Ecological impacts of shellfish dredging on coastal soft-sediment communities

Simon Thrush, Vonda Cummings and Judi Hewitt

MARINE FISHING is one of New Zealand's major industries, and an important recreational activity. Fisheries are sustained by natural productivity, yet very little is known about how fishing and marine ecosystems interact. Unlike other human influences on the marine environment, fishing occurs throughout New Zealand's Exclusive Economic Zone from deep to near-shore waters. There is therefore potential for effects on marine ecosystems to be extensive.

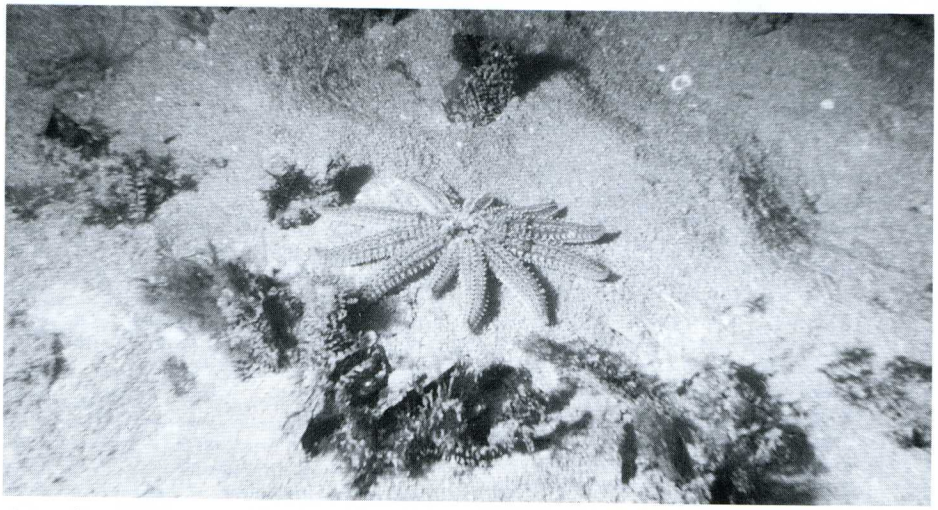
The issue of adverse environmental impacts of fishing is important for both conservation and the fishing industry, because commercially exploited species are integral components of natural systems. This means that understanding these impacts could have positive benefits for the fishing industry, in terms of management and sustainability.

Study of scallop dredging

NIWA recently completed a 3-year study, commissioned by the Department of Conservation, to investigate the impact of scallop dredging on the structure of marine soft-sediment communities. Two sites in the Mercury Bay area of the Coromandel Peninsula were chosen for experimental dredging. One was located in the centre of Opito Bay, an area regularly used by commercial scallop fishers. The other was situated at Cathedral Cove, Hahei (now a marine reserve). Both sites were on bare sandflats at about 24 m depth. These habitats can seem quite barren places but they actually contain a large number and wide variety of animals which play important roles in ecosystem functioning. In this study we collected over 200 different types of sediment-dwelling animals.

We used various techniques to sample these seafloor communities: visual observations (diving), cores (the best way to sample such areas), and a suction dredge (to collect larger animals). Initial sampling of each site revealed no pre-experiment differences in the densities of animals within sites, but considerable differences in the communities between sites. Small crustaceans were common at Hahei, while polychaete worms were common at Opito Bay.

The experiment commenced in autumn by dredging half of each site with a commercial scallop dredge. Samples were collected from both the dredged half and reference (undredged) half of each site as soon as possible after dredging and again three months later.



An undisturbed, coastal soft-sediment community.

Impacts of dredging

Similar effects were immediately apparent at both sites. The dredge had smoothed over the natural sediment surface and partially exposed animal burrows. As these animals are usually buried in the sediment, this could expose them to higher levels of predation. At both sites, scavenging snails were highly active. Starfish were also active, although many were torn to pieces by the dredge.

Because the animal communities at the two sites were different, we carried out separate analyses on the changes in density of common animals and community structure. At both sites, eight of the 14 common animals were affected by dredging immediately and/or three months later. In general, the dredged plots had lower densities of animals. In core samples from Hahei, dredging reduced the variety of animals immediately and the total number of individuals was still lower in the dredged plot after 3 months. At Opito Bay, both the variety and total number of animals were still lower in the dredged plot three months after dredging. For the larger animals collected in suction dredge samples, a greater number and a larger variety were found in the dredged plot both times at Hahei. At Opito Bay, only the variety of larger animals increased with dredging. These effects were a result of large mobile scavengers/-predators being attracted to the disturbed plots.

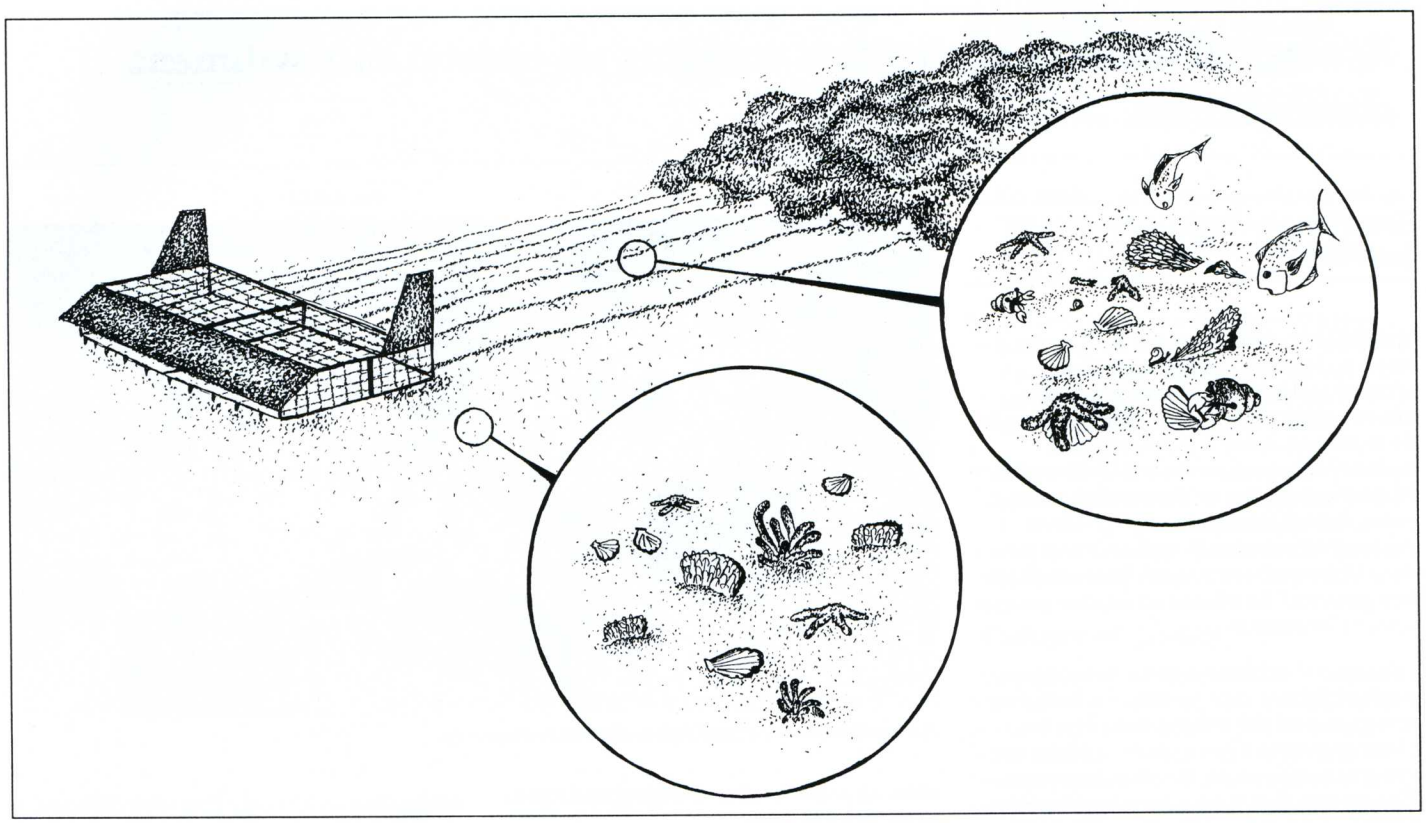
Survey of dredged sites

To complement the dredging experiment, larger-scale surveys were conducted of other sites in Mercury Bay with different dredging histories. Sites which had not been commercially dredged had a higher variety and number of surface dwelling animals (e.g., sponges) and a greater diversity of surface sediment features. Tremendous variation was evident in the composition of the seafloor communities, e.g., the common animals at each site were mostly different. This variation among sites in a small length of coastline with basically similar sandy bottom habitats emphasises the diversity of these coastal seafloor communities. Despite this variation, two animals (a cumacean and a shellfish) which showed increased densities with dredging in the experiment, were also higher in the commercially dredged survey sites.

Ecological effects of dredging

This study was designed to assess a once-only dredging effect on seafloor communities in sandy habitats. It thus concentrated on the effects on the mostly hidden residents of marine sediments. These animals are very important in soft-bottom marine systems. They influence the movement of chemicals between sediments and water. They stabilise the seafloor, making the habitat suitable for other species. They also provide food for many larger bottom-dwelling animals, such as octopus, starfish and fish. Repeat dredging of the same patch of seafloor, which commonly occurs in commercial dredging operations, must result in much more disturbance than observed in our experiment. Habitats with more obvious residents, such as reef or garden-forming animals, may be expected to show even greater effects.

Our results highlight the damage or death of non-target organisms caused by one



Artist's impression summarising the immediate effects of dredging. In dredged areas, fine sediments are resuspended and sediment composition modified; damaged or partially excavated animals are attacked by scavenging invertebrates and fish. **(Drawing: Vonda Cummings)**

fishing method (scallop dredging) in one area. While different communities in different habitats can be expected to respond differently to habitat disturbance by fishing, in general fishing gear which removes surface-dwelling organisms, modifies sediment topography. When used over large areas it is likely to result in reduced diversity in seafloor communities. Communities subjected to repeated disturbance are likely to become dominated by juvenile stages, mobile, rapid colonists and quick-growing species.

A broad, ecosystem-wide perspective of fisheries issues is necessary in order to achieve well-managed, sustainable exploitation of natural fisheries. It is likely that this can be achieved in harmony with objectives set for the conservation of marine ecosystems. Our results were used to make recommendations minimising the negative side-effects of dredging, ranging from development of fishing gear and practices which create less disturbance to creation of Marine Protected Areas in coastal soft-sediment habitats. ■

Simon Thrush, Vonda Cummings and Judi Hewitt are all science staff with NIWA, at Hamilton.

New benthic ecologist at NIWA, Hamilton

DR STEPHANIE TURNER, a benthic ecologist, recently joined NIWA at Hamilton. Stephanie has spent the past four years working as a marine scientist with the Department of Conservation and Land Management in Western Australia. Her research in Western Australia focused on the early life history of *Drupella cornus*, a marine gastropod that has been responsible for extensive coral mortality on several Indo-Pacific reefs. She has undertaken extensive studies of the larval biology of *Drupella*, both under laboratory conditions and in the field. Most recently she has been involved with a project to document the temporal and spatial variability associated with the recruitment of *Drupella* into areas of reef differing in their previous history of *Drupella* predation, with a view to establishing a long-term prognosis for the recovery of the reef.

Before moving to Australia, Stephanie undertook her PhD studies in marine ecology at the University of St Andrews in Scotland. Through this research she was involved with work examining the community dynamics of intertidal and sublittoral epifaunal assemblages. She was particularly interested in larval recruitment, the influence of herbivorous grazers on developing assemblages, and the significance of competition for space among encrusting bryozoans in structuring these assemblages. Some of her work will be an extension of this work, using epifaunal communities to assess the cumulative effects of marina operations.

She will also be involved with work on soft sediment communities, including an assessment of the feasibility of the restoration of impoverished shellfish beds. She is also hoping to become involved with further coral reef projects in the Pacific.