are consecutive processes, a sustained period of higher temperatures is needed to achieve recruitment of viable Year 0 individuals to the population, and even if minimum limits are reached, the rate of these processes may be retarded. There is evidence that in North Wales, water temperature slows gametogenesis

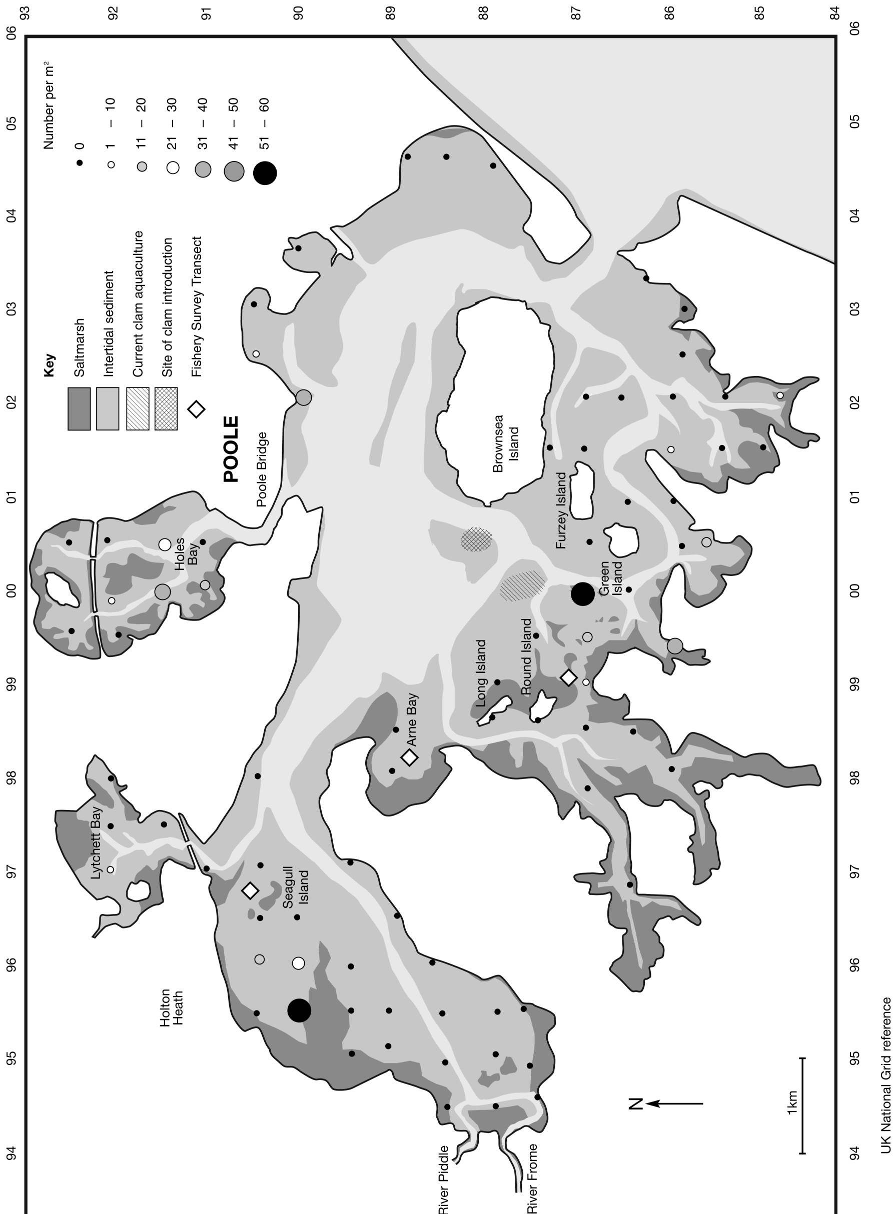

Figure 1 Distribution of the Manila Clam in 2002 survey.

with the consequence that spawning, even if it happens, is delayed to late summer, when larvae are unlikely to survive (Millican and Williams, 1985). The absence of reported naturalization at sites of field trials other than Poole Harbour, including the Exe estuary in Devon and in Ireland, suggests a similar explanation. Temperature data from areas of Poole Harbour (Grisley, 2003) with an intertidal population of Manila Clams combined with histological analysis of gonads shows that the temperature regime allowed ripe gametes to develop and spawning to start in June/July in 2000 and 2001. The successful survival and growth of the larvae is self evident from the success of the fishery and the presence of juvenile clams in benthic and fishery surveys within the harbour.

That the Manila Clam has naturalized in Poole Harbour may be related to features of the harbour that make it distinct from most other UK estuaries and sheltered coastal locations. The harbour is shallow, with small tidal range and, due to the narrow entrance, has a low flushing rate. This means that temperatures are not moderated much by exchange of water with the open sea. This along with its south coast location makes the harbour in summer probably amongst the warmest substantial bodies of seawater around the UK.

If we are correct in our hypothesis that the ability of the clam to naturalize in Poole Harbour is linked to the distinctive nature of the harbour environment, then we would not expect the species to proliferate extensively on the UK coast. It remains possible, however, that certain somewhat similar UK harbour environments may in due course be colonized.

Clam fishing in the harbour

The presence of a naturalized clam population in the harbour attracted the attention of Poole fishermen and by 1994, a licensed (by the Southern Sea Fishery Committee (SSFC)) fishery had become established. The fishery for clams is focused on the intertidal mudflats of the western part of the harbour and (following a SSFC restriction on hand picking in Poole Harbour to avoid disturbance to feeding birds at low tide after concerns expressed by English Nature and RSPB) is undertaken from boats working during daylight high tides during late October, November, December and early January. Clam harvesting was initially achieved by the use of a ‘clam scoop’ – a toothed mesh basket open at one end with a long (*c*. 2.5 m) handle (Figure 2). The scoop is pushed into the sediment and pulled along by the forward motion of the boat. Sediment is removed from the scoop by an up and down motion on the handle as the scoop passes through the sediment. This is hard physical work and naturally fishers looked at ways to improve catch efficiency with less physical effort. Over a number of years the current ‘pump-scoop’ was developed (Figure 3), the major difference being that a spray of water (from an engine-powered pump) is placed at the mouth of the scoop which washes sediment out of the basket, so removing the need for the manual up and down motion on the scoop handle. This is a system almost unique to Poole Harbour and should not be confused with suction or hydraulic dredging techniques which differ in that they both fluidize the sediment by inserting water into the sediment immediately in front of the suction device or dredge. A variation of this technique was developed to work within the harbour with cockle dredges.

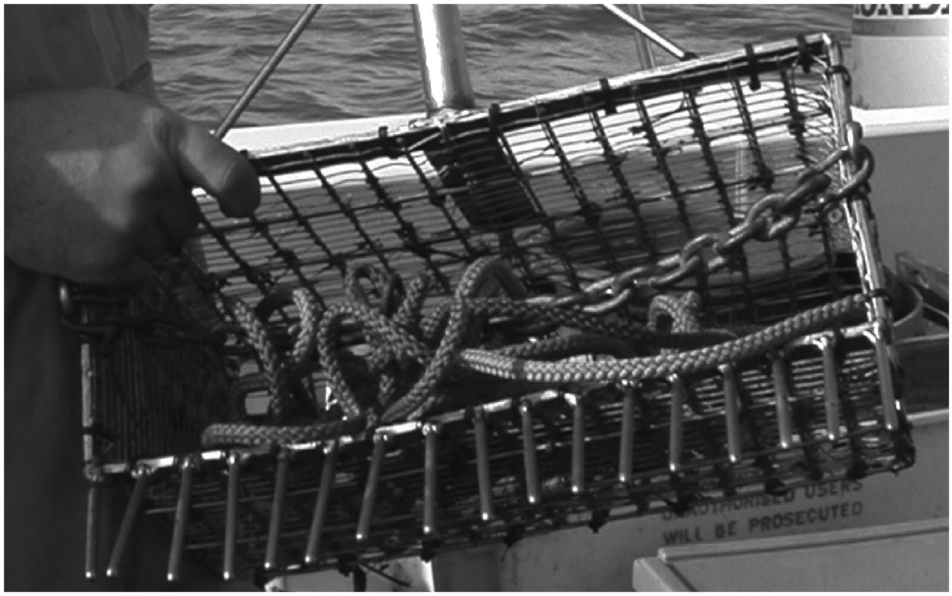

Figure 2 A Poole Harbour clam scoop. This scoop has been modified with a finer internal mesh to retain smaller clams than taken commercially to facilitate scientific survey work.

Figure 3 A Poole Harbour clam pump-scoop. Note how the water jets enter the front of the scoop and wash the sediment out of the basket.

Potential impact of pump-scoop fishing in the harbour

Concerns were expressed by environmental groups, predominantly English Nature and RSPB, that the pump-scoop fishing technique may be: (i) disturbing roosting birds by creating significant noise; and (ii) impacting on the amount and type of intertidal infauna (mostly marine worms and bivalves) available for overwintering birds. Whilst (i) could be dealt with by noise abatement orders, (ii) required some further research to quantify the impact of the pump-scoop fishing technique in the harbour. The impact of cockle fishing with a pump-dredge is considered elsewhere in this volume (see chapter 17), some preliminary results relating to the clam pump-scoop fishery in 2001/02 are described below (Cesar, 2003).

Three replicate 0.06 m^2 sediment samples were taken from 13 sites in Poole Harbour before and after the clam fishing season in 2002/03 (and a 14 sample site survey has been completed for 2003/04). The 2002/03 samples were sieved on a 1 mm sieve and preserved in 4% formalin. Separate samples were taken to establish sediment granulometry. Data from four sites have been analysed to date (February 2004) and data from a single site (Seagull Island) that experienced 'high' fishing pressure (as designated by district fishery officers) is shown here as an example. Preserved infaunal samples were sorted, identified and counted and these data were analysed using the multivariate analysis package PRIMER (Plymouth Routines In Multivariate Ecological Research) (Clarke and Warwick, 1994). To establish dry weight data, animals were grouped by taxonomic family and dried at 60 ºC for 24 hours. Biomass and abundance were then compared using the Dominance plot program in PRIMER (Clarke and Warwick, 1994), which generates abundance-biomass comparison plots and allows a qualitative (W statistic) and quantitative estimation of biological community disturbance (if abundance plots out above biomass the community is dominated by short-lived species and is likely to be disturbed, if biomass plots out above abundance the community is dominated by long-lived species and is unlikely to be in a disturbed state). Sediments were wet sieved to separate fine sediments (<63 mm) from coarse (>63 mm). Coarse sediments were then dry sieved and fine sediments analysed using a calibrated LS130 Coulter counter. It was expected that if sediment granulometry altered during the fishing season, the fine sediments would show most change.

Abundance-Biomass Comparison (ABC) plots for Seagull Island (Figure 4) show the infaunal community to have a qualitatively similar level of disturbance before and after the pump-scoop fishing season. The W statistic values generated by this method (18 species and average W value of 0.325 before fishing, 15 species and average W value of 0.297 after fishing at Seagull Island) for all four sites that were sampled before and after fishing were tested statistically by Analysis of Variance (ANOVA) and found not to be statistically different (F = 0.348, a = 0.05) (Cesar, 2003).

Fine sediment (<63 mm) granulometry (Figure 5) also shows some quantitative change in the period between sampling at Seagull Island but when sediment samples from all four sites were subjected to a χ^2 test, no significant difference was seen at the 5%

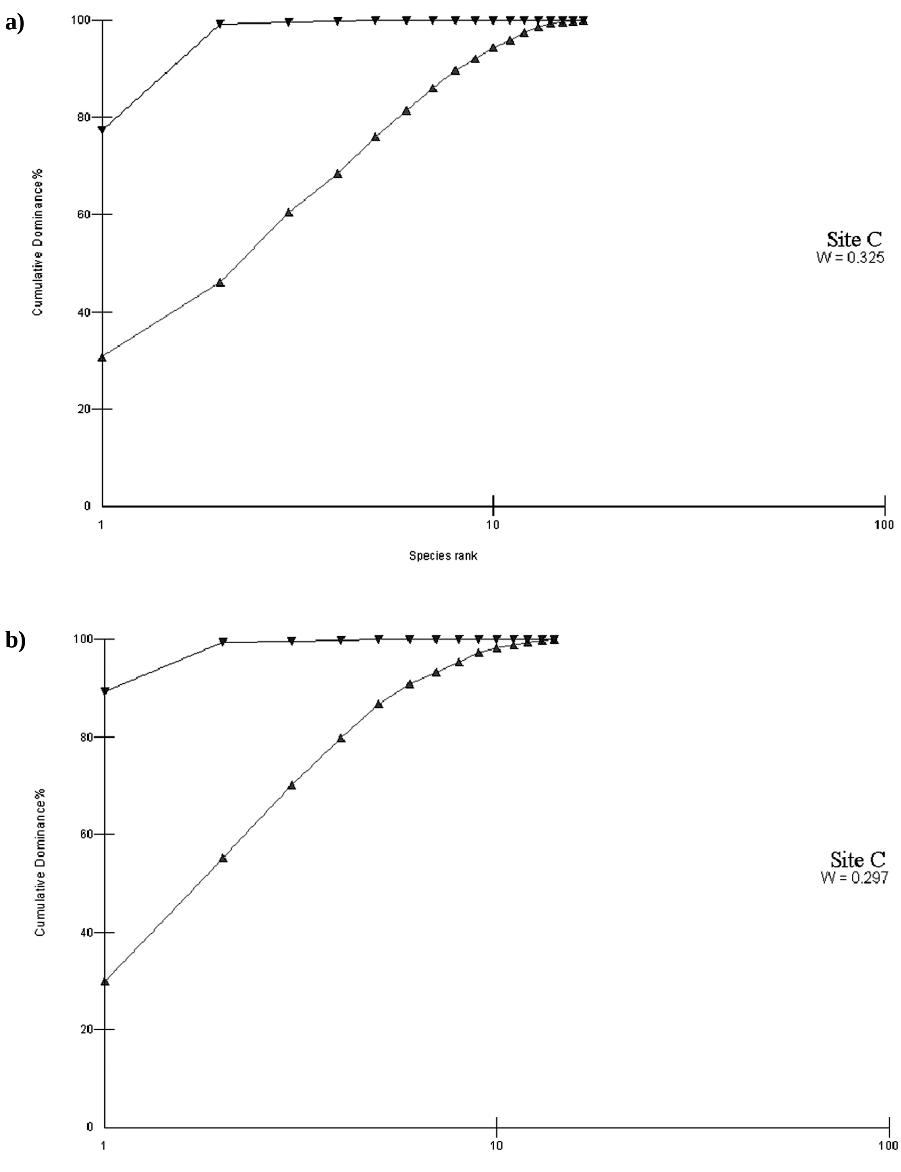

Figure 4 Abundance-Biomass Comparison (ABC) plots for Seagull Island before (a) and after (b) the 2001/02 fishing season: ▲ = abundance, ▼ = biomass (Cesar, 2003).

significance level between before and after fishing season granulometry (Cesar, 2003). Data such as the ABC plots and fine sediment comparisons allow some assessment to be made of the changes happening in the harbour over time. It would seem that some qualitative changes had occurred to sediments at Seagull Island but these were much less

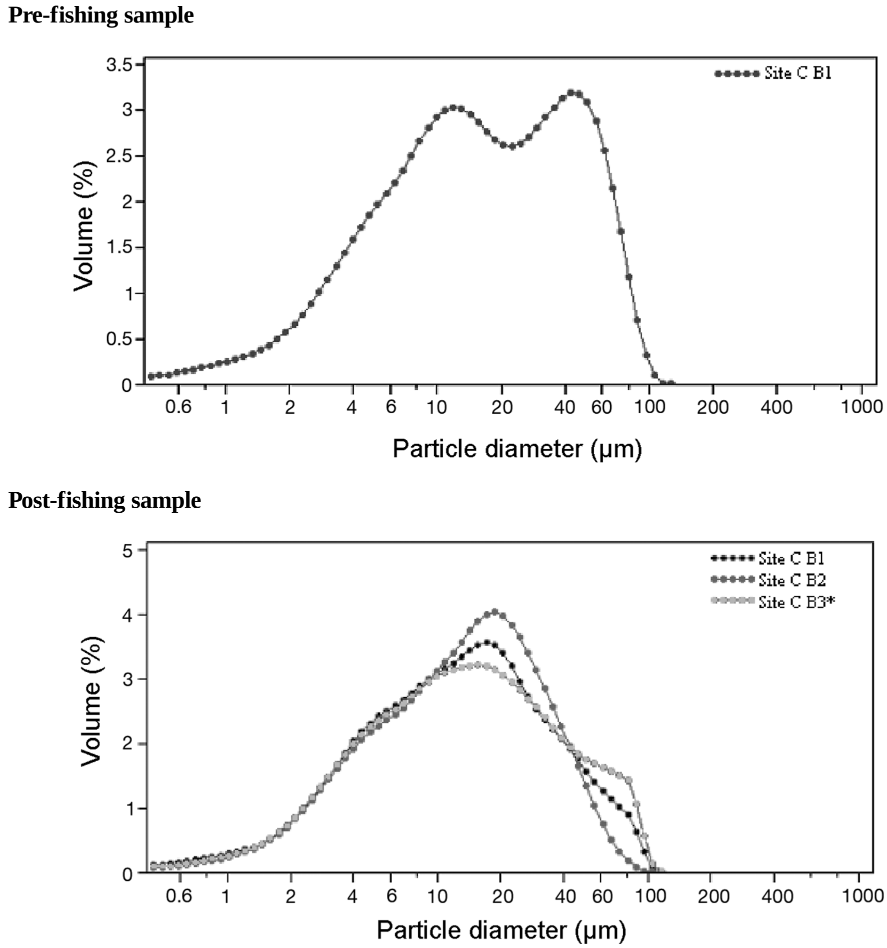

Figure 5 Fine sediment granulometry before and after the 2001/02 fishing season at Seagull Island. Note replicate samples were not taken for this site pre-season.

at the other three sites surveyed. Conclusions drawn from these preliminary data must be tentative but it would seem that there was no significant additional disturbance to the infaunal community, as measured by ABC plots, before and after the 2002/03 fishery season in the four sites sampled. However, whilst not statistically significant, there was a suggestion at one site in particular (Seagull Island), that some changes in the sediment granulometry had occurred between the dates sampled. The remainder of the samples for 2002/03 and 2003/04 now need to be analysed to provide a clearer assessment of what alterations, if any, are occurring in the harbour areas subject to pump-scoop fishing activity.

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