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Appendix 14

Biological and fishing data within the Minerals Prospecting Licence 50270 area within the Chatham Rise (Beaumont et al. 2013b)

Chatham | Rock Phosphate Ltd

Taihoro Nukurangi

Biological and commercial fishing data

within the Minerals Prospecting Licence 50270 area on the Chatham Rise

Prepared for Chatham Rock Phosphate Ltd

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Executive summary

The Chatham Rise is a submarine ridge extending eastwards from New Zealand into the southwest Pacific Ocean and sits within New Zealand's Exclusive Economic Zone. Elevated phytoplankton productivity in the region (as a result of the presence of the Subtropical Convergence) supports a rich benthic and pelagic ecosystem which in turn supports valuable deep water fisheries. In addition, the benthic ecosystem of the Chatham Rise is interesting in that there are very different biological communities on the northern and southern slopes.

The Chatham Rise phosphorite deposit is potentially an important economic marine mineral resource. These deposits occur as patchily distributed nodules in a matrix of glauconitic sandy mud. The layer of phosphorite nodules in the sediment extends from a few centimetres to a known maximum of 70 cm.

Chatham Rock Phosphate Limited have been granted a licence to prospect for phosphorite nodules within a defined area on the Chatham Rise (Minerals Prospecting Licence 50270), hereafter referred to as 'the licence area'.

The licence area is located on the mid-slope of the Chatham Rise in an area where there is very little trawling compared with the rest of the Chatham Rise. In addition, approximately 80 % of the licence area is a Benthic Protected Area that has been closed to bottom trawling since 2007. Bottom longline activity in the area is also patchy and has been inconsistent in recent years. The lack of fishing in the area suggests that catches are poor. It is likely then that any phosphorite sampling or extraction will be the main source of anthropogenic activity that disturbs the seafloor and benthic communities within the licence area.

The macro-benthic fauna on the Chatham Rise has been relatively well sampled compared with many areas of the deep sea. However, only limited data were available from within the licensed area and these data were mostly qualitative and patchily distributed. Despite this, data from the Sonne SO-17 research cruise, in 1981, suggest that there are some distinct communities within and in the vicinity of the licensed area, including an epibenthic community with an abundant population of a giant isopod (Seriolis bromleyana) and a community associated with phosphorite nodules which was described by Elliot Dawson (1984) as an "oases on an otherwise soft sediment". This latter epibenthic community included the giant bivalve Acesta, which to date has not been recorded within New Zealand outside of the Chatham Rise region. NIWA's *Trawl* database also showed the presence of sponge beds within the licensed area, with sample weights of sponge per trawl reaching nearly 2000 kg in some locations.

A lack of quantitative data and the patchy nature of the available data made it difficult to identify strong relationships between the density of phosphorite nodules and the benthic community. However, high sample weight of sponges and high specimen records of brachiopods were apparent in the vicinity of dense patches of phosphorite nodules.

1 Background information

The Chatham Rise is a submarine ridge extending eastwards from New Zealand into the southwest Pacific Ocean and sits within New Zealand's EEZ (Exclusive Economic Zone). The ridge is approximately 800 km long and 300 km wide with steeply sloping flanks rising to less than 500 m from water depths of more than 3000 m (the Hikurangi and Bounty troughs).

The Chatham Rise has been the subject of many scientific voyages and associated publications. It has been well documented that the region is associated with high levels of primary production (planktonic). This is thought to be associated with the presence of the Subtropical Convergence along the rise – a major permanent circumglobal front formed by the interface of the Subtropical and Subantarctic water masses each with their pelagic ecosystems (e.g. Robertson and Roberts 1978; Probert and McKnight 1993; Bradford-Grieve et al. 1999; Nodder et al. 2003).

The elevated phytoplankton productivity in the Chatham Rise area supports a rich benthic and pelagic ecosystem which in turn supports valuable deep water fisheries, primarily for hoki (*Macruronus novaezealandiae*), orange roughy (*Hoplostethus atlanticus*), ling (*Genypterus blacodes*) and oreo species (*Allocyttus niger*, *Neocyttus rhomboidalis*, *Pseudocyttus maculatus*). Parts of this body of water are also important nursery areas for juvenile hoki (Livingston and Schofield 1996). The benthic ecosystem of the Chatham Rise is interesting in that there are very different biological communities existing on the northern and southern slopes of the rise. These differences have been attributed to the differing quantity and quality of benthic flux generated from the water masses on either side of the Subtropical Convergence (Probert and McKnight 1993; Nodder et al. 2007). Similarly, differences in the distributions of some deepwater fish species exist between the north and south rise (Bull et al. 2001).

The importance of the region is reflected in the considerable body of environmental and fisheries knowledge that exists for the Chatham Rise. This includes assessments of fisheries catch and by-catch, marine community structures, area covered by trawls, effects of trawling on the substrate and benthic fauna of seamounts, biodiversity, and analyses of sediments types, bathymetry, oceanography, and hydrology (for example, Anderson et al. 2001; Bull et al. 2001; Rowden et al. 2002; Clark and O'Driscoll 2003; Livingston et al. 2003; Baird et al. 2006; Hadfield et al. 2007; Dunn 2009).

1.1 Phosphorite deposits on the Chatham Rise

Phosphorite deposits occur in water depths of around 400 m along some 400 km of the crest of the Chatham Rise (Glasby and Wright 1990). Phosphorite occurs as nodules ranging from 2 to >150 mm with a maximum size frequency of 10–40 mm. The local distribution of these nodules is very patchy. Where present, the layer of phosphorite nodules in the sediment extends from a few centimetres to a known maximum of 70 cm (typically 20–30 cm). They occur in a matrix of glauconitic sandy mud.

The Chatham Rise phosphorite deposit is also potentially the most important economic marine mineral resource around New Zealand (Glasby and Wright 1990). The distribution of phosphorite deposits in the region was mapped by Cullen and Singleton (1977) (Figure 1), who showed the highest concentrations of deposits to be on the rise and upper southern slope of the Chatham Rise.

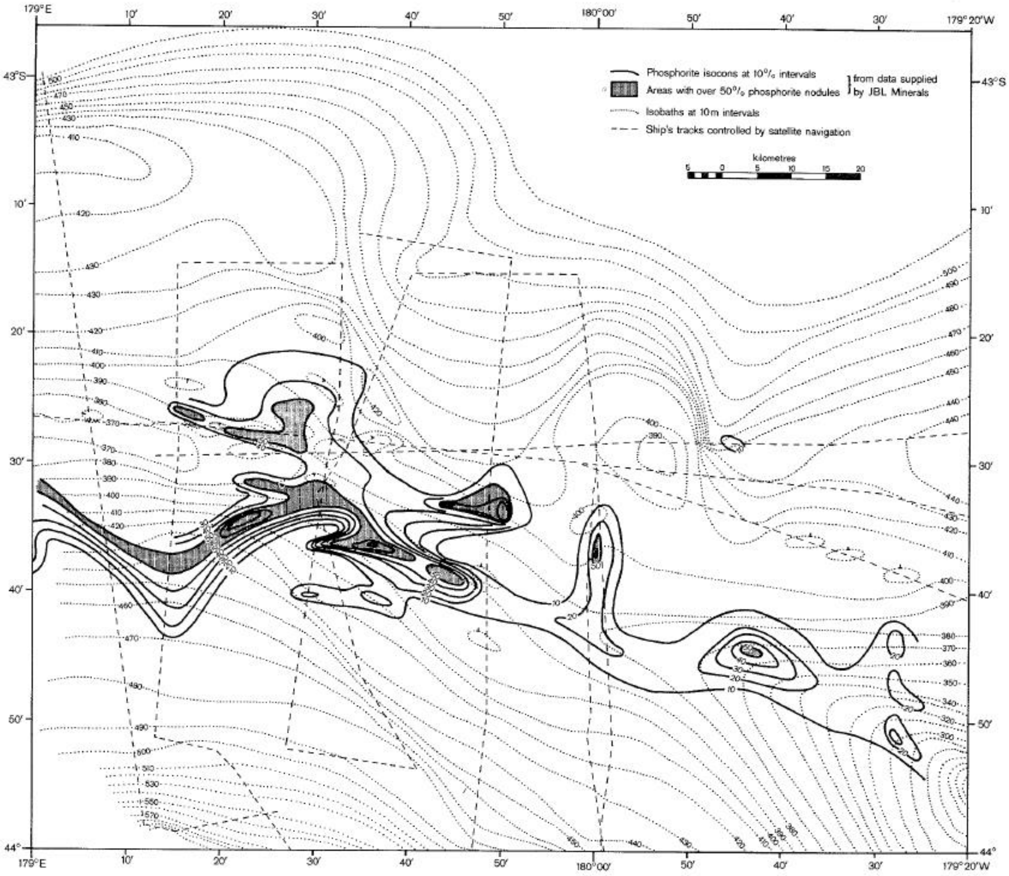

Figure 1: Map of central Chatham Rise showing the phosphorite distribution derived by JBL Minerals from the Global Marine samples collected in 1967–68 (taken from Cullen and Singleton 1977).

Chatham Rock Phosphate Limited have been granted a licence to prospect for phosphorite nodules within a defined area on the Chatham Rise (Minerals Prospecting Licence 50270). The licensed area covers approximately 4726 square kilometres in waters shallower than 500 m (Figure 2). The licence area is located within part of the mid Chatham Rise Benthic Protected Area (BPA) – one of the 17 BPAs in which the seafloor has been protected by the Government from fisheries activity that involves trawl and dredge gears since November 2007. The area of overlay (shown in Figure 2) represents approximately 44 % of the mid Chatham Rise BPA and 80 % of the licence area.

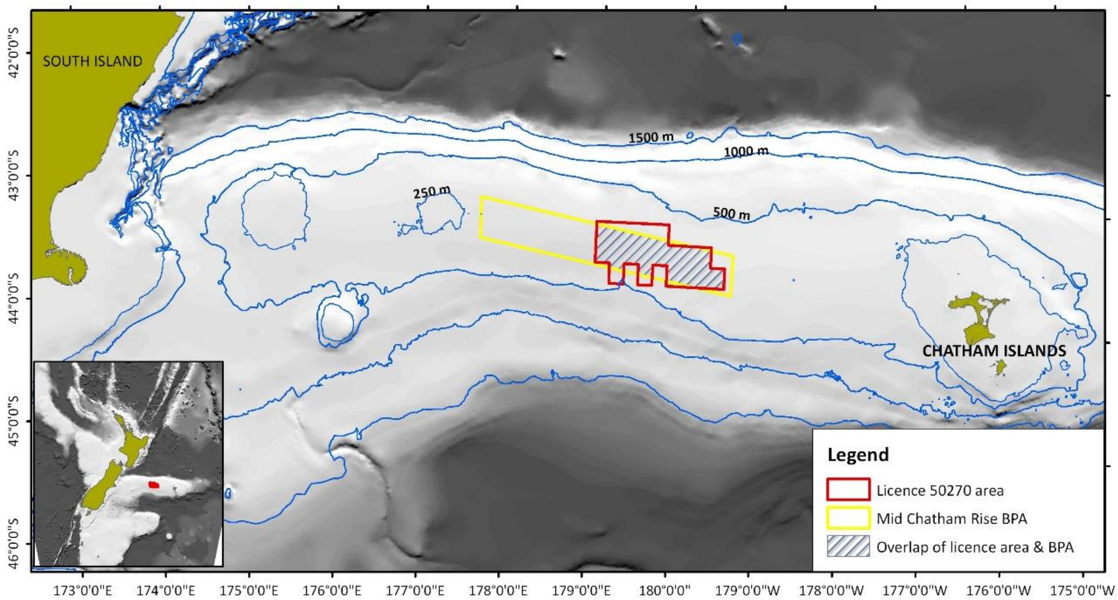

Figure 2: Location of Minerals Prospecting Licence 50270 area on the Chatham Rise in relation to the mid Chatham Rise Benthic Protected Area (BPA), major depth contours, and land masses.

Prospecting is a small-scale form of mineral exploration, a process to identify commercially viable deposits; in this case phosphorite nodules. The Crown Shelf Act (Section 5, 1964), under which this licence was issued, states that while conducting prospecting activities, the Licensee must not cause serious harm to the marine environment, cause serious harm or damage to life (including fish and other aquatic life), property or the coastal environment, or cause pollution of the marine environment.

This report summarises biological and commercial fishing data from within the licence area as a preliminary step towards assessing likely effects of phosphorite prospecting and mining within the area. It also includes a brief description of the fishing methods used on or near the seafloor of the Chatham Rise. At the request of the client, potential effects of phosphate extraction, possible mitigation methods or recommendations for future research are not discussed in this report.

2 The licensed area: current knowledge.

Existing knowledge of the licensed area on the Chatham Rise is summarised below.

2.1 Fishing activity

The Chatham Rise is an important fisheries area within the New Zealand EEZ, particularly in depths down to 1500 m, with bottom fishing methods such as bottom and midwater trawls being the main gear type (Baird et al. 2011).

Although there is a wide range of commercial and other species occurring here (Bull et al. 2001), most trawl fishing effort on the Chatham Rise has been directed at hoki, hake (*Merluccius australis*), ling (*Genypterus blacodes*), silver warehou (*Seriolella brama*), and scampi (*Metanephrops challengeri*) in depths of 200–800 m (Baird et al. 2006; Baird et al. 2011). On the northern and southern Rise the deeper water fisheries for orange roughy and various oreo species have operated in depths of 800–1200 m.

The other main fishing method used on the Chatham Rise is bottom longline, though to a far lesser extent than trawling. This method, as its name implies, rests on the seafloor and is primarily used to target ling.

Analyses of the area of the seafloor covered by trawls (often described as the “footprint”) show that commercial vessels carry out relatively few trawls in the central area of the Chatham Rise slope waters (Baird et al. 2006; Baird et al. 2011). Trawling effort is generally concentrated in areas that can be readily trawled and result in higher catches (National Research Council 2002). Annual research trawl surveys undertaken by NIWA for the Ministry of Fisheries (now Ministry for Primary Industries –MPI) on the Chatham Rise to assess the hoki stock abundance and the fish community structure sample these mid-slope waters and indicate that there is a reasonable amount of rough (‘foul’) ground as well as broad areas of sponge ‘gardens’ (N. Bagley, NIWA, pers comm.).

To determine the amount of fishing effort in the licence area shown in Figure 2, we requested an extract of commercial fisheries data from MPI for an area that included the licence area (bounded by 178.833° E, 179.33° W, 43.167° S, 44.0° S). This extract indicated that the fishing methods used in this area were bottom trawls, midwater trawls used on or near the seafloor, and bottom longlines.

In the following sections we present a summary of available information to describe broad trends since the 1989–90 fishing year (1 October to 30 September), when comprehensive data collection forms were introduced. Publication of these data is subject to restrictions by MPI and thus the data are presented here at a resolution of 5 x 5 km (25 km2) cells. The commercial bottom longline effort is presented as the number of hooks set per 25 km2 cell, summed over the years of available data.

To describe the trawl effort on or near the seafloor we used, with permission, a subset from a dataset developed under an MPI contract (described by Baird et al. 2011). These data provide an indication of the relative area of the seafloor contacted by trawls. Each trawl trackline (between reported start and finish locations) was buffered by an estimated doorspread value (a distance between the trawl doors which gives a measure of the spread of the trawl gear and its path along the seafloor) to provide a trawl swept area in square kilometres. The individual trawl swept areas were overlaid and merged to provide the seafloor area contacted by trawl gear within each 25 km2 cell. Thus, where a 25 km2 cell has been contacted throughout its area, it is represented as a cell with 100% coverage by the footprint.

2.1.1 Trawl effort within the licence area

During 1989–90 to 2007–08, 35 vessels reported some trawl effort in the licence area, and nearly half of these vessels reported trawl effort there in one year only. Trawls were made in, or crossed into, the area in 16 of the 19 fishing years, with most made during the late 1990s to early 2000s —a period of higher catch rates of hoki (see Ministry of Fisheries 2009). About 370 tows (or portions of those tows) occurred in this area, representing a swept area total of about 360 km2 (Table 1). Figure 3 shows the distribution of the trawl footprint within the licence area relative to a subset of the effort in surrounding waters.

Most cells that show fishing effort within the licence area have less than 20% of the cell area fished and for those close to the main fishing area indicated by the darkest cells, the coverage shown here may represent longer tows from established fishing areas or trawls on the edge of established areas. Almost 90 % of the licence area tows targeted hoki and these tows occurred in the south-western rectangle of the licence area in depths shallower than 500 m (see Figure 3) and across the northern boundary of the licence area. Silver warehou was targeted at the extreme south-eastern edge of the licence area and hake in the tows crossing the licence area from the north Chatham Rise east of 180°. The effort reported from the licence area peaked in 2002–03, the year before a series of gradual, then sharp reductions in the Total Allowable Catch for hoki (Ministry of Fisheries 2009).

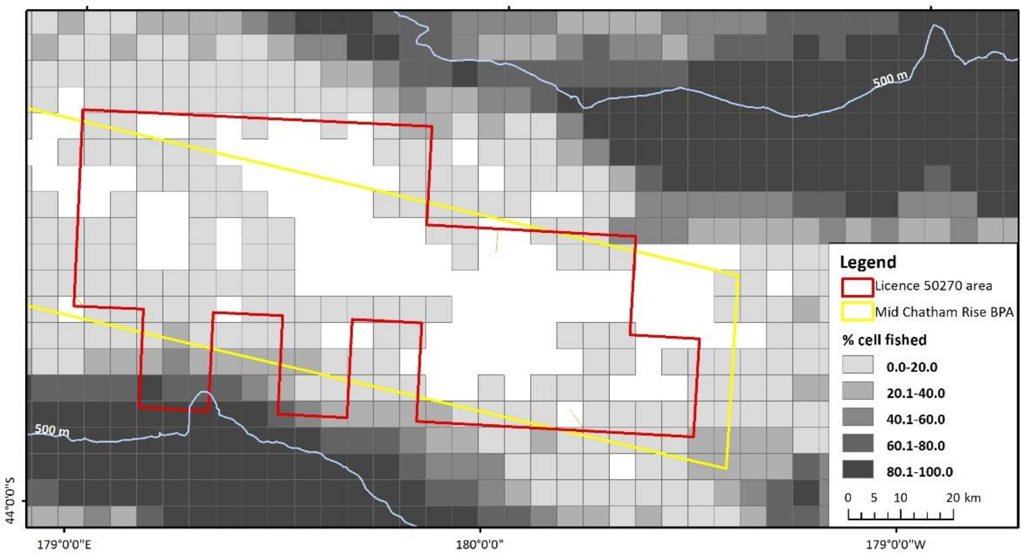

Figure 3: Commercial trawl effort on or near the seafloor within the licence area and in surrounding waters for the fishing years 1989–90 to 2007–08. Effort is presented as the proportion of each 25 km2 cell that has been contacted by trawl gear, based on the estimated swept area of each trawl (see section 2.1). The location of the mid Chatham Benthic Protected Area (BPA) is overlaid: trawling restrictions in this area were regulated in November 2007.

Table 1: The annual number of vessels, number of trawls, and swept area of trawls within the licence area shown in Figure 3, by fishing year for 1989–90 to 2007–08 and the target species reported for that year.

Fishing year	No. vessels	No. tows	Area (km2)	Target species
1989–90	1	5	5.60	Hoki
1990–91	0	–	–	–
1991–92	0	–	–	–
1992–93	0	–	–	–
1993–94	2	2	3.05	Hoki
1994–95	3	4	0.26	Hoki
1995–96	3	6	7.78	Hoki, silver warehou
1996–97	4	8	6.61	Hoki, silver warehou
1997–98	10	27	27.23	Hoki, silver warehou, stargazer*
1998–99	12	48	36.86	Hoki, silver warehou
1999–00	9	44	57.58	Hoki, Ling, scampi
2000–01	9	31	36.52	Hoki
2001–02	6	40	31.58	Hoki
2002–03	10	61	73.34	Hoki, Ling
2003–04	8	35	29.70	Hake, Hoki
2004–05	8	25	22.91	Hoki, scampi
2005–06	6	13	8.74	Hoki, scampi
2006–07	5	11	9.39	Hoki
2007–08	3	9	1.63	Hoki
All	35	369	358.77	–

* Stargazer (*Kathetostoma giganteum*).

No tows were reported from the licence area where it overlaps with the mid Chatham Benthic Protected Area (BPA) subsequent to the regulation of the BPA in November 2007. In the last few years of this time period, trawl effort across the licence area has been entirely in the south-western corner, close to the main fishing grounds.

The small amount of effort shown in the central area of the licence area appears to be real, and some of this effort may represent trawls made as vessels moved between areas, for example from the north to the south Chatham Rise.

2.1.2 Bottom longline effort within the licence area

Fishers on bottom longline vessels have reported their fishing effort on several different forms since 1989–90, and the collection of position data on these forms has been at different scales (either at large fishery areas or latitude and longitude coordinates that represent the vessel position at the start of a longline setting operation). However, some fishers have always reported these finer scale locations, and generally it has been those operating smaller vessels that provide the broader fishery scale location information. Only fishing records with position data have been used in this summary, but it is likely to capture most, if not all, the bottom longline effort in this area because the distance from port means that fishing here is likely to be by larger vessels. [Analyses of the ling longline fishery based on commercial data and observer data are provided by Horn (2004) and Horn (2009).]

An extra year of data was available for the bottom longline fishing. However, the effort was more difficult to quantify. As noted in Section 2.1, the hook numbers reported for the start of each set were summed with others within the same 5 x 5 km cell to provide a spatial measure of bottom longline effort. Figure 4 shows the total hooks set both inside the licence area and in the wider area to display the effort beyond the licence area. These data allow for no extrapolation to an area covered by the longline (or the direction); a longline of about 7500 hooks stretches about 10 km along the seafloor in 500 m depth (Smith 2001). MPI observer information indicates that the largest vessels in this fishery set lines of between about 6 and 12 km. The variation in the distribution of effort over five-year blocks is shown in Appendix 1.

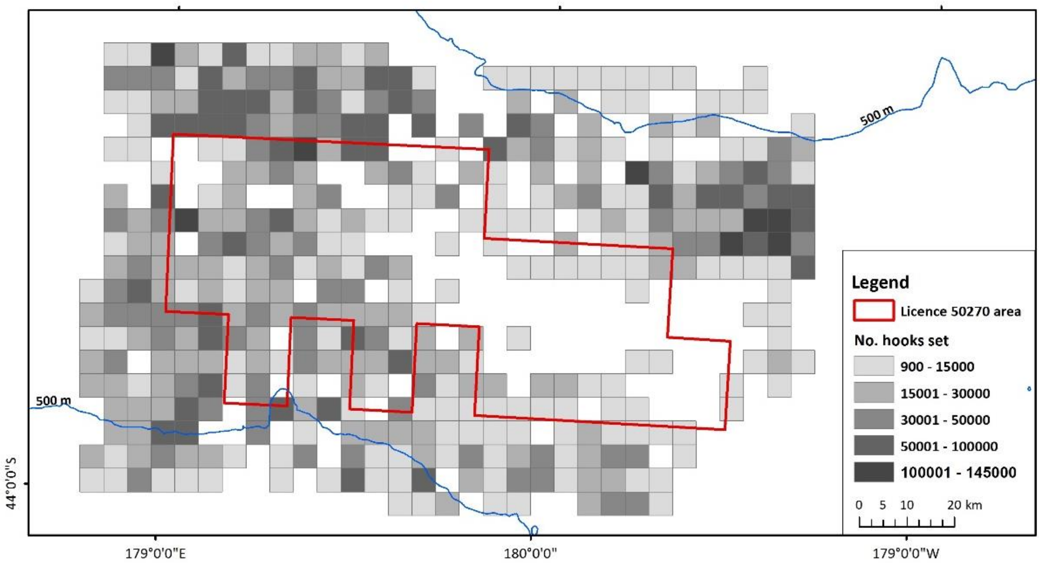

Figure 4: The number of hooks set in each 25 km2 cell based on the start positions of commercial bottom longline effort within the licence area and in surrounding waters for the fishing years 1989–90 to 2008–09.

All the longlines set in the licence area targeted ling and this species is usually fished at depths of between 300 and 500 m (Peter Horn, NIWA, pers comm.). Of the 17 longliners that reported effort in the wider area, 15 fished inside the licence area during 1989–90 to 2008–09. Nine vessels fished at some stage during 1989–90 to 1997–98, but only two of these vessels fished in later years (one in just one year) (Table 2) . Between 1998–99 and 2008–09, five different vessels fished in the licence area, though three reported effort in only one or two years. A maximum of 4 vessels fished in the licence area during the main years of activity (1994–95 to 1997–1998 and 1999–2000). Effort has declined in recent years (see Table 2), and since 2000, although up to 3 vessels have fished in some years, relatively few hooks were set. Thus, there is not consistent fishing using bottom longlines in this area and there appears to be a trend of decreasing effort.

Table 2: The annual number of vessels and number of longline hooks set to target ling within the licence area shown in Figure 4, by fishing year for 1989–90 to 2008–09.

Fishing year	No. vessels	No. hooks set (1000s)
1989–90	1	1.5
1990–91	2	121.8
1991–92	1	8.2
1992–93	1	12.2
1993–94	1	234.0
1994–95	4	574.9
1995–96	4	321.0
1996–97	4	362.5
1997–98	4	230.5
1998–99	2	65.6
1999–00	4	409.4
2000–01	0	–
2001–02	2	30.3
2002–03	3	67.6
2003–04	1	12.3
2004–05	3	136.7
2005–06	3	123.4
2006–07	0	–
2007–08	2	15.6
2008–09	1	12.0
All	15	2 740.0

2.2 The macro-benthic community

The Chatham Rise has been relatively well studied compared with many parts of the deep sea. However, much of the biological data available is qualitative rather than quantitative which restricts the usefulness of the data with respect to the information that can be derived from it. As a result, the distribution of the taxonomic groups of the Chatham Rise benthos is known only crudely in terms of numbers and may not accurately reflect the diversity (Dawson 1984).

Data available from within the licensed area are summarised below.

2.2.1 Sonne SO-17

The Sonne SO-17 was a joint German/New Zealand scientific cruise onboard the R/V SONNE from March to May 1981. During this cruise, numerous equipment types were used to gather a variety of geological, biological and physical data on the Chatham Rise, with particular focus on phosphorite deposits.

Ten video transects were made within the licensed area during the scientific programme of the Sonne SO-17. Position files of the video transects were not available but the transects were categorised into 3 survey areas for analysis (Kudrass and von Rad 1984). These were Area 1, Area 2 and Area 4 (Figure 5). A current meter station was also located within the licensed area, also shown in Figure 5.

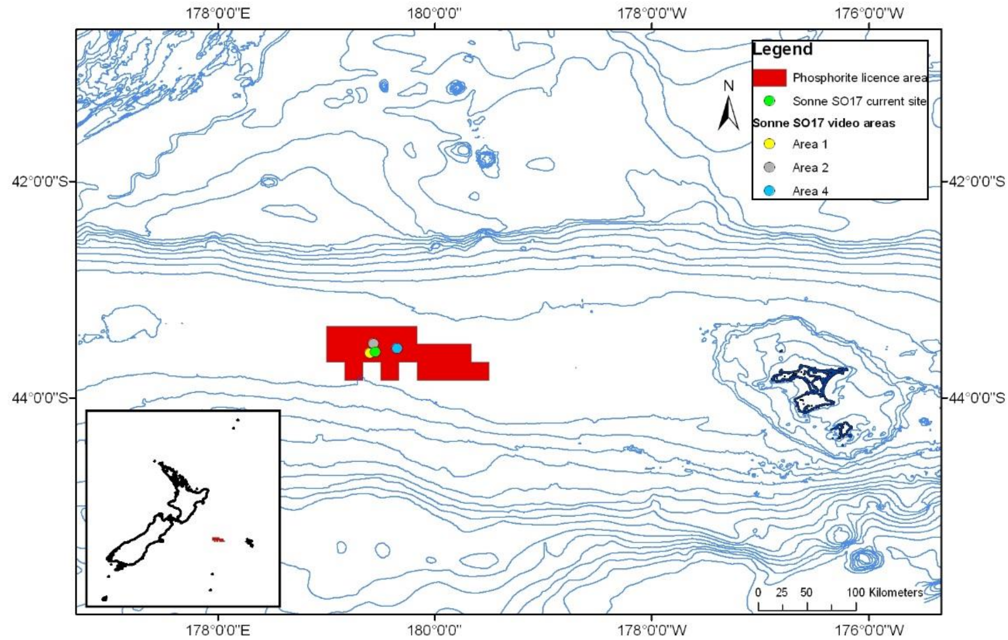

Figure 5: Location of Sonne SO-17 video and current meter stations in relation to the licensed area.

Results from the video tows from Sonne SO-17 are summarised in Table 3. It should be noted that the video footage was made using old technology, is mostly in black and white making observations very difficult, and much of it was taken in apparently unfavourable sea conditions resulting in the video camera “bouncing” towards and away from the seabed. However, the video observations are adequate to characterise the principal epibenthic fauna (i.e. those that live on the surface of the seabed) and describe the substrates in the study area. It is common for benthic fauna to be more abundant and diverse in areas where rocks or other hard substrate provide increased seabed heterogeneity and many of the epibenthic species observed on the video transects appeared to have positive associations with phosphorite nodules (Table 3). These included molluscs, crabs, echinoids, holothurians, asteroids, corals, brachiopods, and cidarid urchins. Of these, only the brachiopods and corals are sessile taxa that require hard substrata on which to settle and grow.

Table 3: Observations of benthic fauna from seabed video transects within the phosphorite prospecting licence area taken during research voyage Sonne SO-17 (adapted from Kudrass and von Rad 1984).

Area	Video transect	Approx distance (km)	Water depth (m)	Epibenthos *	Remarks
1	59	2.1	440-445		± no phosphorite. Giant sponges
1	60	1.5	412-420	Molluscs, shell debris, crabs, very few corals	
1	79	0.4	412-413	Echinoids, molluscs, holothurians, crabs	Very little phosphorite, ± flat giant sponges
1	80	0.3	419-424	Asteroids, corals, crabs	Bioturbation
2	120	0.2	388-392	Molluscs, brachiopods, crabs	
2	121	0.4	387-396	Molluscs, cidarids, echinoids, corals	
2	131	2.3	388-403	Corals, molluscs, Echinoids	
4	240	5.5	380-398	Abundant: corals and crinoids, Common: echinoids, asteroids and molluscs	
4	241	2.9	384-400	Abundant: corals and crinoids, Common: echinoids, asteroids and molluscs	
4	242	3.9	383-401	Abundant: corals and crinoids, Common: echinoids, cidarids, asteroids and molluscs	

* underlined taxa showed positive correlation with the presence of phosphorite nodules.

In addition to epifauna noted in the above table, the presence of infauna (e.g. worms and other burrowing animals) and other macrofauna (e.g. gastropods and crustaceans) can be noted from tracks and burrows visible on the surface of soft sediments (Beaumont, pers obs.).

The video frame width at the seabed is approximately 1 m and the total length of all transects combined was 19.5 km. Not all of this area was able to be observed due to the unfavourable sea conditions during sampling, but even if all of this was useable footage the total area of seabed covered is just 0.0195 square kilometres. The licence area is 4726 square kilometres, so we have video observations from 0.00004 % of the licensed area. Thus, it is quite possible that there are other faunal assemblages present that we are not aware of. Indeed, the observation of “giant sponges” on two of the SO-17 transects suggests that more developed, long-established, sessile assemblages may be present in the area.

Some still images were taken to accompany the video transect. While some of the photographs are clear enough to identify aspects of the benthic community (Dawson 1984), the photographs have been calculated to cover approximately 3 % of the video transects and, therefore, a very small percentage of the licensed area.

Dawson (1984) described benthic communities associated with phosphorite nodules as being “oases on an otherwise soft sediment” with a “special” fauna including the brachiopods *Dallina* and *Terebratulina* and the giant limid bivalve *Acesta*, which has not been found elsewhere in New Zealand waters. He described these assemblages as closely resembling the coral/brachiopod/*Acesta excavate* association in the Norwegian fjords. The observation of *Acesta* is potentially important because current knowledge supports Dawson’s (1984) statement that this species is not found elsewhere in the EEZ. *Acesta* spp. has been recorded from only 6 sites in New Zealand (NIWA’s Specify database, see section 2.2.4 below), all of which are on the Chatham Rise, in depths ranging from 397 m to 1129 m (Figure 6). Note, however, that any specimens collected prior to 1996 may not be entered into the database so further records from elsewhere may exist.

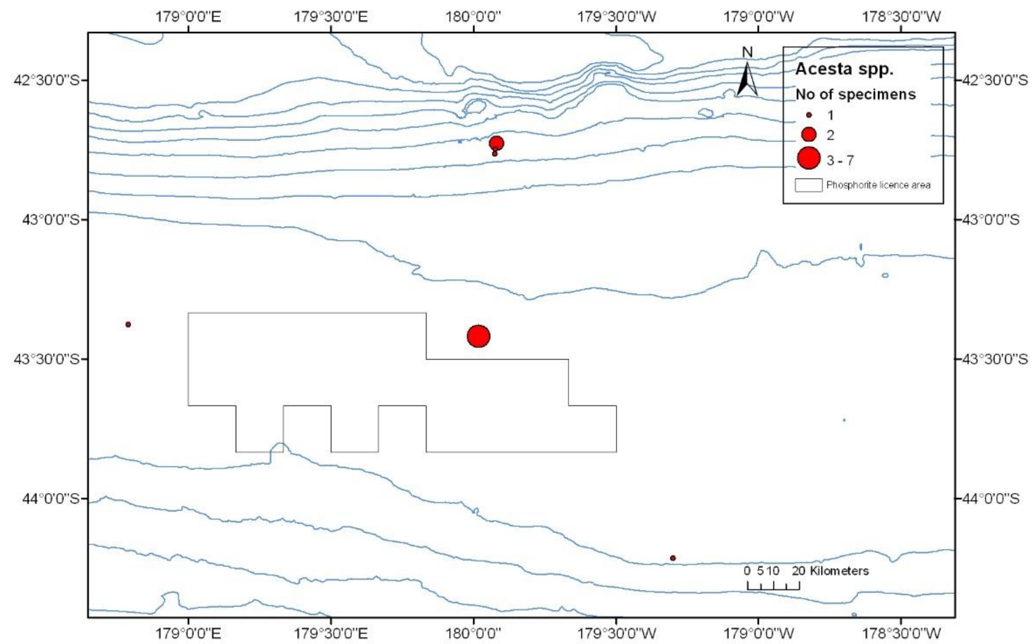

Figure 6: All New Zealand records of Acesta spp. within NIWA’s Specify database.

2.2.2 Chatham Islands 1954 Expedition Stations (Hurley 1961)

As part of the Chatham Islands Expedition in 1954, beam trawls were towed in two locations within/in the vicinity of the study area (Figure 7).

The specimens recovered in the beam trawls are listed below (in Appendix 2). The epibenthic communities observed included an abundant population of the giant isopod, *Seriolis bromleyana*, leading Hurley (1961) to describe a *Seriolis bromleyana-Spatangus multispinus* deepwater (“bathyal”) community; further characterised by the following species: the echinoderm *Ophiuroglypha irrorata*; the decapod *Campylonotus rathbunae*; the molluscs *Nassarius ephamillus*, *Micantapex parengonius*, *Neilo australis*, *Falsilunatia powelli*, *Fusitron laudandus*, *Fax alertae*, *Coluzea mariae* and probably the polychaete *Hyalinoecia tubicola*.

Seriolis bromleyana mostly lives at depths between 360 m & 3700 m. The isopod is fairly widely distributed in the NZ region though there are not many records of it (Hurley 1961).

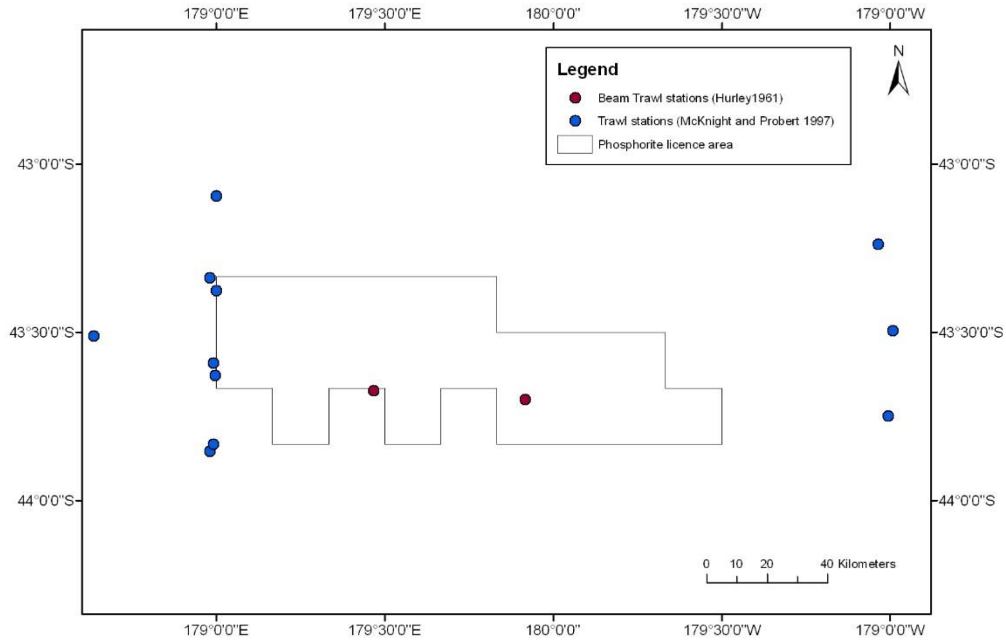

Figure 7: The location of beam trawls from the 1954 Chatham Rise expedition and trawl stations from McKnight and Probert (1997).

2.2.3 McKnight and Probert (1997)

McKnight and Probert (1997) collected epibenthic samples from the Chatham Rise using a small sledge-trawl during September 1989. The locations of those trawls in the vicinity of the study area are shown in Figure 7. The trawl was 1.2 m wide and 0.45 m high with a 7 mm minimum trawl net size (knot to knot). Samples were washed on a 1 mm sieve.

McKnight and Probert (1997) found several distinct communities within the trawl samples they collected. Those samples collected in the vicinity of the licence area were all described as “community A”. Community A consisted of 63 species of which 19 were “endemic” – only found within community A (i.e. not found on the slope). The characteristic species included 8 crustaceans (*Acutiserolis bromleyana*, *Pontophilus acutirostris*, *Notopaldulus magnoculus*, *Camplylontus rathbunae*, *Nephrops challengeri*, *Munida gracilis*, *Phylladiorhynchus pusillus*, *Carcinoplax victorienesis*), 4 echinoids (*Coniocidaris parasol*, *Brissopsis oldhami*, *Echinocardium lymani*, *Paramaretia peloria*) , 3 ophiuroids (*Ophiacantha vilis, Amphiura lanceolata*, *Ophiura irrorata*), 2 bivalves (*Cuspidaria fairchildi*, *Euciroa galatheae*), 2 polychaetes (*Hyalinoecia tubicola*, *Aphrodita talpa*), 2 holothurians (*Echinocucumis hispida*, *Paracaudina chilensis*), 1 asteroid (*Crossaster japonicas*) and 1 gastropod (*Surculina expeditionis*). Many of the prominent species observed are scavengers or carnivores.

This community A is essentially the same community described by Hurley (1961) as *Seriolis bromleyana* – *Spatangus multspinus* community. None of the characteristic species appear to be restricted to the Chatham Rise, though the extent of their respective distributions is mostly poorly known (McKnight and Probert 1997).

2.2.4 NIWA's "*Specify*" database

NIWA's "*Specify*" database is a collation of taxonomic records and specimens of species collected from New Zealand science programmes. Specimen data located within the licence area were from 30 different scientific voyages. It should be noted that, as with previous data described, these data are qualitative rather than quantitative. Generally only a subset of the specimens sampled at each site are recorded into Specify and these are often "voucher" specimens or specimens of interest (i.e. new records for a site). It is rare for all samples collected to be entered into this database. Despite this limitation, some useful information can be gained from these data.

Table 4 shows the number of specimens recorded within the Specify database from within the licence area. The arthropods, brachiopods, and echinoderms were the most numerous of the phyla with 687, 487, and 453 specimens respectively. These data do not enable us to draw any conclusions on the relative size of the populations of each taxonomic phyla, but they indicate that these phyla are present in reasonable numbers. It should be noted that because of the nature of the Specify data, that those phyla, such as the annelida, that are represented by a small number of specimens may not necessarily have a small population.

These nine phyla encompass a broad range of animal types. Some are only found on hard substrata (e.g. the brachiopods and many types of cnidarian, including corals). The echinodermata, for example, include a variety of functional groups and many echinoderms can be associated with both hard and soft sediments. Asteroids (star fish) are generally predators and/or scavengers; echinoids (sea urchins) are grazers. Crinoids (feather stars) are generally suspension feeders, ophiuriods (brittle stars) are scavengers and/or detritivores, and holothurians (sea cucumbers) are either deposit feeders or suspension feeders.

Table 4: Number of specimens per Phylum and Genus within each phylum recorded in the Specify database within the licence area.

Phylum	Includes	No of Genera	Total number of specimens
Annelida	Polychaetes	1	1
Arthropoda	Amphipods, Decapods, Isopods	>24	687
Brachiopoda		>3	487
Bryozoa		>11	127
Chordata	Ascidians	1	5
Cnidaria	Anthozoa, Hydrozoa	>21	183
Echinodermata	Asteroids, Crinoids, Echinoids, Holothurians, Ophiuroods	>33	453
Mollusca	Bivalves, Cephalopods, Gastropods, Chitons, Limpets	>6	118
Porifera	Calcarea, Demospongiae	13	24
Total		>113	2085

The number of specimens per site have been plotted to show the relative distribution (Figure 8). Again, note that the presence of a large number of specimens simply shows that this is where many specimens were recorded within Specify. A large sample size, therefore, shows that numerous animals were present in this area. However, a small sample size does not necessarily mean that few animals were present – it may be that only a token number of specimens were recorded. Plots showing the spatial distribution of *Specify* records for each of the more numerous phyla are shown in Appendix 3.

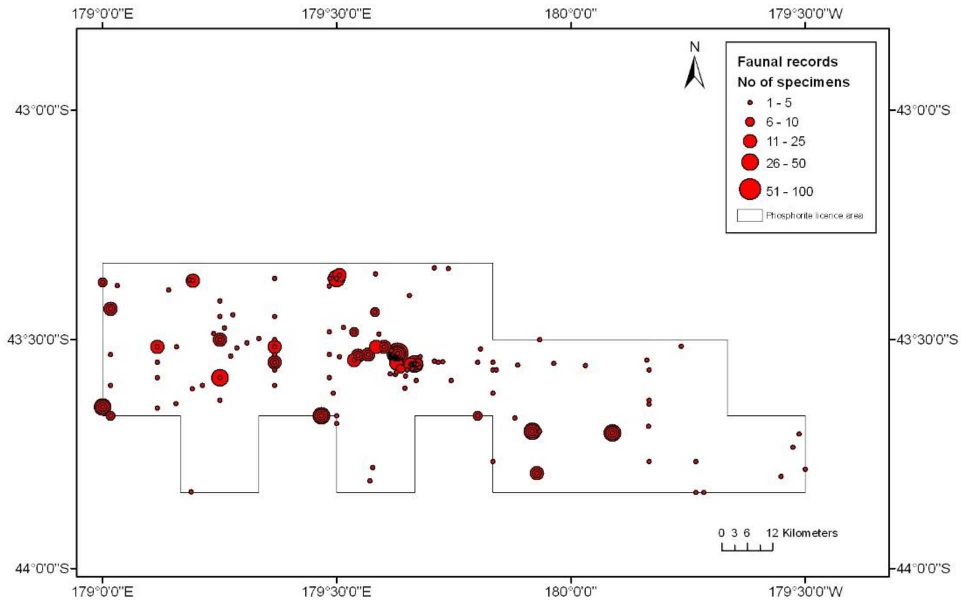

Figure 8: Spatial distribution of the total number of benthic invertebrate specimens recorded in the *Specify* database per site. Note that data from the *Specify* database is not fully quantitative and thus does not represent absolute seabed abundances.

2.2.5 MPI Trawl database

The MPI Trawl database contains records of biological samples collected during research trawl surveys using NIWA vessels (for example see Stevens et al. (2009)). Data are recorded as wet weight of each taxonomic group or species together with a location (the start and finish positions of each trawl), making this one of the few quantitative datasets available. Data were available within the licensed area from eighteen research voyages. The trawl finish positions together with the total biomass of benthic invertebrates recorded in each trawl are shown in Figure 9.

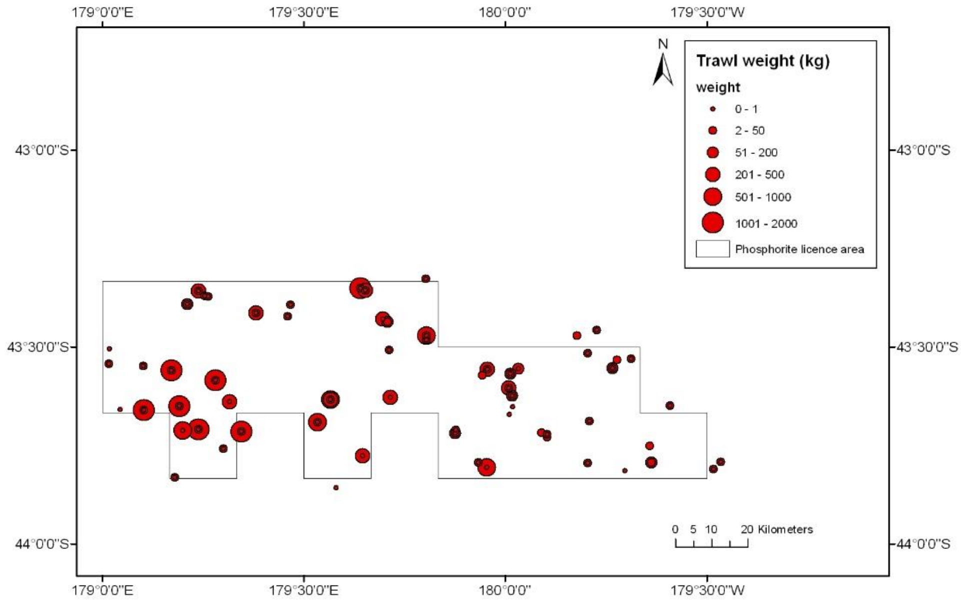

Figure 9: The trawl finish positions together with the total sample weight of benthic invertebrate fauna recorded in each trawl. Total weight (kg) of each trawl (benthic species only)

Sample weight per trawl ranged from less than 1 kg to nearly 2000 kg. These data are the most reliable quantitative data available for benthic biomass in the area. However the coverage is patchy across the licence area and some large areas have not been sampled. It should also be noted that the samples represent catches in a bottom trawl net which is not specifically designed to catch benthic organisms and so the benthic samples are likely to be biased towards larger animals.

Figures 10 to 15 show this information broken down by the major invertebrate Phyla, with start and finish trawl locations to indicate the location of trawls.

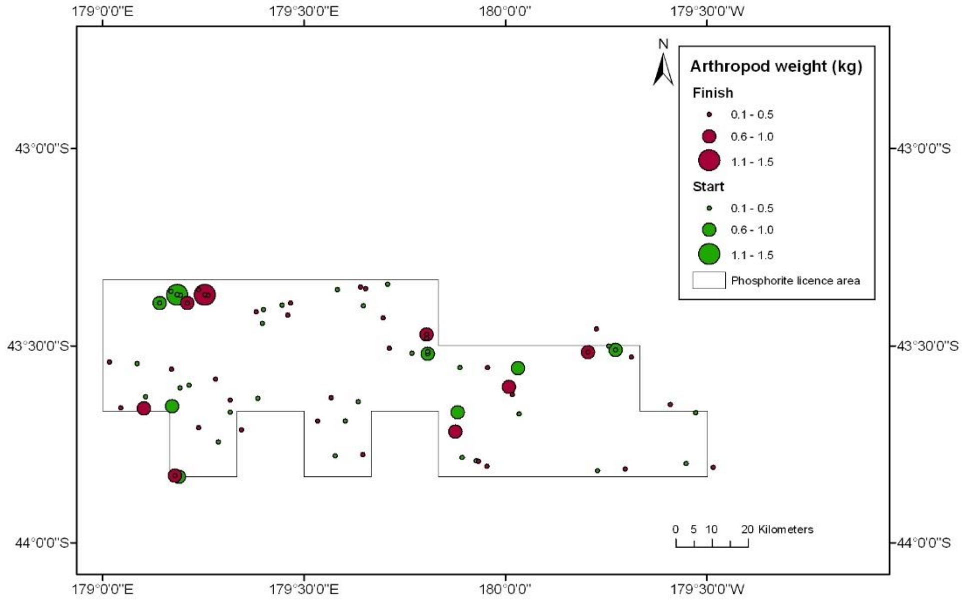

Figure 10: Weight of arthropod samples collected in trawls within the licensed area on the Chatham Rise. Start and finish locations of each trawl are given to indicate the length of the trawl.

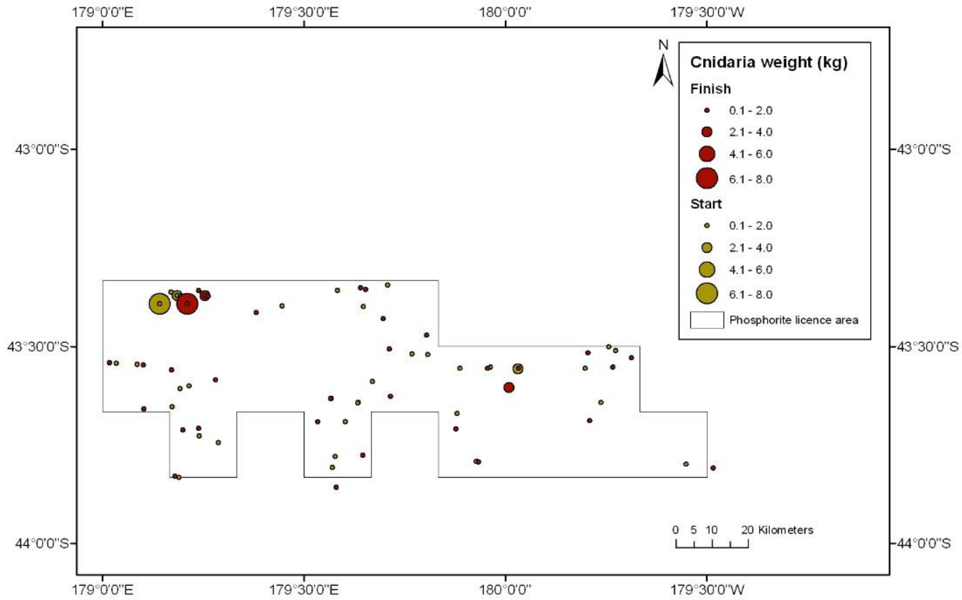

Figure 11: Weight of cnidarian samples (hard and soft corals, anemones etc.) collected in trawls within the licensed area on the Chatham Rise. Start and finish locations of each trawl are given to indicate the length of the trawl.

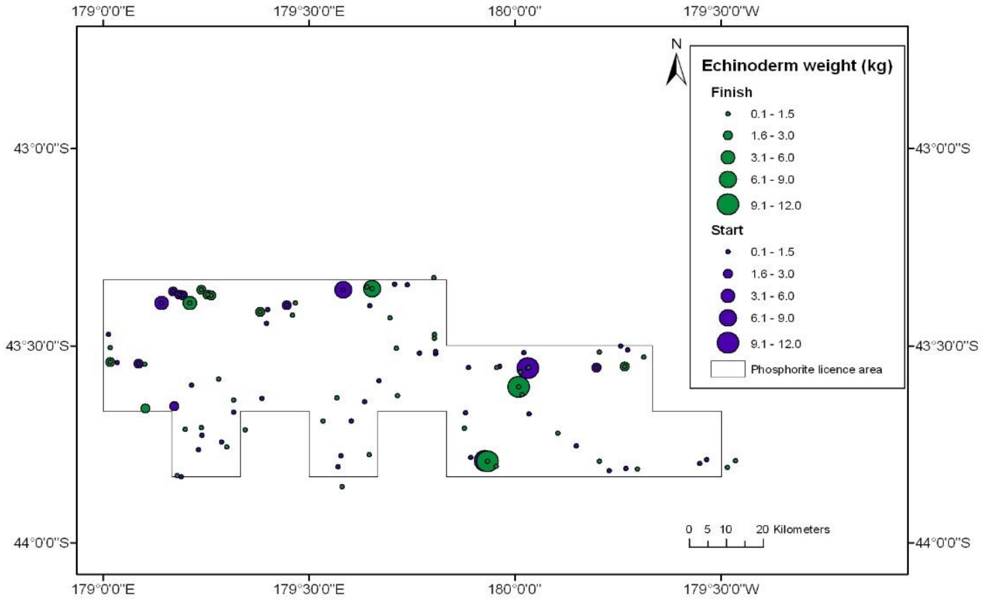

Figure 12: Weight of echinoderm samples collected in trawls within the licensed area on the Chatham Rise. Start and finish locations of each trawl are given to indicate the length of the trawl.

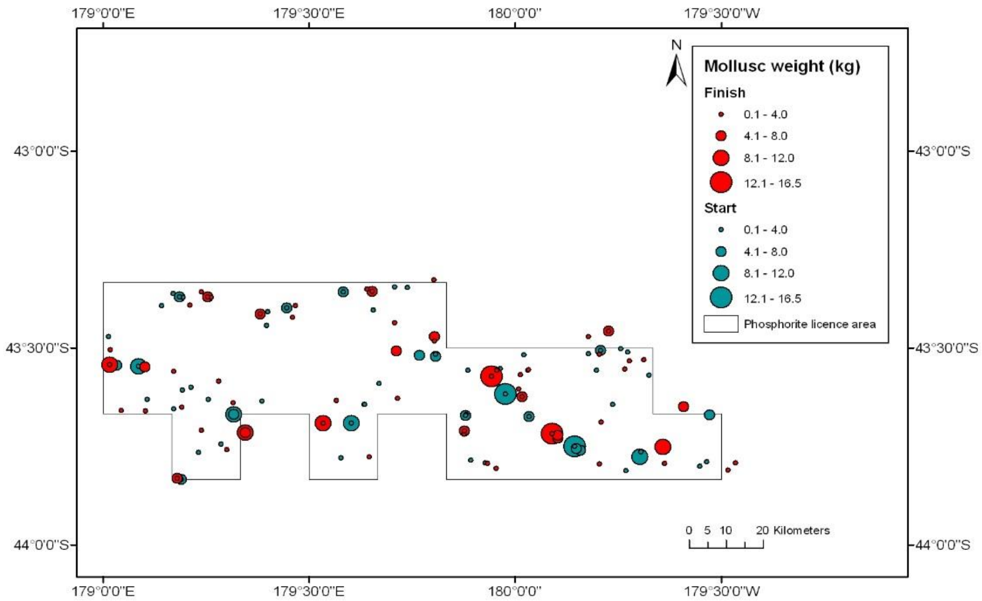

Figure 13: Weight of mollusc samples collected in trawls within the licensed area on the Chatham Rise. Start and finish locations of each trawl are given to indicate the length of the trawl.

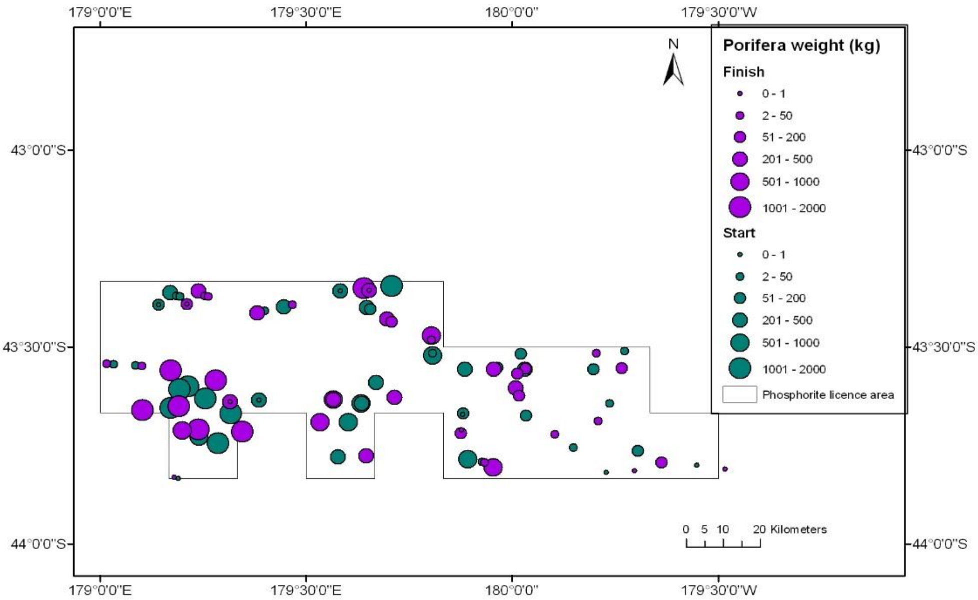

Figure 14: Weight of porifera samples (sponges) collected in trawls within the licensed area on the Chatham Rise. Start and finish locations of each trawl are given to indicate the length of the trawl.

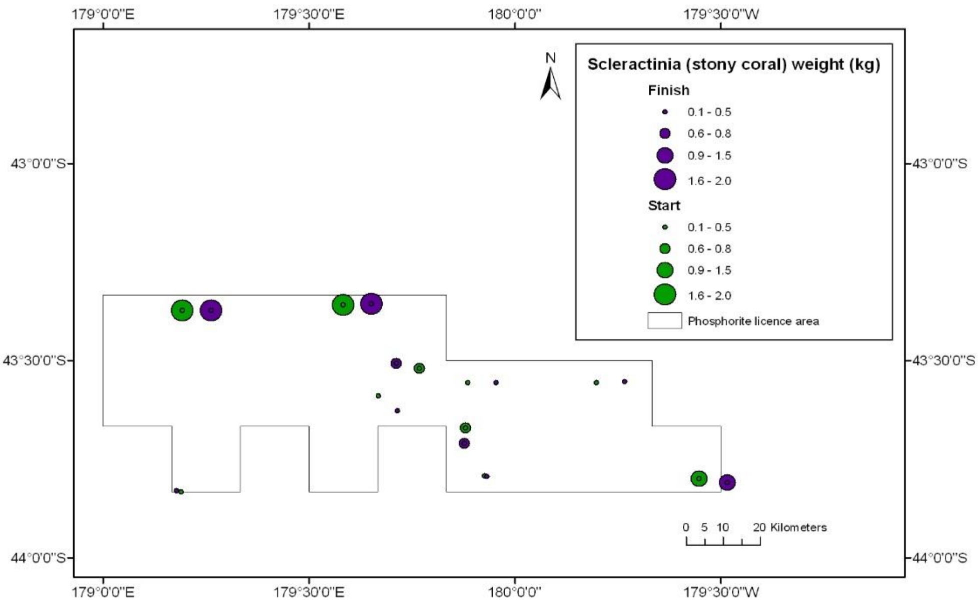

Figure 15: Weight of scleractinia samples (stony corals) collected in trawls within the licensed area on the Chatham Rise. Start and finish locations of each trawl are given to indicate the length of the trawl.

2.3 Relationship between the density of phosphorite nodules and the benthic community

The data from the Sonne SO-17 survey suggest that there is a positive correlation between some benthic biota and the presence of phosphorite nodules (e.g. Dawson 1984; Kudrass and von Rad 1984). This was particularly apparent in Area 4 where large phosphorite nodules were associated with colonies of branching corals (e.g. *Goniocorella dumosa*) and gorgonian corals (Kudrass and von Rad 1984). These authors noted that coral colonies were much less frequent where phosphorite nodules were smaller (in Areas 1 and 2). High phosphorite occurrences were also positively correlated with the abundance of small burrowing crabs, molluscs, asteroids and cidarid echinoids (Kudrass and von Rad 1984).

The distribution of some taxa (from trawl sample weights) and number of records (from *Specify*) have been overlaid onto the distribution of phosphorite nodules (mapped by Cullen and Singleton 1977) (Figures 16 to 18). The distribution of nodules is locally very patchy (Glasby and Wright 1990) and these plots do not represent the fine scale heterogeneity of the presence of nodules and fauna. The trawl data are also spatially very patchy. However, the plots do give an indication of where higher biomass has been recorded from trawls in relation to areas where high densities of phosphorite nodules have been reported.

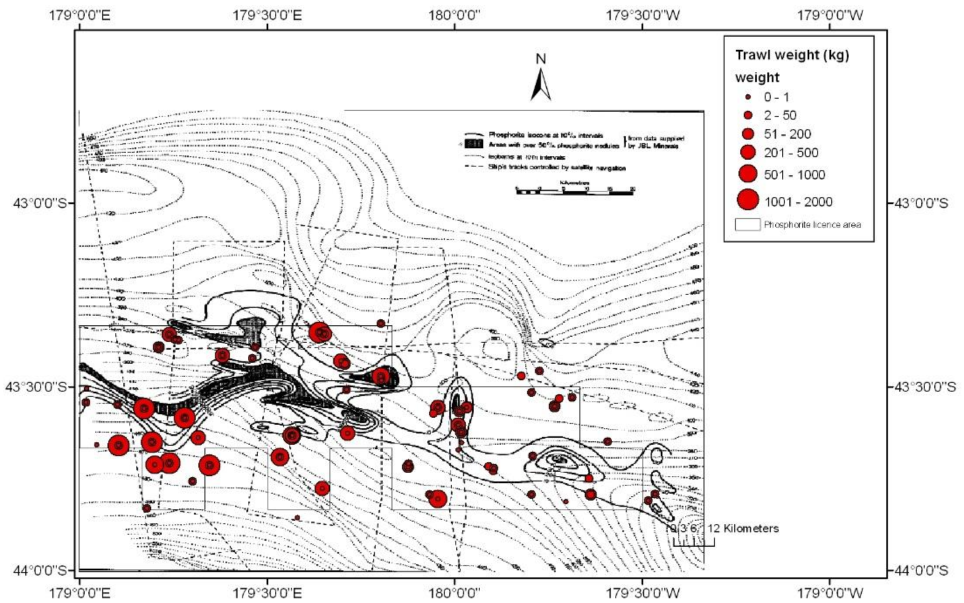

Figure 16: The spatial distribution of sample weights from NIWA's *Trawl* database overlaid onto a plot of the density and distribution of phosphorite nodules (mapped by Cullen and Singleton 1977). Dark shading indicates areas of higher phosphorite nodule density.

There may be some relationship between the Cullen and Singleton's (1977) plot of phosphorite distribution and the distribution of key benthic taxa. Both porifera and phosphorite sample weight and densities appear to show an east – west gradient, with higher values in the west of the area (Figure 17). Similarly, high specimen numbers of brachiopods have been recorded within the *Specify* database from areas of high phosphorite densities (Figure 18). These taxa require hard substrata to attach to and correlations between phosphorite density and the abundance of sponges and brachiopods are likely to be a consequence of the increased availability of settlement substrata afforded by the phosphorite nodules. Regardless of the underlying cause, however, there are certainly some dense beds of both sponges and brachiopods in the vicinity of dense patches of phosphorite nodules.

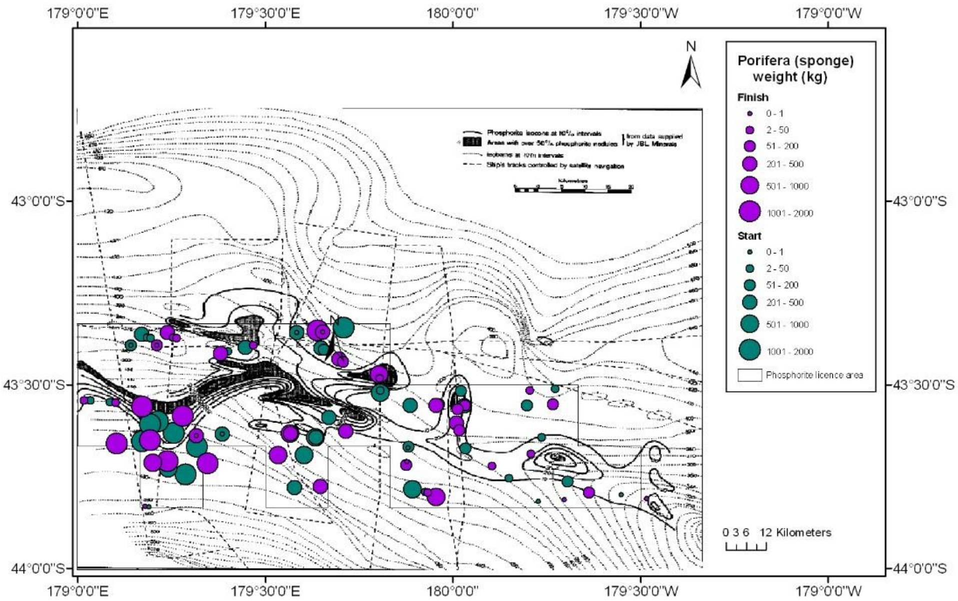

Figure 17: The spatial distribution of the weight of porifera (sponge) samples from NIWA's Trawl database overlaid onto a plot of the density and distribution of phosphorite nodules (mapped by Cullen and Singleton 1977). Start and finish positions of each trawl are shown, with the total sample weight collected for the trawl represented at each point. Dark shading indicates areas of higher phosphorite nodule density.

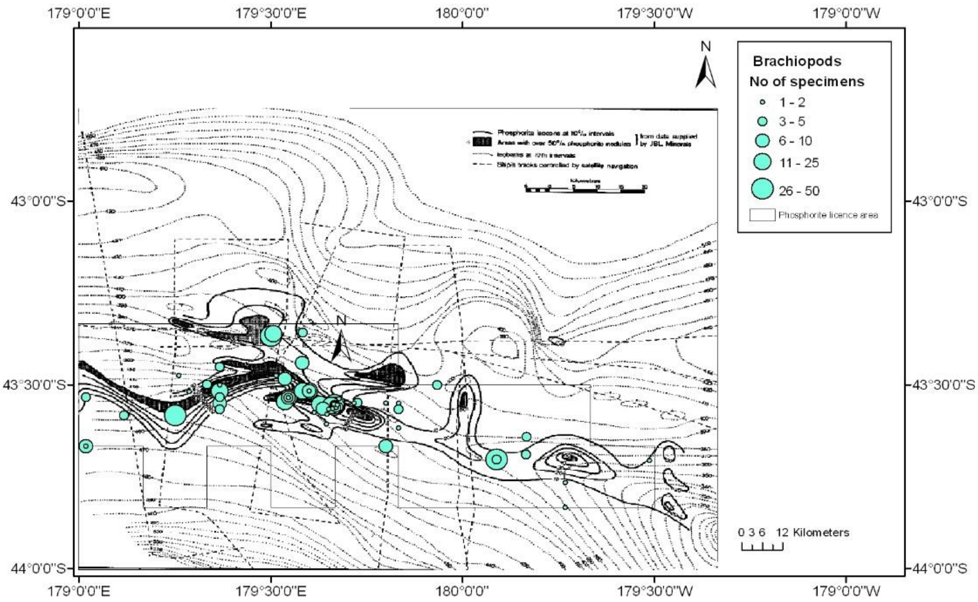

Figure 18: The distribution of the brachiopod records from NIWA's *Specify* database overlaid onto a plot of the density and distribution of phosphorite nodules (mapped by Cullen and Singleton 1977). Dark shading indicates areas of higher phosphorite nodule density.

A diverse and abundant hard-substrate community associated with manganese nodules was described by Mullineaux (1987). He suggested that the large size and abundance of the organisms attached to nodules may result in their contribution to benthic community interactions and to benthic fluxes being substantial relative to adjacent sediment-dwelling organisms. The same may be true of the epifaunal communities associated with the hard substrate provided by phosphorite nodules.

3 Fishing gear used on or near the seafloor

We provide below a concise description of the trawl and longline fishing gears and the ways in which these gears are used relative to the seafloor.

3.1 Bottom trawl gear and midwater trawl gear used on the seafloor

Bottom trawl gear is designed to be in contact with the seafloor and the contact varies with target species, sediment/substrate type, and relative size of the fishing gear (weight of gear). Midwater trawl nets can be fished close to the seafloor and are likely to have contact as the net moves up and down in the water.

A bottom trawl consists of a net with a wide horizontal opening that tapers to a closed cod-end (Figure 19). Contact is made with the seafloor by the trawl doors, sweeps, sweep/bridle join, bottom bridle, wing-end assemblies, groundrope, and chain extensions. Trawl doors are used to spread the trawl net in the horizontal plane and to increase the area swept. They stir up a sand or mud cloud making a visual barrier back to the net and, in combination with the sweeps, bridles, and groundrope, they act to herd the fish with a sand/mud cloud and sound. The doors are designed to sit at an oblique angle (which depends on the size and construction) to the direction of the fishing gear. Water flow and negative pressures behind the door also stir up sediment.

Sweeps and bridles are used to ‘sweep’ a larger area and, with the sediment cloud produced by the trawl doors, herd fish towards the net mouth. The groundrope is attached to the bottom edge of the trawl net and its construction depends on the target species, vessel size, and substrate of the seafloor. On clear bottom it may be made from chain or rope-wrapped wire, whereas on rough bottom, rubber discs, rollers, bobbins or rockhopper gear may be used. The groundrope provides protection to the lower section of the trawl net and is used to disturb species hard on the seafloor into the net.

On occasions large catches of some species may drag the cod-end along the seafloor so chafing gear may be used on the underside of the cod-end. Some trawls use tickler chains in front of the groundrope to disturb or dig out target species. The rigging of bottom trawls (adjustments) will determine how hard down on the seafloor the gear is fished. A general description of the gear and its use is given in Sainsbury (1996). The size of the trawl gear often depends on vessel size and engine power. The use of modern electronic technology allows fishers to search for fish schools, get depth and seafloor information, reliably position nets, accurately relocate successful fishing grounds and avoid foul ground.

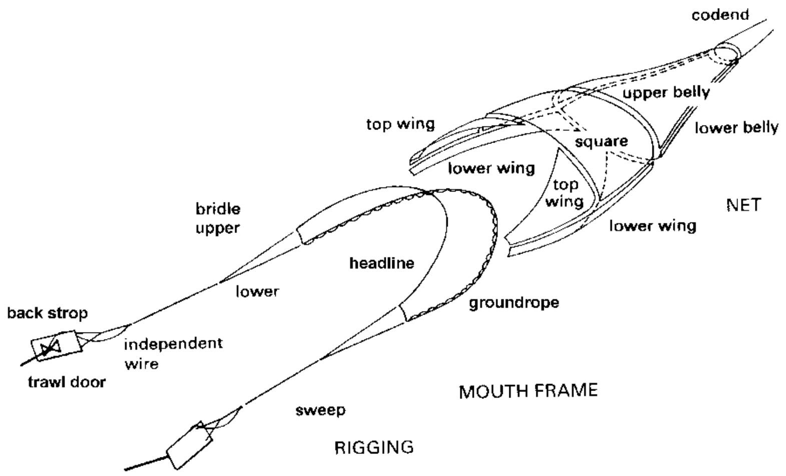

Figure 19: Diagram of a typical bottom trawl net similar to those used in New Zealand waters. After Sainsbury (1996).

3.2 Bottom longline gear

Smith (2001) provides a description of bottom longline fishing gear used by the larger vessels that set the majority of hooks on the Chatham Rise. The hooks are attached to the backbone by short snoods, and the backbone is anchored to the seafloor by two grapnels (about 40 kg). A line of about 7500 hooks stretches about 10 km along the seafloor. The backbone, hooks and snoods all contact the seafloor.

4 Discussion

This report details the current available knowledge of the fishing activity and benthic communities present in the licence area on the Chatham Rise. While the Chatham Rise as a whole has been relatively well sampled compared with many areas of the deep sea, only limited data were available within the study area. These data, too, were mostly qualitative and patchily distributed due to the sampling methodologies.

The macro-benthic fauna on the Chatham Rise is reasonably well known, and comprises a fairly normal quota of mobile epifaunal and infaunal species (Dawson 1984). There appears to be a positive relationship between benthic biodiversity and the presence of phosphorite nodules, most likely reflecting the dependence of sessile epifaunal organisms such as stony corals, brachiopods and bryozoans on hard substrate for attachment.

It is known that dense beds of sponge exist on the Chatham Rise within and in the vicinity of the licence area. Biogenic habitats, such as sponge beds, may increase the overall diversity, abundance, and productivity of a range of species that associate with them (Morrison et al. 2009). The presence of *Acesta* spp., the giant limid bivalve, which to our knowledge has only been recorded on the Chatham Rise area within the New Zealand region is also potentially important. There are, almost certainly, further records of this genus pre-dating 1996 which have yet to be entered into the *Specify* database. It is interesting to note that no records of Acesta were made during the recent Ocean Survey 20/20 which surveyed large areas of the Chatham Rise and Challenger Plateau, suggesting that this bivalve may indeed have a very limited range within New Zealand (David Bowden, NIWA, pers comm.). It is difficult to determine how important the Chatham Rise is with respect to the distribution of this large bivalve, because of the lack of presence/absence data for Acesta in locations other than the 6 sites that are currently in the database.

Ministry for Primary Industries commercial data collected from fishers operating trawl and bottom longline vessels between 1989–90 and 2008–09 indicate that there are very few fishing operations in the area covered by the Minerals Prospecting Licence on the mid Chatham Rise compared with the wider Chatham Rise area. For example, 8000–9000 tows were made annually in waters east of 176° E on the Chatham Rise in recent years (Baird et al. 2011). However, over the last 10 years, there was a maximum of 61 trawls in any one year in the licence area (see Table 1). Trawl effort is most likely to cross the southern boundaries of the licence area, extending from the main trawling grounds that have been modified by annual trawl activity. Since late 2007, the trawling restrictions in the mid Chatham BPA have resulted in no reported trawl effort in the area of overlap between the BPA and the licence area (as shown in Figure 2). It appears that longline activity in the area is also very small, and that the distribution of this effort in recent years is very patchy. In recent years the number of hooks set in the licence area represents between less than 0.4 % and 2 % of the ling hooks set on the Chatham Rise east of 176° E (MPI unpublished data).

5 Acknowledgements

We thank the Ministry for Primary Industries for the use of their fisheries-related data and acknowledge David Bowden and Don Robertson at NIWA for reviewing this report and Sadie Mills for her help with the Specify database.

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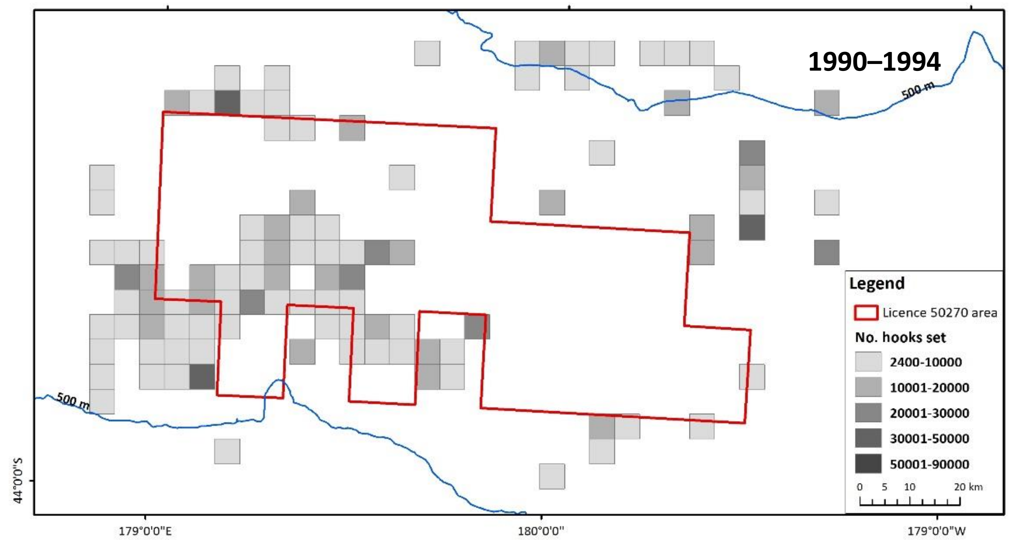
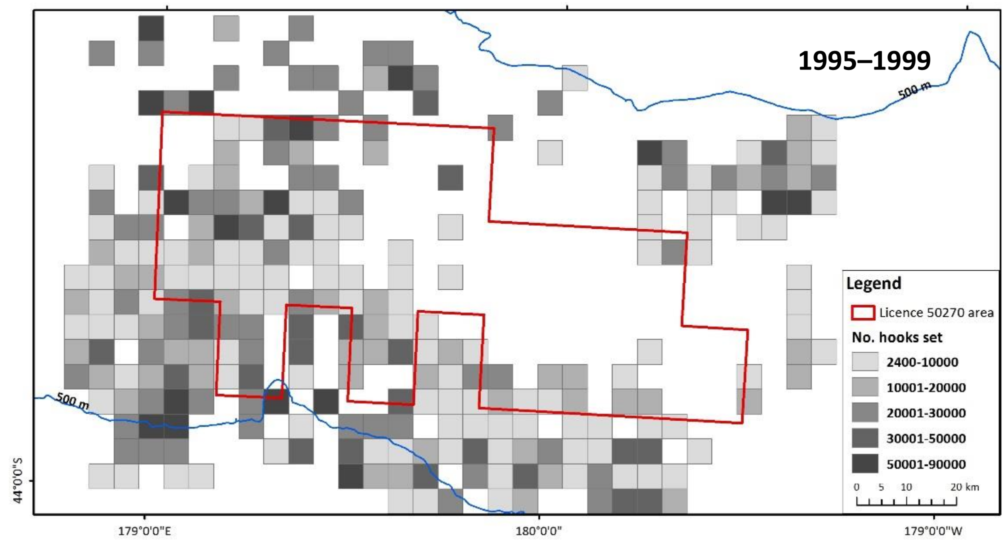
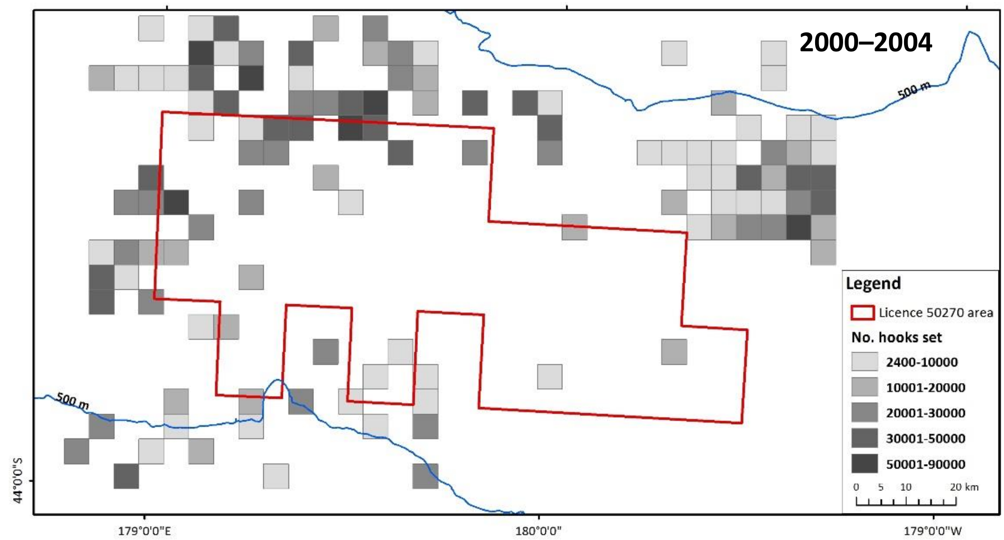
7 Appendices

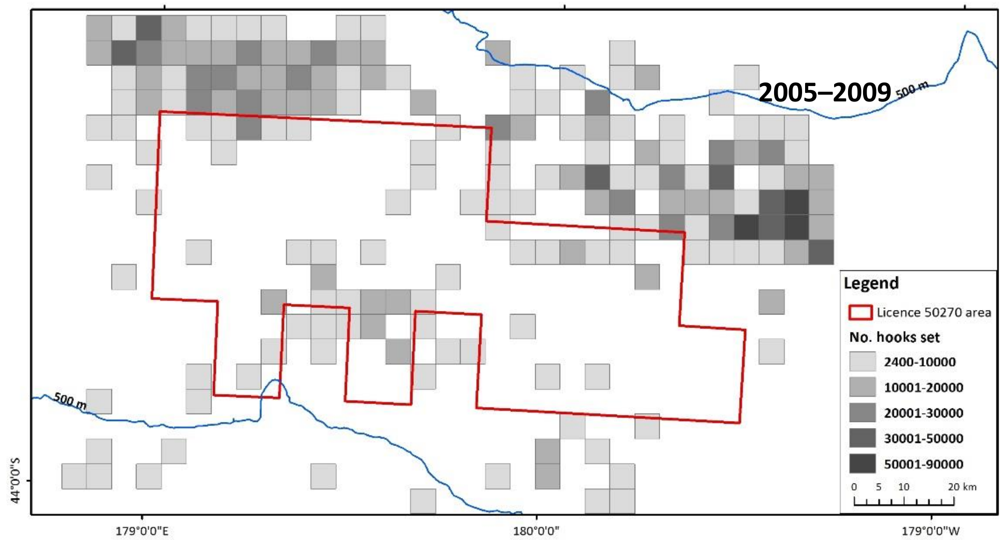
Appendix 1: The number of hooks set per 25 km2 cell where longline fishing occurred, summed over five fishing year periods, from 1989–90 (1990) to 2008–09 (2009). Note the same scale for the number of hooks is used for the four maps.





Appendix 1:— continued



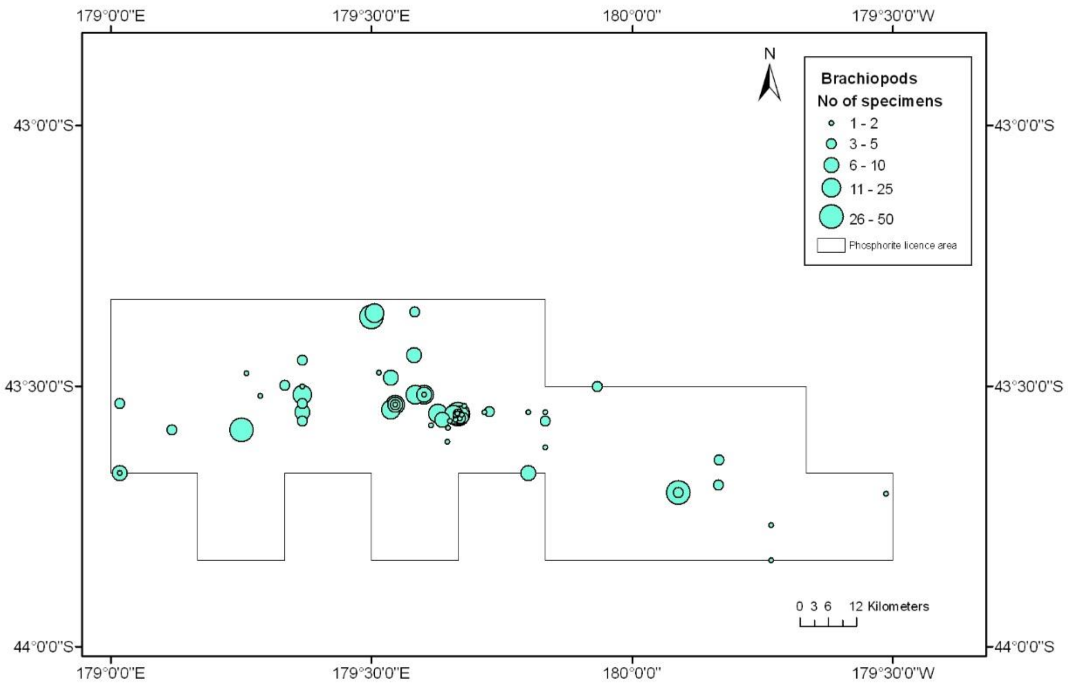


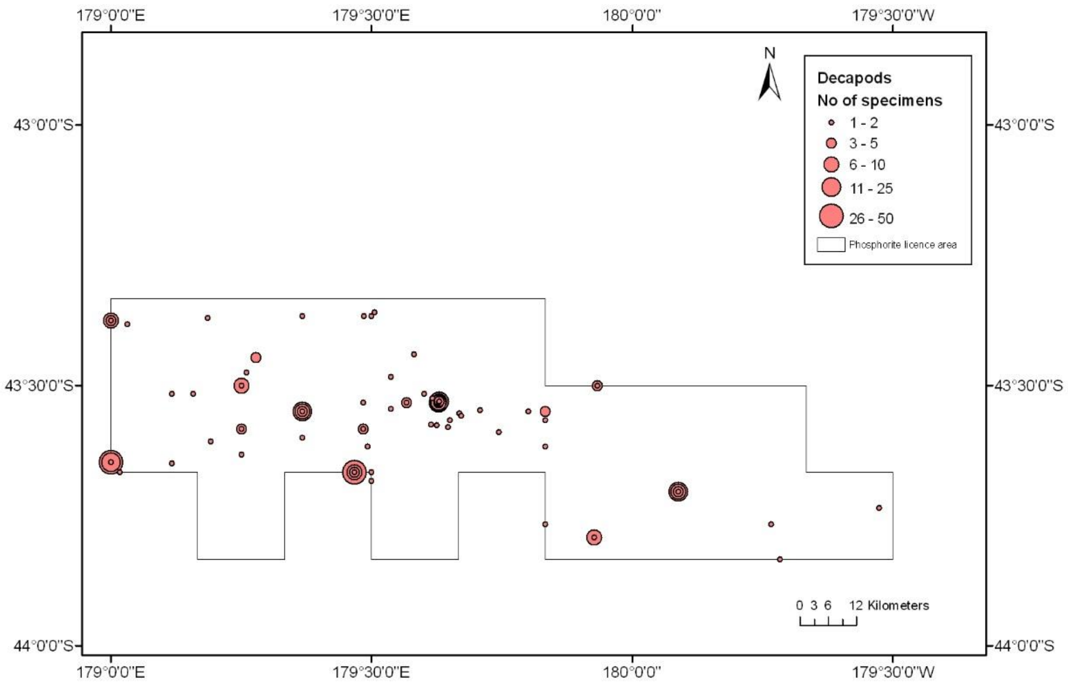
Appendix 2: Specimens recorded from beam trawls taken within the licensed area as part of the Chatham Islands Expedition in 1954 (Hurley 1961)

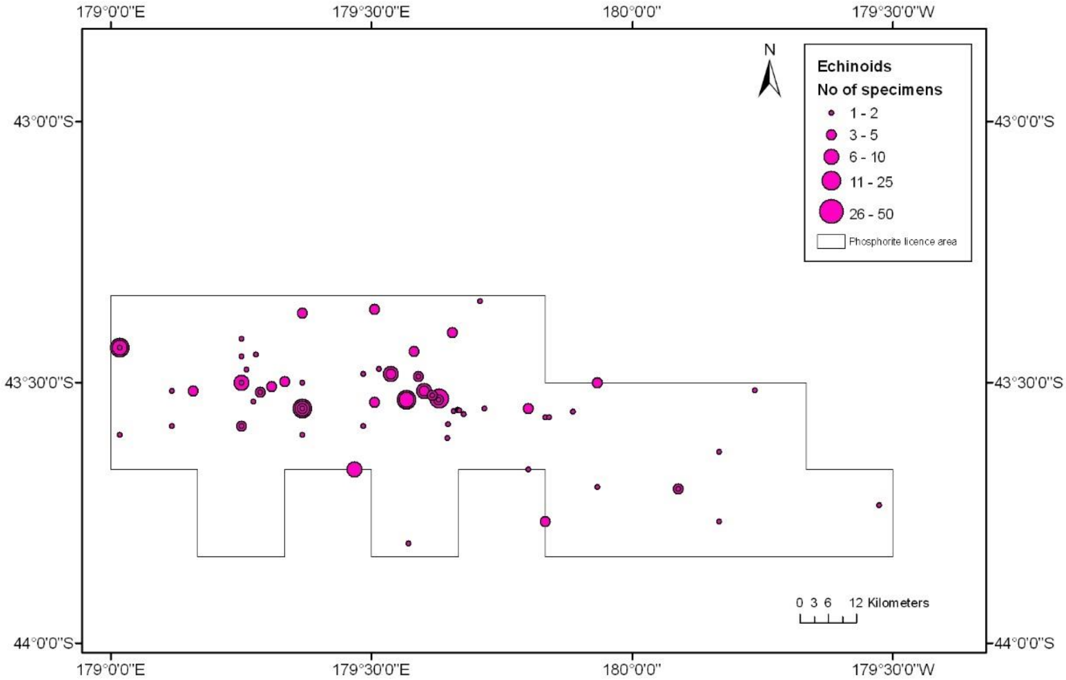
Stn 6: 107 males & 373 female *Serolis bromleyana* (isopod like *Glyptonotus*) – also Echinoderms: *Ophiuroglypha* irrorata, Spatangus multispinus, Crossaster japonicas, Pseudechinus flemingi; Polychaetes: *Hyalinoecia tubicola*; Brachyuran decapods: *Leptomithrax richardsoni*, *Carcinoplax victoriensis*; Decapoda Natantia: *Campylonotus rathbunae*, *Notopandulus magnoculus*, *Sclerocrangon knoxi*, *Prionocrangon curvicaulis*; Mollusca: *Nassarius ephamillus*, *Micantapex parengonius*, *Neilo australis*, *Falsilumatia powelli*, *Fusitriton laudandus*, *Fax alertae*, *Coluzea mariae*, *Comitas onokeana vivens*, *Alertalex blacki*, *Aeneator recens*, *Dentalium tiwhanum*, *Nucula strangiformis*, *Zeminolia meridiana*, *Proximitra banksi*, Aeneator.

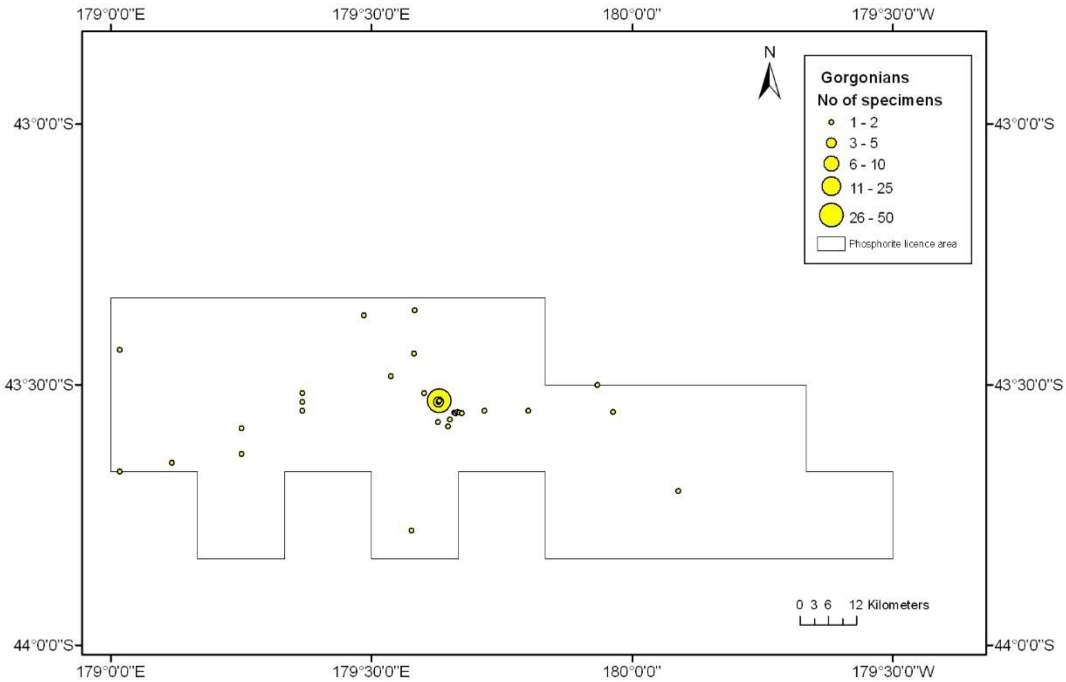
Stn 7: 105 males & 184 female. – also Echinoderms: *Ophiuroglypha irrorata*, *Spatangus multispinus*, *Crossaster japonica*, *Paramaretia multituberculata*; Polychaetes: *Hyalinoecia tubicola*; Brachyuran decapods: *Leptomithrax richardsoni*; Decapoda Natantia: *Campylonotus rathbunae*, *Sclerocrangon knoxi*, *Prionocrangon curvicaulis*, *Pontophilus acutirostratus*; Mollusca: *Nassarius ephamillus*, *Micantapex parengonius*, *Neilo australis*, *Falsilumatia powelli*, *Fusitriton laudandus*, Fax *alertae*, *Coluzea mariae*, *Comitas onokeana vivens*, *Alertalex blacki*, *Aeneator recens*, *Dentalium tiwhanum*, *Zeminolia meridiana*, *Aeneator valedictus*, *Teremelon knoxi*.

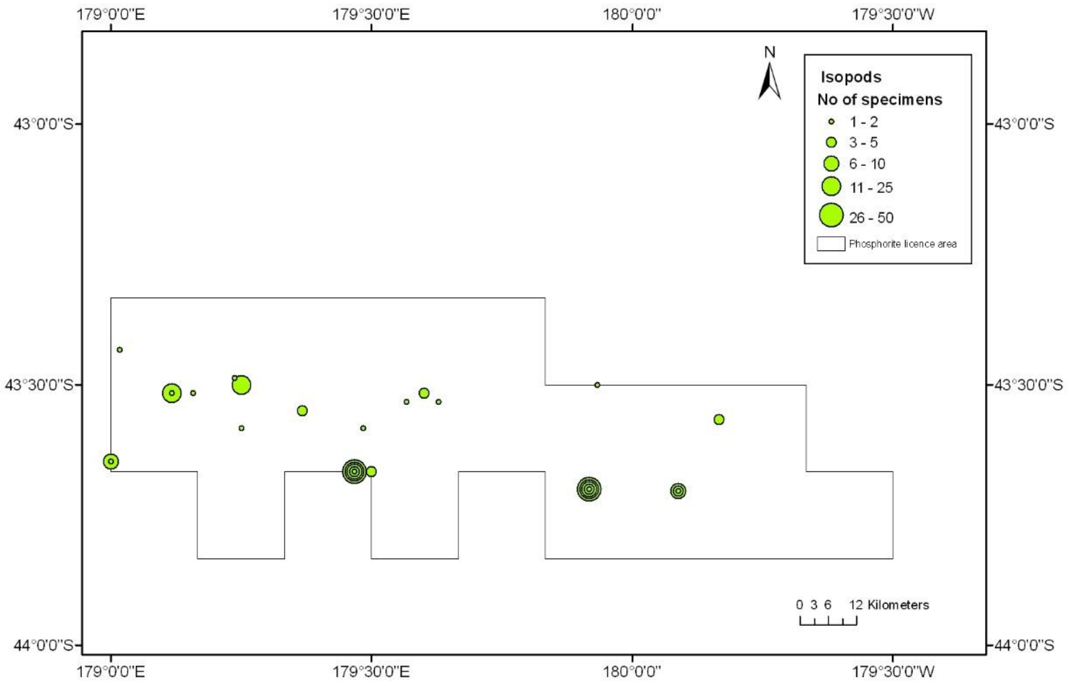
Appendix 3: Spatial distribition of benthic invertebrate specimens recorded per site in NIWA's *Specify* database. Note that the data from the *Specify* databse is not fully quantitative and thus does not represent absolute seabed abundances.






179°0'0"E
179°30'0"E
180°0'0"
179°30'0"W
43°0'0"S
43°30'0"S
44°0'0"S
N
Echinoids
No of specimens
1 - 2
3 - 5
6 - 10
11 - 25
26 - 50
Phosphorite licence area
0 3 6 12 Kilometers


179°0'0"E
179°30'0"E
180°0'0"
179°30'0"W
43°0'0"S
43°30'0"S
44°0'0"S
N
Gorgonians
No of specimens
1 - 2
3 - 5
6 - 10
11 - 25
26 - 50
Phosphorite licence area
0 3 6 12 Kilometers


179°0'0"E
179°30'0"E
180°0'0"
179°30'0"W
43°0'0"S
43°30'0"S
44°0'0"S
N
Isopods
No of specimens
1 - 2
3 - 5
6 - 10
11 - 25
26 - 50
Phosphorite licence area
0 3 6 12 Kilometers