

MARINE BIOLOGICAL RESOURCE DATA AS AN AID TO OIL EXPLORATION IMPACT ASSESSMENT

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Biological samples taken from the sea floor across the entire New Zealand continental shelf are housed at the N.Z. Oceanographic Institute collections. Appropriate analysis of these samples can provide a first-order appraisal of possible impacts of oil exploration without the need for expensive field investigations.

Data are presented from the Taranaki shelf as a case history to define the existing marine communities living on the sea floor and possible consequences should these communities be affected by exploratory drilling.

INTRODUCTION

The Taranaki shelf area has been extensively sampled for geological features of relevance to oil exploration, and charts of the surface sediments have been published by Doyle and Arron (1982) and Arron and Doyle (1983), and described by McDougall and Brodie (1971). In contrast, there is little known of the animal seafloor communities, other than those described by McKnight (1969, 1974), based mainly on the occurrence of dead bivalves.

McKnight (1969) recognised two communities; the *Scalpomactra scalpellum*/*Maorimactra ordinaria* community, and the *Nemocardium pulchellum*/*Pleuromeris zelandicus* community. Both are widespread around the New Zealand shelf over a range of sediment types from sand to mud, and in depths from 20 m to at least 200 m. The distribution of a few echinoderms were included in McKnight's (1974) description, but he considered none to be characteristic of, or restricted to, the area. These descriptions give an overall impression of some of the animals likely to occur within the area, but are not sufficient for an assessment of potential ecological effects of building structures, dumping material, or extracting resources from the Taranaki Shelf.

The New Zealand Oceanographic Institute (NZOI) holds large collections of biological material collected from over 8000 stations across the entire New Zealand continental shelf and slope which are an important resource for environmental assessment when analysed appropriately, and correlated with physical and geological parameters.

This paper is not intended to describe the biological communities of the seafloor across the Taranaki shelf in detail. It is an attempt to analyse existing biological samples in such a way that the species' associations present in the area which may be vulnerable to environmental disturbance by extractive activities can be recognised. It does, however, also present the first description of the biological communities on the continental shelf of the North Island using all species, not just selected groups.

METHODS

A total of 29 stations collected from the continental shelf off Taranaki (Fig. 1) in depths between 21 m and 253 m were analysed by sorting and identifying all species and counting the numbers of individuals of each present. Various statistics, including the Shannon-Weaver species diversity index (Shannon and Weaver, 1963), Pielou evenness (Pielou, 1966), and Margalef species richness (Margalef, 1958) were calculated to enable trends with depth or sediment type to be recognised.

To reduce the data into a manageable unit, all stations were clustered using the multivariate technique of group-average sorting, based on the similarity between every pair of stations, calculated with the Czekanowski coefficient (Lance and Williams, 1967). The output was produced as a dendrogram which grouped stations with similar numbers and types of species.

The biological significance of the station groups produced by the dendrogram was determined by calculating a community score value for every species in every group (Grange, 1979, 1989). This allowed an objective ranking of all species occurring in each dendrogram group by combining each species' abundance within, and fidelity to, the group, and its distribution across the entire data set.

RESULTS

The 29 stations produced a total of 155 species, but some, such as the polychaete worms, were unidentifiable in some stations due to poor preservation, and some species were very rare, occurring at only one station, so these were omitted from subsequent analysis. The data set that was used, then, consisted of 91 species and 4576 individuals from 29 stations.

Cluster analysis produced a dendrogram with four station groups and three stations not apparently closely related to any others (B785, C293, C380) (Fig. 2). The depths and

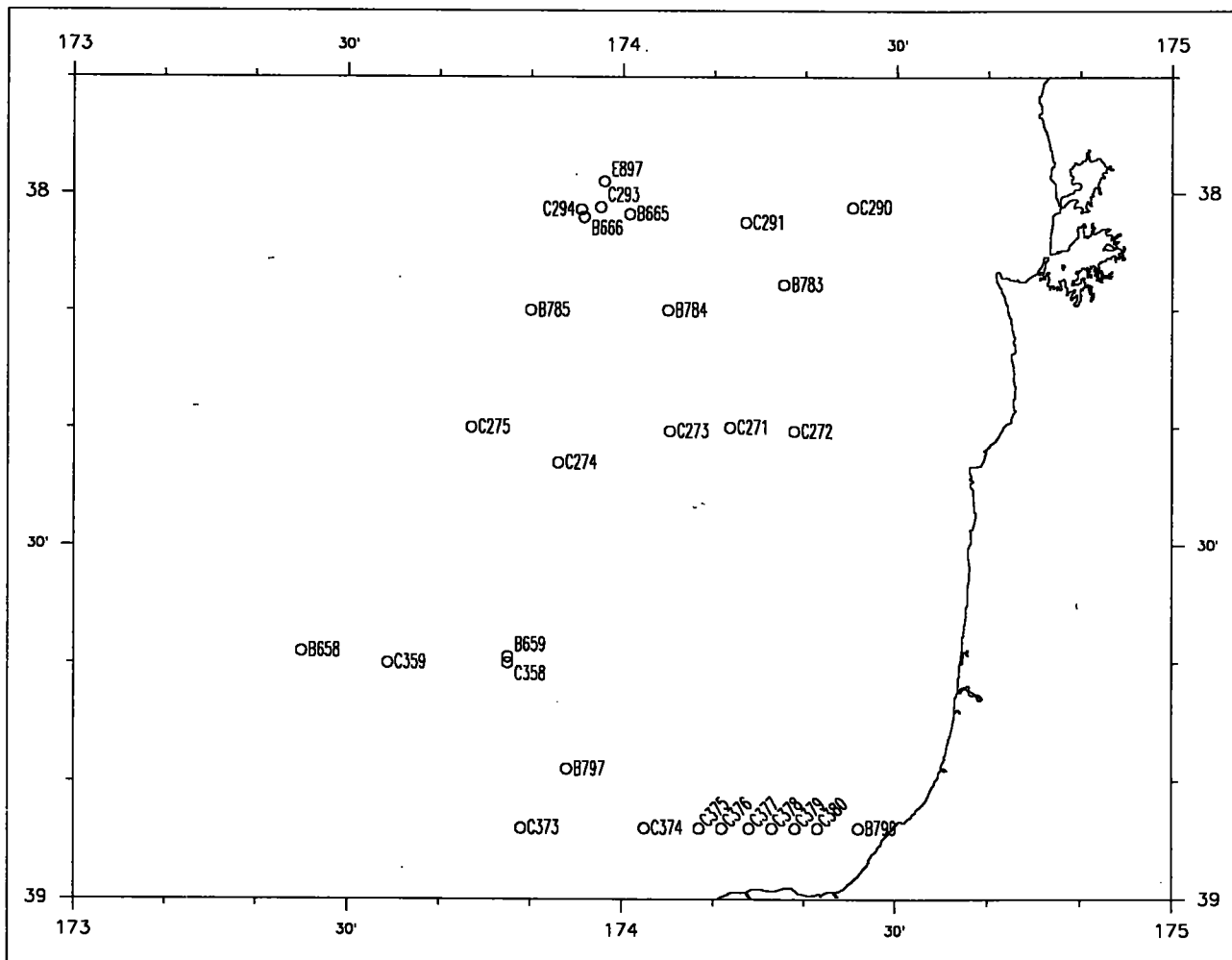


Fig. 1: New Zealand Oceanographic Institute biological stations analysed for biological communities, Taranaki shelf.

biological attributes of each station in each of these groups show that group 4 occurs in shallower water than groups 1, 2, and 3; and that group 1 contains the greatest mean number of species and individuals, is more diverse, and is higher in species richness (Table 1). Groups 2 and 3 are similar in depths and numbers of species and individuals, but group 2 has higher mean species diversity, caused by a more even spread of the individuals amongst the species, reflecting a general lack of dominance by any one species in the samples.

The relationship between the numbers of species and diversity, and the stations in each group is also shown in Fig. 3. This confirms the high diversity with low absolute numbers of species in groups 3 and 4, whereas group 2 generally contains more species, but lower diversity. Stations in group 1 clearly have greater numbers of species and are higher in diversity.

The groups may also be separated by sediment characteristics. Group 1 stations consist of fine silty sands, group 2 of medium sands, group 3 of silt, and group 4 stations have coarse sand sediments.

The community score analysis showed significant differences in species composition among the groups, with the dominant species in each group being quite distinct (Table 2). A total of 71 species were recorded from stations in group 1 and almost half of these were endemic, that is, they

were only collected at stations within this group. Group 1 was dominated almost entirely by burrowing bivalve shellfish, most of which were common at all stations, reflecting their widespread distributions. Group 2 stations contained 26 species, 23% of which were restricted to the group. The dominant species are surface-dwelling sedentary organisms such as the brachiopod and solitary coral, and slow-moving urchins that crawl over or just below the sediment surface. Group 3 stations contained 15 species, but very few were endemic, including all the dominant species. Most of the organisms are very slow moving, and bury just below the sediment surface, such as tusk shells, urchins and bivalves. The eight species recorded from group 4 were dominated by swiftly moving hermit crabs and other species that crawl actively on the sediment surface or just below. These species are capable of reburial if disturbed. Only one of the dominant species is endemic to this group.

The geographic distributions of these biological communities are shown in Fig. 4. Communities 1 and 2 (the *Scalpomectra/Nemocardium* and *Neothyris/Flabellum* communities) are aligned along the mid-shelf, approximately parallel to the coast. Community 3 (the *Dentalium/Peronella* community) is further offshore in deeper water, and community 4 (the *Paguristes/Pervicacia* community) occurs at the coastal stations in the southern component of the area.

	Station	Depth	Number of species	Number of individuals	Species diversity	Species evenness	Species richness
Group 1	B659	124	10	61	1.388	0.603	2.189
	C271	91	20	389	1.919	0.641	3.186
	C273	97	25	160	2.317	0.720	4.729
	C290	60	24	527	2.161	0.680	3.670
	C291	68	26	363	2.001	0.614	4.241
	C358	121	13	90	1.923	0.750	2.667
	C359	134	15	61	2.504	0.925	3.406
	C373	123	27	78	2.832	0.859	5.968
	C374	93	35	557	2.487	0.699	5.378
	C375	71	15	86	1.730	0.639	3.143
	C376	68	34	256	2.728	0.774	5.951
	C378	41	7	11	1.799	0.924	2.502
	E897	253	3	6	1.099	1.000	1.116
	C377	49	8	17	1.925	0.926	2.471
		mean	99	19	190	2.058	0.768
	s.d.	53	10	193	0.489	0.134	1.465
Group 2	B658	142	7	27	1.413	0.726	1.820
	B665	126	5	24	1.041	0.647	1.259
	B783	86	4	6	1.330	0.959	1.674
	B784	108	11	54	1.154	0.481	2.507
	B797	106	8	66	1.366	0.657	1.671
	C272	91	7	121	0.729	0.374	1.251
		mean	110	7	50	1.172	0.641
	s.d.	21	2	41	0.259	0.203	0.461
Group 3	C275	137	11	14	2.342	0.977	3.789
	C294	101	2	4	0.693	1.000	0.721
	B666	170	3	9	1.099	1.000	0.910
	C274	123	4	5	1.332	0.961	1.864
		mean	133	5	8	1.367	0.985
	s.d.	29	4	5	0.702	0.019	1.404
Group 4	C379	40	5	9	1.523	0.946	1.820
	B799	21	4	13	1.157	0.835	1.170
		mean	30	4	11	1.340	0.891
	s.d.	13	1	3	0.259	0.078	0.460

Table 1: Depth and biological attributes of stations, Taranaki shelf.

DISCUSSION

Analysis of existing NZOI stations across the Taranaki continental shelf has shown the existence of four biological communities, separated by depth and sediment characteristics as well as species composition. These communities are similar to those recognised by McKnight (1974) but since the present analysis is objective and includes all animal taxa in the samples, it can be used more successfully as an aid to assess the potential impacts of resource extraction (including oil exploration) in the area.

The potential impacts during oil exploration are generally not likely to be of major significance to seafloor animal communities. Most oil leakage will float to the sea surface, and drilling muds which can be released in sufficient volume to smother benthic species, are likely to affect only those organisms in the immediate vicinity. Physical disturbance of the seafloor and sediment during platform construction

or pipeline laying, however, have the potential to disrupt benthic communities and since these are an integral part of the food webs leading often to species of economic importance, such as fish, this may have serious ecological consequences. Some benthic communities are inherently more susceptible to environmental disturbance than others. Communities that contain a large number of rare species, or species with restricted distributions, will take longer to recover from disturbance since recruits are not readily available from adjacent, undisturbed, areas. Communities dominated by sedentary species that live on the sediment surface and cannot move often require stable substrate conditions and are vulnerable to sediment disturbance or increases in volumes of suspended sediment. Disruption to communities that include several species important as food for other organisms, or that are necessary for the survival of other organisms may have consequences beyond the boundaries of that community.

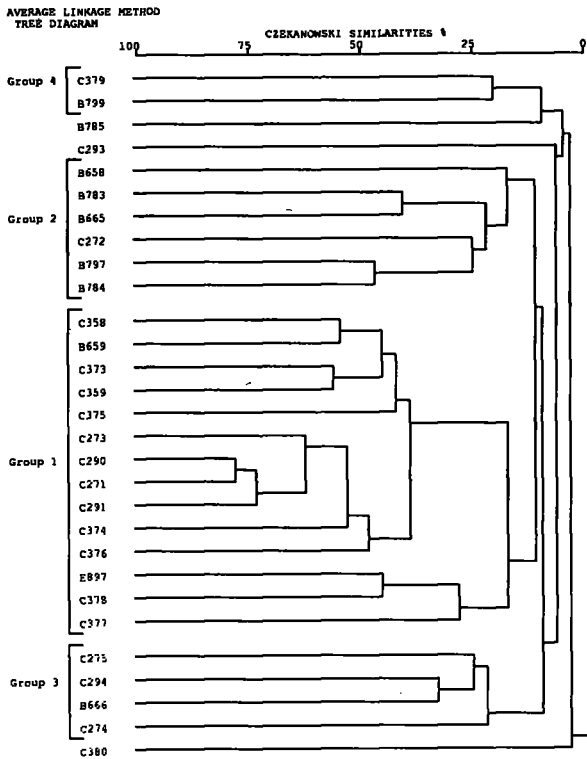


Fig. 2: Dendrogram of station groups produced by cluster analysis, Taranaki shelf.

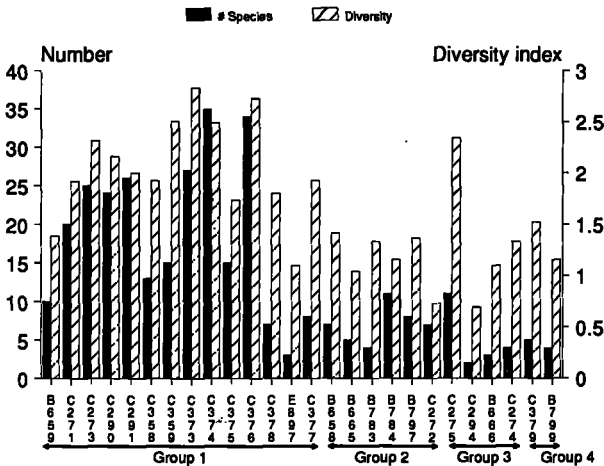


Fig. 3: Numbers of species and species diversity of each station in each group, Taranaki shelf.

The benthic communities on the Taranaki shelf can be ranked according to their ecological values, and hence vulnerability to environmental disturbance.

Group 1, the *Scalpomactra/Nemocardium* community

This contains 14 stations along the mid-shelf, mostly less than 100 m deep, on fine silty sands. They contain high biological diversity with 71 species recorded, 34 being endemic, including the dominant species. The species are dominated by burrowing bivalve shellfish, important as food for demersal fishes. This community has high ecological values, and is susceptible to environmental alteration.

Group 1: 71 species recorded altogether, 48% endemic

- Bivalvia
 - * *Scalpomactra scalpellum* (endemic)
 - * *Nemocardium pulchellum*
 - * *Notocallista multistriata* (endemic)
 - * *Pleuromeris zelandica*
 - * *Divaricella huttoniana*
 - * *Saccella bellula*
 - * *Chlamys gemmulata*
 - * *Nucula nitidula*
 - Hiatella arctica* (endemic)
 - Cuspidaria trailli* (endemic)
 - Tellina huttoni*

- Gastropoda
 - * *Austrofusus glans*
 - Zeacolpus delli*

Group 2: 26 species recorded altogether, 23% endemic

- Brachiopoda
 - * *Neothyris lenticularis*

- Scleractinia
 - Flabellum rubrum*

- Echinoidea
 - Fellaster zelandiae*
 - Peronella hinemoae*

Group 3: 15 species recorded altogether, 7% endemic.

- Scleractinia
 - * *Dentalium zelandicum*

- Echinoidea
 - Peronella hinemoae*

- Bivalvia
 - Myadora novaezelandiae*

Group 4: 8 species recorded altogether, 12% endemic

- Paguridea
 - Paguristes pilosus*

- Gastropoda
 - Pervicacia tristus* (endemic)
 - Struthiolaria papulosa*
 - Zegalerus tenuis*

- Bivalvia
 - Gari lineolata*
 - Tellina huttoni*

- Echinoidea
 - Echinocardium cordatum*

- Brachyura
 - Ebalia laevis*

*denotes the 10 most widespread species throughout all samples.

Table 2: Dominant species, those that occurred in more than 50% of all stations in each group, as produced by cluster analysis, Taranaki shelf.

Group 2, the *Neothyris/Flabellum* community

This contains six stations along the mid-shelf, mostly greater than 100 m deep, on medium sands, which contain low biological diversity, although 26 species were recorded, six of them endemics. The species are dominated by a brachiopod, a coral, and urchins not likely to be important as food for demersal fishes, but because they live on the sediment surface and are incapable of moving away from the smothering effects of suspended sediment, they are susceptible to sediment disturbance. This community has medium to high ecological values.

Group 3, the *Dentalium/Peronella* community

This contains four stations along the outer shelf, all greater than 100 m deep, on silt. The stations have relatively high

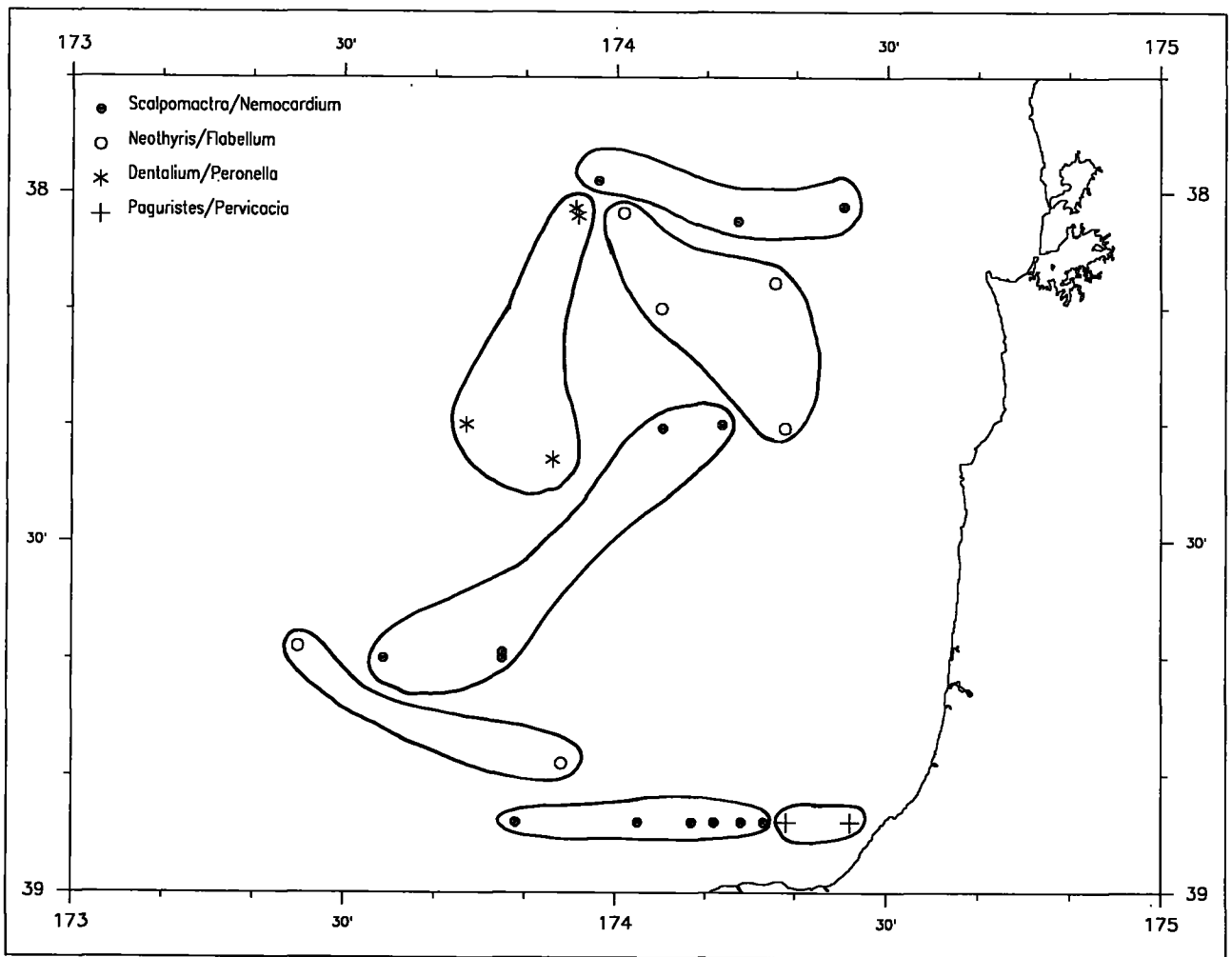


Fig. 4: Geographic distribution of biological communities, Taranaki shelf.

species diversity but contain low mean numbers of species. A total of 15 species was recorded, but only one was endemic. The species are dominated by a tusk shell, urchin, and bivalve, not likely to be important as food because they tend to remain buried in the sediment. This community has low ecological value, and recruitment could come from adjacent communities since few species are endemic.

Group 4, the *Paguristes/Pervicacia* community

This contains two coastal stations, both less than 40 m deep, on coarse sands. Biological diversity is high but the average number of species is low, with only eight species recorded, and only one of these endemic. The species are dominated by hermit crabs and snails adapted to unstable sediments, since they are capable of rapid movement if disturbed. Some of the species are important as food for demersal fishes. This community has low to medium ecological value, and is resilient to environmental disturbance since the sediments are continually and naturally moved by wave action.

In general, the benthic animal communities off the north Taranaki coast contain few rare species or unusual species assemblages. This may be a reflection of the gently sloping bathymetry and relatively uniform sediments. As such, oil exploration should not cause significant ecological disturbance but more detailed sampling would be required to define the precise boundaries between the communities should production drilling occur.

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