Commercial Fishing in Whangarei Harbour and Bream Bay

Prepared for Refining NZ
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1.0 Introduction

1.1 Refining NZ's Crude Project

Refining NZ is proposing changes to the approaches to Whangarei Harbour to allow bigger cargoes of crude oil to be brought to the refinery (Tonkin & Taylor 2016). Bigger cargoes would reduce the cost of transporting crude oil to the refinery and allow it to better compete with much larger Asian refineries.

Refining NZ's proposed project has a number of components listed below. Each of these is further described in the following paragraphs.

- Capital and ongoing maintenance dredging to first increase and then maintain the shipping channel at a depth that would allow safe passage for ships with 16.6m draft,
- Partially realigning the shipping channel to provide safe navigational access for fully laden 'Suezmax' ships
- Changes to navigational aids along the new shipping channel, including removal, replacement and relocation of these aids
- Disposal of the dredged material from both capital and ongoing maintenance dredging at sea at two sites in Bream Bay.

Figure 1 shows the area to be dredged and the proposed disposal sites.

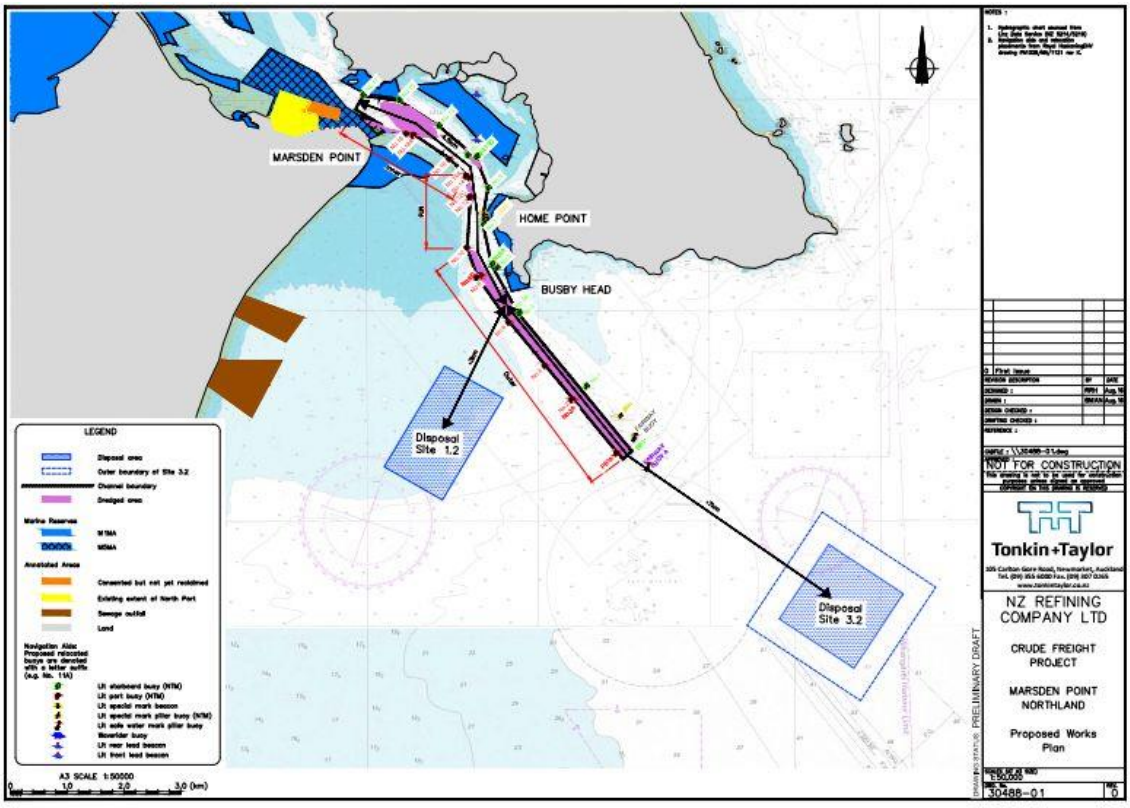

Figure 1: Proposed dredging and disposal sites (from Tonkin & Taylor 2016).

Tonkin & Taylor (2016) gives a description of the project including the physical characteristics of the dredge and disposal areas, and the equipment proposed for the work. To deepen the approach channel to the Refinery, 3.7Mm^3 of fine and medium sand will be dredged (capital dredging), most of this from the outer channel. The material to be dredged is predominantly medium sand with small fractions of silts and clays, fine and coarse sand and some gravel-like coarse shell. The total area to be dredged is 1.95km^2. In future years some ongoing maintenance dredging is likely to be required at periodic intervals to maintain the depth of the deepened channel.

It is likely that a Trailing Suction Hopper Dredger (TSHD) will undertake most of the capital dredging and that it would be completed within a period of six months or less depending on the size of the dredge. A number of smaller support vessels would support the TSHD. Periodic maintenance dredging is expected to be required at intervals of 2-20 years depending on location and rates of deposition in the berthing and channel areas.

The approach channel will be slightly re-aligned to improve safety for tanker ships delivering crude oil to the Refinery. This will require installing new additional navigational aids for the re-aligned shipping channel, and the relocation of some existing aids.

Most of the dredged material would be relocated to the seabed at a depth of 45 metres south east of Whangarei Harbour and east of 3 Mile Reef (Figure 1, Site 3-2). The dredged material would be spread evenly to cover all of Site 3-2.

A small quantity (2.5-5% of the total dredged material from the capital dredging) would be deposited on the south-eastern side of Mair Bank (Figure 1, Site 1-2) at depths of 7 to 15 metres, with the aim of helping to slowly replenish sand that is gradually being lost from the harbour's ebb-tide delta. At Site 1-2, it is likely that smaller areas will be targeted for deposits rather than the material being spread uniformly over the site and the location. The quantity and placement of these targeted deposits may vary according to how they perform as replenishment sources for the ebb-tide delta.

Following the proposed work to deepen the approach channel to Whangarei Harbour, the dredged material from periodic maintenance dredging would use the same disposal sites as the capital dredging.

Both proposed disposal sites are 2.5km^2 and the existing seabed is comprised of sandy sediments very similar to the material to be dredged from the harbour channel. At Site 3-2 there is a maximum area of 5.75km^2 around the disposal site where the sediment may disperse over time. No similar area is calculated for Disposal Site 1-2 as the intended purpose is for material to move shoreward over time as a result of natural coastal processes. At both disposal sites the deposited material will soon compact to a similar density as the surrounding area. At Site 3-2 which is deeper, little dispersal is expected over time. At Site 1-2 which is shallower, targeted disposal of small quantities of dredged material over part of the site (10% of the total area) is designed to provide a source of material to replenish the adjacent areas and some dispersal will occur.

1.2 Interaction of Commercial Fishing with Refining NZ's Crude Project

The primary purpose of this report is to examine commercial fishing in relation to Refining NZ's proposed Crude Project in order to identify the potential impacts of the proposal.

Commercial fishing is extensive throughout the northern Hauraki Gulf and Northland coast. The remaining sections of this report commence with a brief background to the inshore commercial fisheries found in the region. It then describes commercial fishing activity in Whangarei Harbour and

Bream Bay focusing on areas where there is interaction between the proposed dredging and disposal, and commercial fishing. The final section of the report examines potential impacts of Refining NZ's project on commercial fishing in Whangarei Harbour and Bream Bay.

2.0 The Commercial Fish and Shellfish Fauna

2.1 Background

Fishes and shellfish are amongst the most important components of marine ecosystems. The distribution of each species is strongly influenced by the presence of its preferred habitat. Some species such as flatfish predominantly occupy shallow harbours. Coastal species such as snapper, gurnard and John dory are found on the open coast from very shallow waters to at least 100m depth but are most abundant in waters shallower than 50m. Shellfish species such as pipi and scallops are generally sessile or less mobile although most shellfish species release their eggs and larvae into the sea where they can be transported over considerable distances.

Comprehensive information on commercial fish and shellfish species, including the most recent stock assessments, can be found in Ministry for Primary Industries' annual Fisheries Assessment Plenary reports (Ministry for Primary Industries 2016a, 2016b). Most of the commercially important fish species found in Whangarei Harbour and Bream Bay are both highly mobile and widely distributed around northern and central New Zealand.

Many fish species exhibit seasonal movements for feeding or spawning. There are also considerable natural fluctuations in the abundance of many fish populations over time due to the effect of changes in environmental conditions that drive variations in survival and recruitment of juveniles into the adult population.

2.2 Bream Bay Fish and Shellfish Fauna

Research trawl surveys undertaken over a 34 year period in the greater Hauraki Gulf area as far north as Bream Head were analysed by Kendrick and Francis (2002). More than fifty species or species groups exceeded a 1% threshold of occurrence in the combined research tows (Table 1). The trawl survey results illustrate the diversity of the demersal (bottom dwelling) fish fauna of the area. All of these species are widely distributed throughout northern New Zealand. Most are vulnerable to commercial fishing and many are commercially valuable although only a handful is of commercial significance.

Table 1: Fish and squid species or species groups occurring in more than 1% of Kaharoa trawl tows, sorted by percentage occurrence in Kaharoa tows. (source: Table 3 in Kendrick & Francis 2002)

		Occurrence (%)	
Species	**Latin name**	**Kaharoa tows**	**Ikatere tows**
Snapper	*Pagrus auratus*	97.40	99.05
Jack mackerels	*Trachurus novaezelandia & T. declivis*	85.97	76.13
John dory	*Zeus faber*	84.62	77.33
Gurnard (Red gurnard)	*Chelidonichthys kumu*	76.82	74.94

Sand flounder	*Rhombosolea plebeian*	41.16	37.71
Leatherjacket	*Parika scaber*	31.60	29.59
Arrow squid	*Nototodarus sloani and N. gouldi*	27.34	8.83
Spotted stargazer	*Genyagnus monopterygius*	26.09	7.88
Broad squid	*Sepioteuthis australis*	24.84	3.82
Rig	*Mustelus lenticulatus*	23.39	63.25
Eagle ray	*Myliobatis tenuicaudatus*	22.25	48.21
Barracouta	*Thyrsites atun*	20.89	14.56
Lemon sole	*Pelotretis flavilatus*	19.96	35.32
Spotty	*Notolabrus celidotus*	19.85	11.46
Trevally	*Pseudocaranx dentex*	19.65	39.62
Blue mackerel	*Scomber australasicus*	18.71	16.47
Ray	*Dasyatis brevicaudata and D. thetidis*	15.70	32.94
Yellow-belly flounder	*Rhombosolea leporina*	14.45	13.13
Opalfish	*Hemerocoetes monopterygius*	14.03	2.63
Red mullet	*Upeneichthys lineatus*	13.72	17.42
Kahawai	*Arripis trutta*	13.41	12.41
Scaly gurnard	*Lepidotrigla brachyoptera*	13.41	6.92
Skates	*Dipturus nasutus and D. innominatus*	12.27	13.13
Pilchard	*Sardinops neopilchardus*	9.56	6.92
Soles	*Peltorhamphus novaezeelandiae and P. latus*	7.38	13.60
Crested flounder	*Lophonectes gallus*	7.17	12.89
Porcupinefish	*Allomycterus jaculiferus*	7.07	7.88
Yellow-eyed mullet	*Aldrichettaforsteri*	7.07	6.92
Blue cod	*Parapercis colias*	6.86	7.40
Witch	*Arnoglossus scapha*	6.55	4.54
Tarakihi	*Nemadactylus macropterus*	6.13	10.26
School shark	*Galeorhinus galeus*	5.51	21.48
Parore	*Girella tricuspidate*	4.99	2.63
Anchovy	*Engraulis australis*	4.57	4.54
Sea perch	*Helicolenus percoids*	4.57	1.43
Spotted gurnard	*Pterygotrigla picta*	4.37	1.19
Carpet shark	*Cephaloscyllium isabellum*	4.16	4.30
Frostfish	*Lepidopus caudatus*	3.95	0.72
Silverside	*Argentina elongata*	3.53	0.48
Kingfish	*Seriola lalandi*	3.12	5.25
Cucumberfish	*Chlorophthalmus nigripinnis*	2.81	0.48
Hammerhead shark	*Sphyrna zygaena*	2.70	9.31
Electric ray	*Torpedo fairchildi*	2.39	8.35
Snipefish	*Macrorhamphosus scolopax*	1.77	0.48
Conger eels	*Conger verreauxi and C. wilsoni*	1.66	1.67
Northern spiny dogfish	*Squalus mitsukurii*	1.56	1.67
Capro dory	*Capromimus abbreviatus*	1.56	0.24
Mirror dory	*Zenopsis nebulosus*	1.46	0.72
Red cod	*Pseudophycis bachus*	1.25	3.82
Gemfish	*Rexea solandri*	1.14	0.48

West & Don (2015) provide a literature review of fishes known from the Bream Bay area, most of which are associated with reef habitats not sampled by research trawls. Although the fishes identified in West & Don's (2015) literature review include some of the above species, many of the reef fishes they identify as known from the area are small and cryptic and not vulnerable to commercial fishing or to research trawls. The species identified in Table 1 are therefore additional to those in West & Don (2015)

Figures 2, 3 and 4 show the relative abundance of snapper, gurnard and John dory from the combined Kaharoa and Ikatere trawl surveys summarised in Table 1. These three species form the mainstay of much of the inshore commercial finfish fishery throughout the region, including Bream Bay. All the other species in Table 1 are relatively common. Many but not all are commercially valuable and form part of the overall commercial finfish catch. (*Note that the catch rate scale differs in each of these three figures.*)

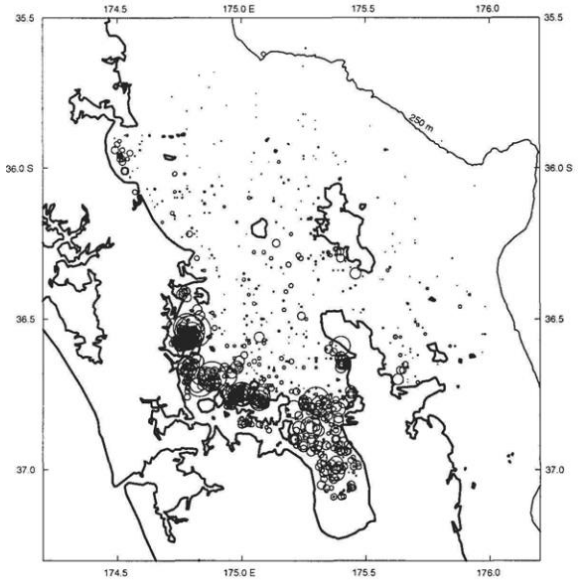

Figure 2: Catch rate of snapper (*Pagrus auratus*) at RV Kaharoa trawl stations. Circle diameter is proportional to catch rate (max catch rate 56 441 kg km^{-2}). (Figure 7 from Kendrick & Francis 2002)

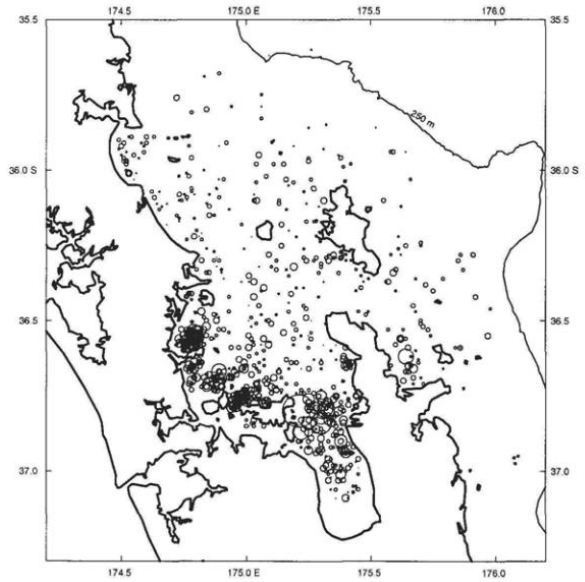

Figure 3: Catch rate of John dory (*Zeus faber)* at RV Kaharoa trawl stations. Circle diameter is proportional to catch rate (max catch rate 2 613 kg km^{-2}). (Figure 8 from Kendrick & Francis 2002)

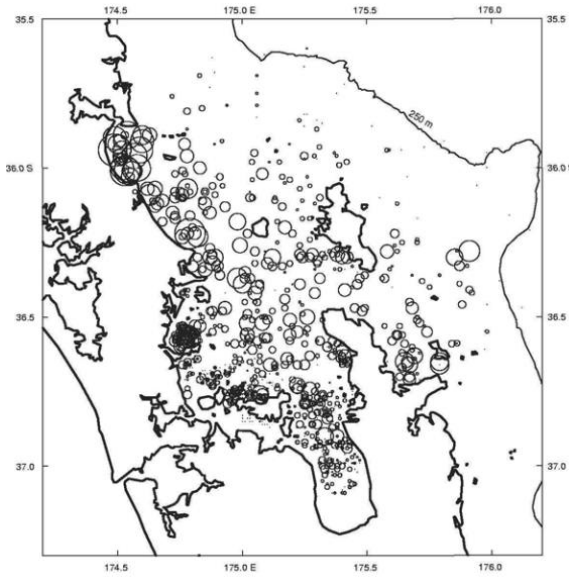

Figure 4: Catch rate of gurnard (*Chelidonichthys kumu*) at RV Kaharoa trawl stations. Circle diameter is proportional to catch rate (max catch rate 782 kg km^{-2}). (Figure 9 from Kendrick & Francis 2002)

Many common intertidal and shellfish species are also present in Whangarei Harbour and Bream Bay. A number of these also support commercial fisheries or have done so in the recent past. Commercial shellfish species occurring in the Whangarei Harbour and Bream Bay area include rock lobsters, scallops, paddle crabs, whelks, cockles and pipi. West and Don (2015) summarise the literature on the invertebrate/shellfish fauna of the area. Additional literature on the commercial shellfish species can be found in Ministry for Primary Industries' annual Fisheries Assessment Plenary reports (Ministry for Primary Industries 2016a, 2016b).

3.0 Commercial Fisheries of Whangarei Harbour and Bream Bay

3.1 Information sources

Commercial fishing catch and effort data is collected by Ministry for Primary Industries (MPI) using different templates or returns for each fishing method. Catch and effort data for some fishing methods (e.g., trawl, longline, set net) is reported by latitude and longitude. For other methods, it is reported only by 'fisheries statistical area' with unique reporting areas used for different species (e.g., rock lobster, scallop). The MPI statistical areas that commercial fishers use to record catch and effort also generally incorporate much larger areas of the coast than Bream Bay. This complicates compiling an overall data set of catch and effort for all species for the area. Therefore, examination of commercial catch and effort data reported by MPI statistical area has been combined with information provided by commercial fishers to provide a much more comprehensive understanding of commercial fishing in Whangarei Harbour and Bream Bay.

The commercial catch and effort data by latitude and longitude that is collected by MPI from trawl, longline and some set net fishing is available in the form of downloadable maps on MPI's website at http://fs.fish.govt.nz/Page.aspx?pk=91. These maps show the distribution of total commercial catch and effort for all species combined. Additional information on catch by method by species by MPI fisheries statistical area is available from the National Aquatic Biodiversity Index System (NABIS)

website at http://www.nabis.govt.nz/. Both sources have been used in the preparation of this report.

The finest-scale geographic subdivision of catch and effort data available for most individual species and commercial fishing methods is for MPI's Fisheries Statistical Area 003 (FSA003) which incorporates the coastline from Karangi, near the west end of Taupo Bay, south about 200km to Waipu Cove (Figure 5). Whangarei Harbour and Bream Bay lie within FSA003.

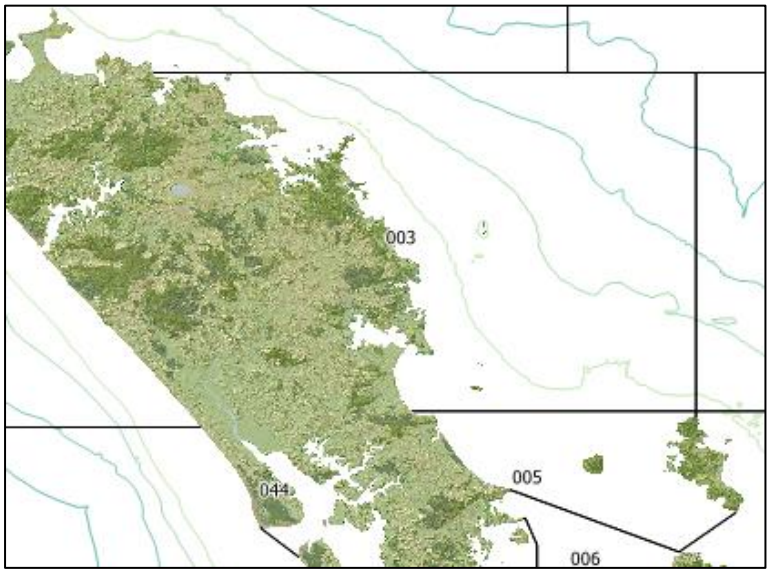

Figure 5: Map of MPI Fisheries Statistical Area 003

Different reporting areas are used for scallops (Figure 6) and rock lobster (Figure 7).

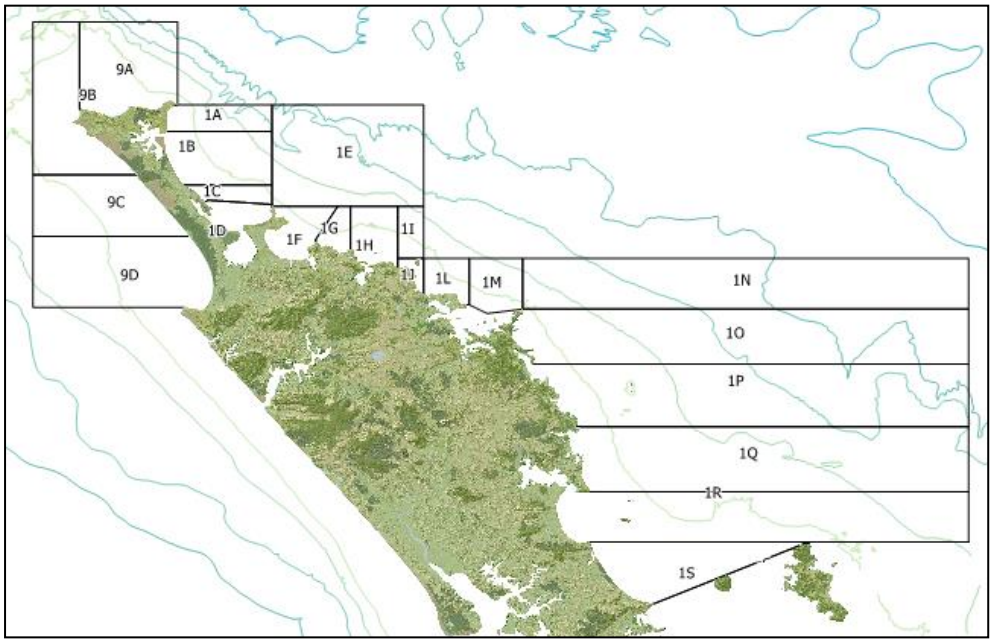

Figure 6: Map of MPI Scallop Statistical Areas for the SCA1 (Northland) scallop fishery. Bream Bay lies in Scallop Statistical Area 1R.

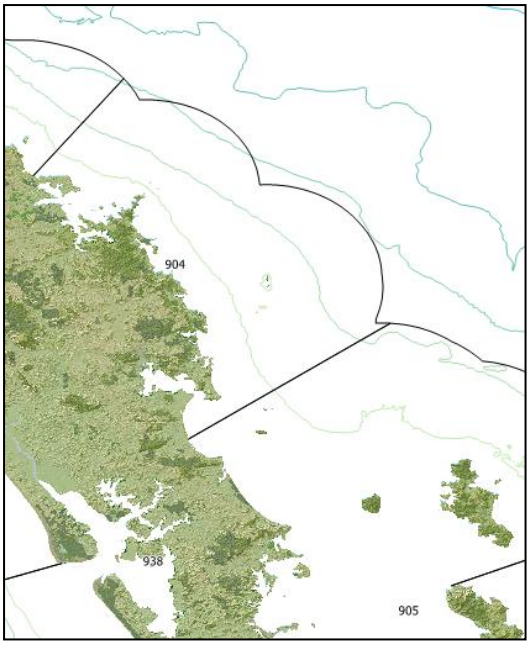

Figure 7: Map of MPI Rock Lobster Statistical Areas 904 and 905.

Scallop Statistical Area 1R incorporates all of Bream Bay. Rock Lobster Area 904 includes the coast from Bay of Islands to Waipu Cove.

To supplement official MPI catch and effort information and published research, local commercial fishers have been consulted to obtain local information on the distribution of commercial fishing activities in the area of interest around Bream Bay and Whangarei Harbour. This has been combined with official MPI catch and effort data (where appropriate data exists). Information available in the fisheries literature and in Ministry for Primary Industries' (2016a, 2016b) Annual Plenary Reports also provides some descriptions of commercial fisheries in the area.

3.2 Commercial Fishing Closures and Prohibitions

Some areas in Whangarei Harbour and Bream Bay are closed to commercial fishing entirely or to commercial fishing by certain methods.

Whangarei Harbour Marine Reserve incorporates two areas – one around Motukaroro Island and Lort Point and a second at Waikaraka – within which all fishing (including commercial fishing) is prohibited.

Under the Fisheries (Auckland and Kermadec Areas Commercial Fishing) Regulations 1986 certain commercial fishing is prohibited in defined areas of Bream Bay and Whangarei Harbour and these prohibitions are summarised below.

i. Trawling and Danish seining is prohibited inside a straight line drawn from the southernmost extremity of Busby Head to the shore on the southern end of Bream Bay (Figure 8).

ii. Fishing with a box or teichi net, purse seine net, Danish seine net, trawl net, or lampara net, or set nets of a total length exceeding 1 000 metres is prohibited in the waters of Whangarei Harbour lying inside a straight line drawn from the south-western extremity of Busby Head

to the northern chimney of the Marsden Point power station. (Figure 9). (This prohibition duplicates part of the closure in i. above).

iii. Drag netting is prohibited in Whangarei Harbour lying inside a straight line drawn from Marsden Point to Lort Point except in certain waters around Snake Bank (Figure 10).

iv. Commercial scallop fishing is prohibited from the waters of Whangarei Harbour lying inside a straight line drawn from the southern westernmost extremity of Peach Cove to the southernmost extremity of Busby Head to the northern chimney of the Marsden Power Station (Figure 11):

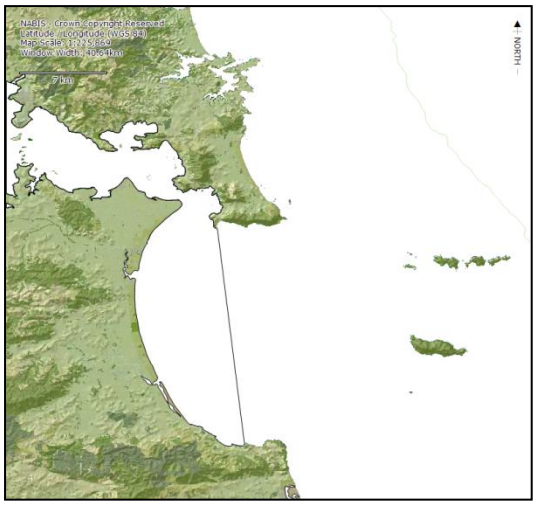

Figure 8: Trawl and Danish seine closed area, Bream Bay and Whangarei Harbour (area inshore of the line).

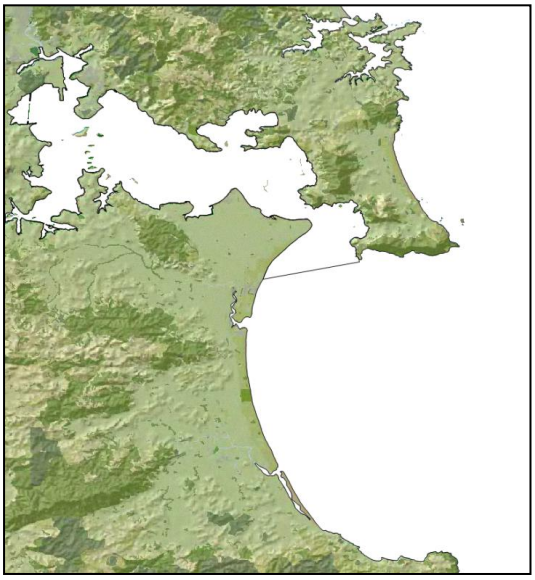

Figure 9: Fishing prohibited with a box or teichi net, purse seine net, Danish seine net, trawl net, or lampara net, or set nets of a total length exceeding 1 000 metres (Whangarei Harbour inshore of the line).

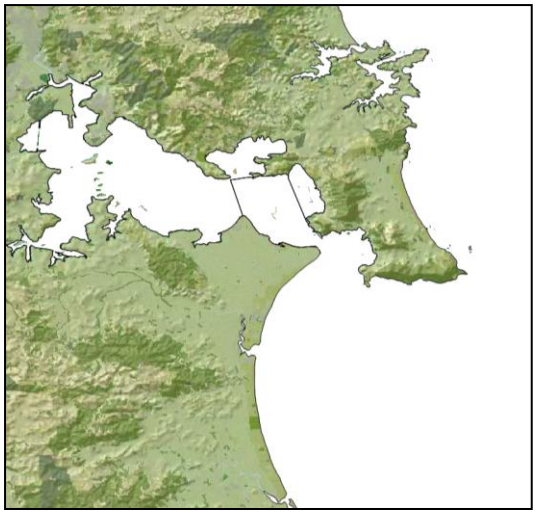

Figure 10: Areas closed to drag nets or beach seine (areas shoreward of the lines).

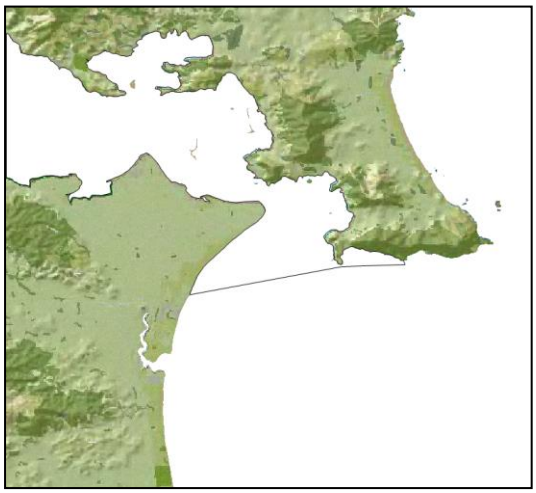

Figure 11: Areas closed to scallop fishing in Bream Bay (areas north of the lines)

Additional species prohibitions and method restrictions apply to commercial fishing under the Fisheries (Auckland and Kermadec Areas Commercial Fishing) Regulations 1986 but none of these close any additional areas. Froude & Smith (2004) provide a comprehensive list and maps of all area-based restrictions in the New Zealand marine environment, including all current commercial fishing restrictions in Whangarei Harbour and Bream Bay except the Whangarei Harbour Marine Reserve which was established in 2006.

3.3 Overview of Commercial Fishing

Inshore commercial fishing in Whangarei Harbour and Bream Bay includes several fishing methods targeting different species. There are no contemporary publications describing inshore commercial fishing activities in the area. MPI's fisheries research is primarily targeted at understanding individual species and the level of harvest they can sustain. MPI publications provide no documentation of the overall fishery, the fishing fleet or the industry's structure. As noted in section 3.1, MPI commercial fishery statistics for most species cover wide areas of the coast and most of these areas do not separate out local coastal areas at the scale of Bream Bay and Whangarei Harbour. Paul (2014) provides a comprehensive and useful overview of the history of the inshore commercial finfish fishery in the wider Hauraki Gulf (including Whangarei/Bream Bay) and how it has

developed until the present time. The snapper (*Pagrus auratus*) has been the mainstay of the inshore commercial finfish fishery throughout its development over the past century or more. However, flounders and grey mullet have been the principal commercial species fisheries targeted within shallow northern harbours such as Whangarei Harbour.

Table 2 gives estimated commercial catches of the main inshore commercial finfish species taken by fishing method reported from FSA003 (see Figure 5) from 1 Oct 2008 to 20 March 2003. Catches of species not generally taken in waters less than 50m depth or by commercial methods not used in the inshore areas of the fishery are not included.

Table 2: Estimated commercial catch (t) of the principal finfish species caught in waters less than 50m deep in MPI's FSA003 by method from 1 Oct 2008 to 20 March 2013. (catch data from Booth 2013). Species listed in order of highest to lowest all methods total catch.

Species	Bottom longline	Bottom trawl	Danish seine	Set net	Beach seine	Other methods	All methods total catch	% of total catch
Snapper	929.1	630.6	498.3	11.1	0.3	48.6	2,118.0	64.2%
Gurnard	76.3	53.5	118.6	2		4.2	254.6	7.7%
John dory		123.9	24.3	0.7		5.4	154.3	4.7%
Grey mullet				110.1		3.2	113.3	3.4%
School shark	66.1	31.5		10.7		1.4	109.7	3.3%
Flounders	0	0	0.9	106.3		0.2	107.4	3.3%
Trevally	8.9	74.1	1.5	10.4	2.4	4.0	101.3	3.1%
Leatherjacket		56.6	2.9			4.1	63.6	1.9%
Parore				55.4	1.6	0.4	57.4	1.7%
Rig	4.2	1.9		37		1.3	44.4	1.3%
Kingfish	12.9	4.9	0.5	2.1		5.2	25.6	0.8%
Kahawai	4.7	0.6		19.2		0.0	24.5	0.7%
Porae	7.5	3.7	0.1	6.9		0.4	18.6	0.6%
Garfish				12.4	4.4	0.2	17.0	0.5%
Yellow-eyed mullet				14.7		0.9	15.6	0.5%
Jack mackerel		12.6				0.0	12.6	0.4%
Red snapper	10.2	0.6				0.6	11.4	0.3%
Blue cod	2.3					1.0	3.3	0.1%
Total	**1,122.2**	**994.5**	**647.1**	**399**	**8.7**	**81.1**	**3,252.6**	

Although catch data for MPI's FSA003 includes a much larger area, both the methods used and species caught are representative of commercial fishing for finfish in Whangarei Harbour and Bream Bay.

Overall, Table 2 indicates that snapper dominates the catch of longline, trawl and Danish seine methods, all of which operate on the open coast of FSA003. Gurnard and John dory are the second and third most important finfish species overall. The set net fishery principally takes flounders and grey mullet in the shallower waters of enclosed harbours, with parore, garfish and yellow-eyed mullet also important. Some set netting occurs outside harbours, predominantly for sharks, snapper, kahawai and trevally.

The catch of shellfish species is not included in Table 2. Scallops and paddle crabs support the main commercial shellfisheries south of Bream Head. Until relatively recently there were also significant commercial fisheries for cockles at Snake Bank in Whangarei Harbour and pipi at Mair Bank. Some rock lobster potting occurs along the northern rocky shores from the harbour entrance out to Bream Head.

Each of the finfish and shellfish fisheries is described in more detail the following sections of the report. The finfish fishery is broken down by fishing method as each fishing method operates in different areas. The shellfish fisheries are broken down by individual species.

There is an extensive fisheries literature on all the individual commercial species available in Ministry for Primary Industries (2016a, 2016b)

3.4 Trawl and Danish Seine Fishery

3.4.1 Target Species

The bottom trawl and Danish seine fisheries in waters less than 50m depth principally target snapper but also catch much smaller quantities of a wide range of other mobile fish species; in particular John dory and gurnard (see Table 1). As noted in the previous section, the inner part of Bream Bay is closed to trawling and Danish seining (Figure 8).

3.4.2 Trawl and Danish Seine Methods

Both bottom trawl and Danish seine methods involve fishing gear that maintains contact with the seabed as it is being fished.

Trawl nets generally have a weighted ground rope or chain at the bottom of the net to maintain contact with the seafloor (Figure 12). Wire sweeps join the wings of the net to trawl doors that keep the trawl net mouth spread open. The trawl doors are weighted and also maintain contact with the seabed as the net is towed. A typical inshore trawl vessel will have a swept door to door path of 50 to 90 metres in width, depending on the size of the vessel. The duration and speed of trawl tows varies, but typical inshore vessels may tow for 2-3 hours at a speed of around 3 knots. Baird et al. (2015) found the average trawl tow length for an inshore trawl targeting snapper to be in the range of 6.6- 8.1 nautical miles (12-15 km).

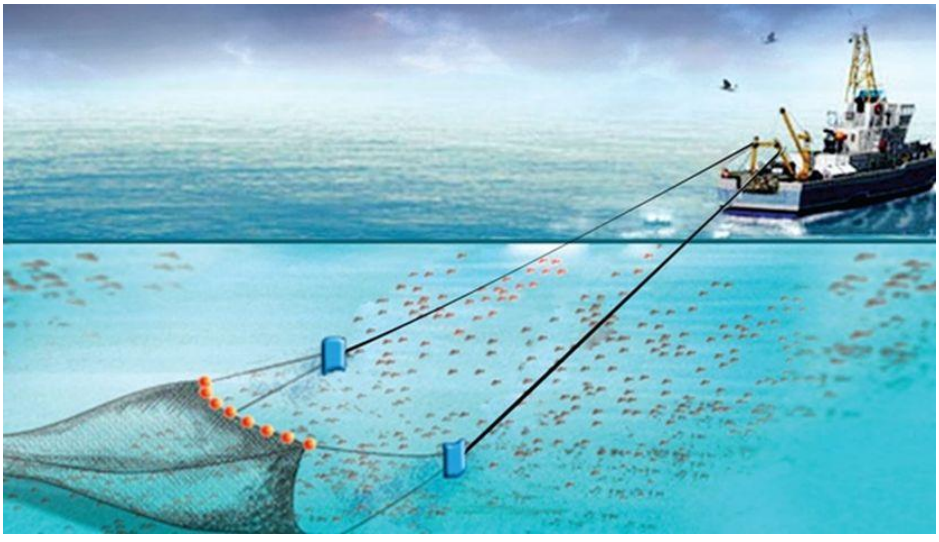

Figure 12: Image depicting typical bottom trawl net, sweeps and trawl doors being towed on the seabed.

Danish seine fishing involves the use of a net that is similar to a bottom trawl net. Instead of the net being towed over the seabed with wire sweeps and trawl doors to keep the net open, the wings of a Danish seine net are attached to very long weighted ropes that are winched back over the seabed toward the net. As the mouth of the net starts to close, the vessel steams slowly to capture the fish in the net. This method progressively encloses an area and herds bottom dwelling fish toward the net before it is brought back to the vessel. An area of several square kilometres may be swept in a typical Danish seine shot. Figure 13 shows a schematic diagram of a Danish seine net and how it is deployed.

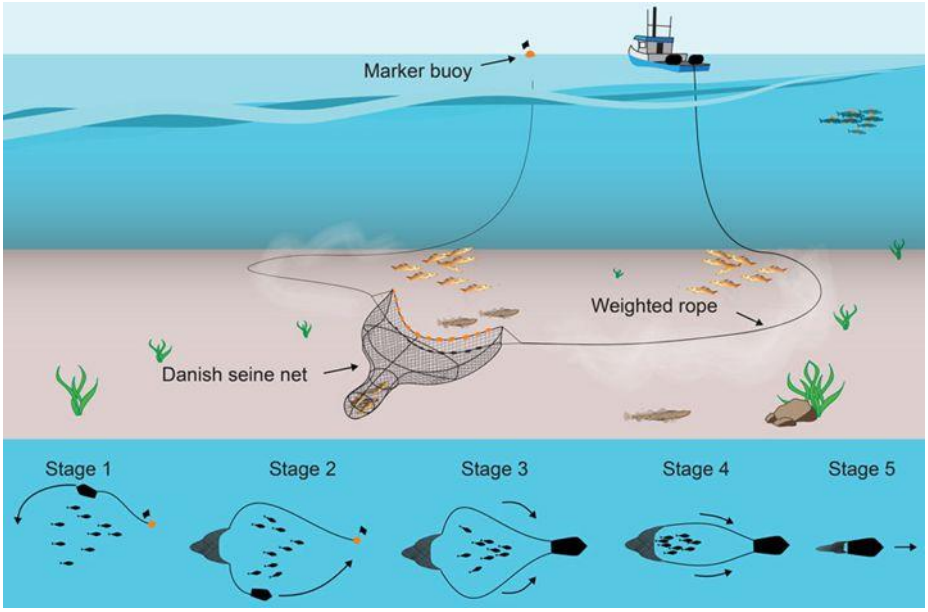

Figure 13: Depiction of Danish seine fishing and how the net and ropes are deployed

In summary, both bottom trawl and Danish seine gear is in continuous contact with the seafloor as it is towed or winched. This means both methods can only be used in areas with soft and relatively smooth seabeds – such as muds, sands and fine gravels. Sometimes trawling is conducted using 'bobbins' on the ground rope to roll over rougher areas.

3.4.3 Where Trawling and Danish Seining Occurs in Bream Bay

The sandy substrate that is found in most of Bream Bay is ideally suited to both trawling and Danish seine methods. Areas with rocky seabed or 'foul ground' such as Three Mile Reef or rocky seabeds or shoals are unable to be fished by either of these methods. Any contact with reefs or large rocks may damage the gear or pose risks to the vessel if the gear becomes snagged. Other seabed obstructions such as the presence of a vessel wreck or lost anchors can also prevent trawling and Danish seining. Modern navigational equipment allows vessels to accurately plot the position of these so called 'fasteners' and avoid them.

MPI maps in Figures 14a and 14b, show the spatial distribution of trawl fishing effort and catch respectively plotted in 1 nautical mile (nm) square grids over a five-year period from 1 October 2008 to 30 September 2013. The data plotted is the starting point of each trawl that may be several nautical miles in length. Trawls may be in any direction from their starting point.

TRAWL PLOT NOTES: Care is needed in interpreting these plots. The following notes are provided to assist in correctly interpreting the information presented in the figures.

Intensity Scale: The legend (top right corner on Figures13a and 13b) indicates the effort and catch range for each colour. Without the use of the legend, the colour density scale can be potentially visually deceptive. On face value, it looks to be a simple progressive linear increase from light to dark (representing light to heavy fishing effort). However, the effort scale in Figure13a is highly skewed. The legend indicates the four lowest effort categories are all very low – an average of 5 or fewer 'events' or trawls per year per $1nm^2$ grid. The highest (darkest) category is anything above 5 trawls per year up to a maximum of 120 trawls. This maximum of 120 trawls may be in a single grid and may located anywhere around New Zealand. It is apparent that MPI have compressed most of the real range in the number of trawls per grid into this single highest category of >5 to 120. For this reason, only limited conclusions can be reached about the importance of specific areas to trawling from the MPI plots. A similar skewed scale has been used by MPI for the plots of average annual catch (see the legend top right, Figure 13b).

Therefore, using Figures 13a and 13b it is only possible to draw limited conclusions about trawling such as:

- where trawling occurs and where it does not occur at all.
- where average trawl effort is very low to low (an average of >0 to 5 trawls per $1nm^2$ grid per year) and where it is higher than an average of 5 per year but may be up to 120 trawls per year.
- information on average annual catch of all species combined.

Effect of Trawl Length: An additional point to be considered when interpreting the MPI trawl plots is that they are based on the grid where trawls commenced. Most inshore trawls in northern New Zealand target snapper. The average length of a snapper trawl is between 6.6 – 8.1 nautical miles (nm) although some trawlers may tow for much shorter distances. Thus, the MPI trawl plot distribution in Figures 13a and 13b is highly biased toward where trawlers prefer to start their fishing. A trawl may head in any direction from its starting point.

Overall: The MPI trawl plots in Figure 13 are most meaningful when viewed on a wide scale – to show broad areas of the coast where trawling occurs or does not take place, and where there is the most trawl effort and average catch. Clusters of grids all with more than 5 trawls per year will be the areas most intensively fished.

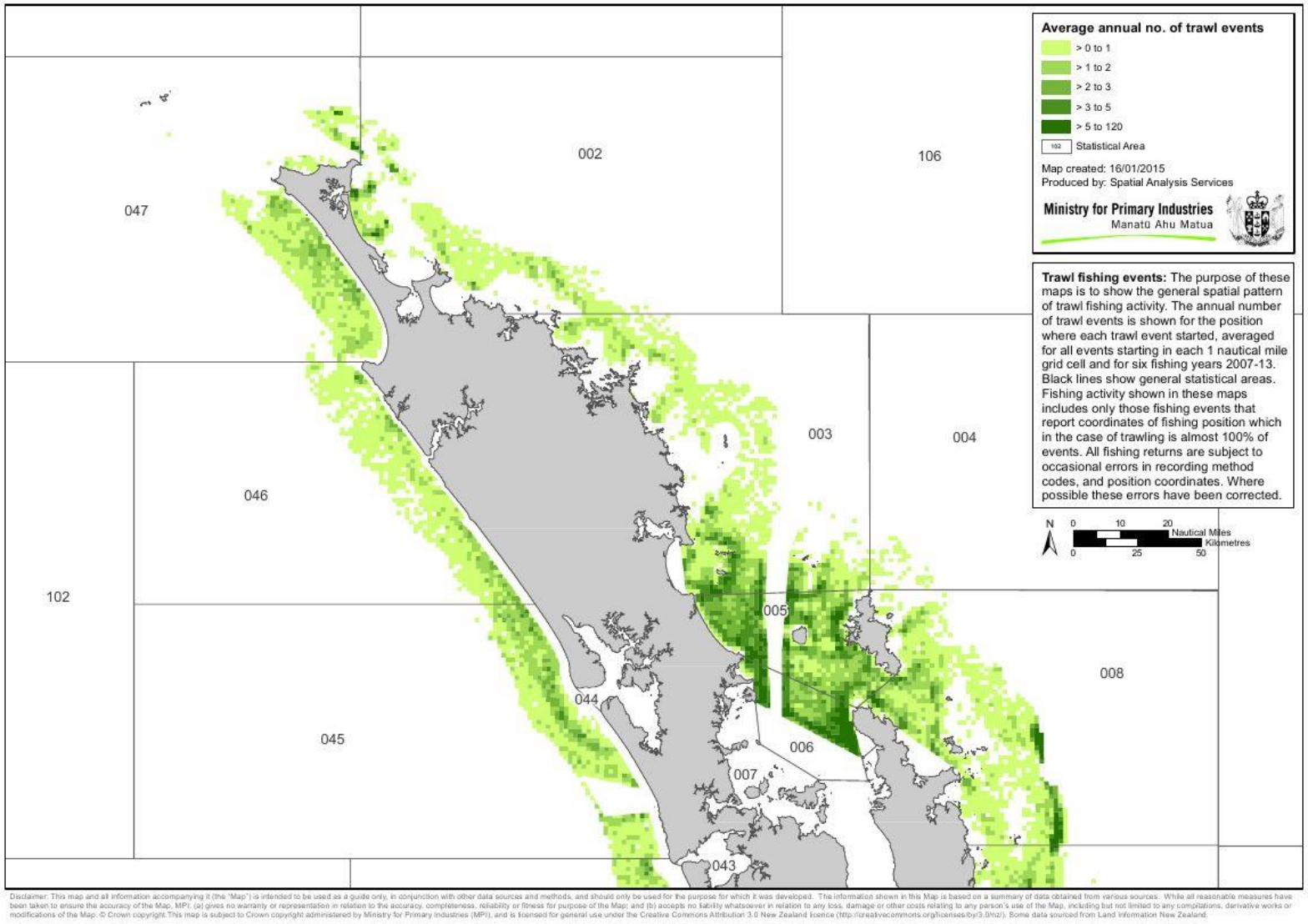

Figure 14a: Annual average no. of trawl tows (events). See insets for legend and other important details.

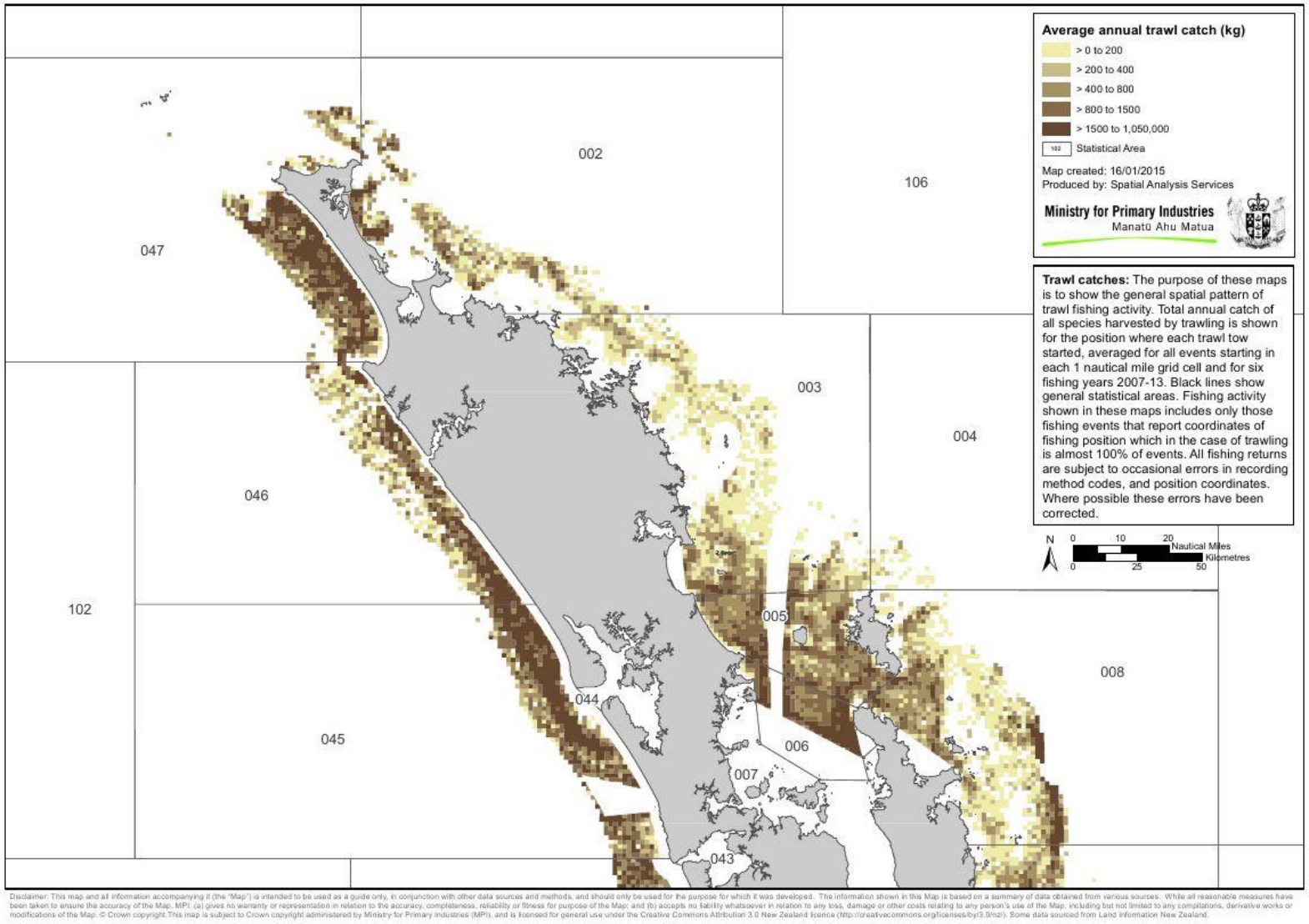

Figure 14b: Average annual trawl catch (all species combined). See inset for legend and other important details.

The plots in Figure 14a show is that trawling is very widespread along the east and west coasts of northern New Zealand. The inshore areas along the Northland coast from Bream Head to Houhora are relatively lightly trawled due to the predominantly rocky inshore seabed. Both effort and catch (Figures 14a and 14b respectively) appear to be highest in the Hauraki Gulf and south of Bream Bay.

The location of the proposed disposal site 3-2 is indicated in Figures 15a and 15b which are magnified images of trawl effort and catch in Bream Bay. Note again that the plots are of the starting position of trawls that may head in any direction from the start point and they may extend for distances of more than 6 nm.

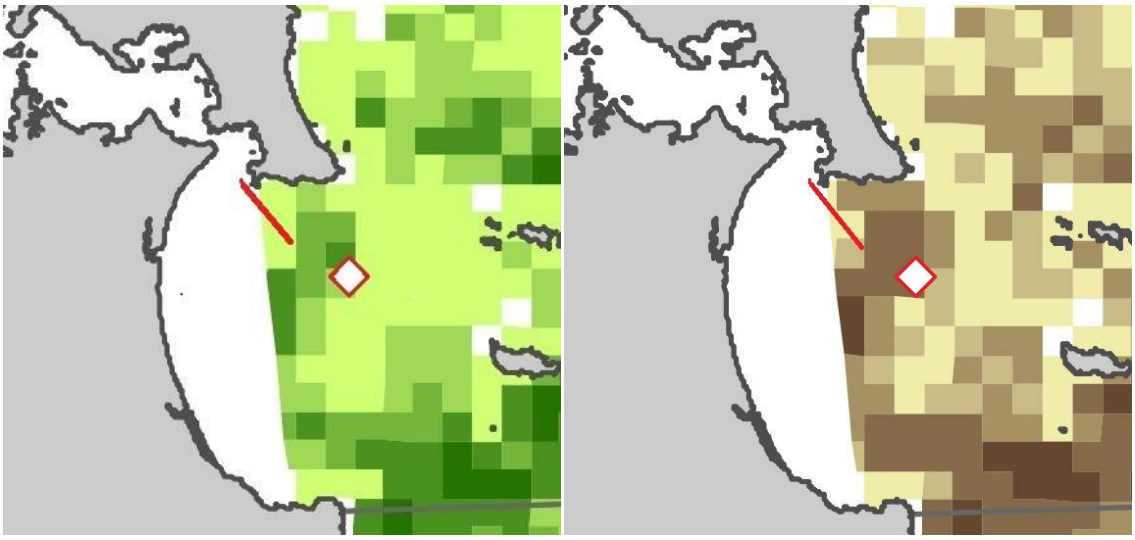

Figure 15a, 15b: Location of proposed outer dredging footprint (solid red line) and proposed Disposal Site 3-2 (red and white diamond) in relation to spatial distribution (1 nm grid) of the average annual trawl events and average annual catch respectively in Bream Bay (magnified images from Figures 14a and 14b). The plots are based on an average of 6 fishing years 2007-2013. Effort and average catch categories are described in the legend insets in Figures 14a and 14b. The advisory notes on interpretation of the MPI trawl plots provided earlier need to be kept in mind.

Figure 15a shows that some trawling occurs throughout Bream Bay (based on starting position). This is consistent with the wide distribution of snapper and the sandy seabed that is suitable for trawling in most of Bream Bay. There is no single $1nm^2$ grid in Bream Bay where there was an average effort of more than 5 trawls commencing per year. Most areas in Bream Bay received low to moderate fishing effort. There is a concentration of slightly higher trawl effort along the trawl limit line and in a single $1nm^2$ grid overlapping proposed Site 3-2. Average annual catches in Bream Bay (Figure 15b) were highest for trawls commencing along the trawl limit line.

Overall, Figures 14a and 15a show that commercial bottom trawling (trawling) is extensive on the northeast coast wherever there is soft seabed, including in Bream Bay. Trawl effort in Bream Bay is generally low to moderate between >1 to 5 trawl events commencing per $1nm^2$ grid per year.

However, this larger perspective of the distribution of trawling risks masking how individual trawl vessels operate. Individual commercial fishers tend to operate in different areas based on their base port and local knowledge. Whangarei based trawlers spend more time operating in Bream Bay. Nonetheless, Figure 15a clearly indicates a relatively low average number of trawls commence annually in most areas of Bream Bay and there is no evidence that Bream Bay is a hotspot for commercial trawling.

There are no similar maps available from MPI showing the spatial distribution of Danish seine fishing. Individual Danish seine shots can encompass several km^2. However the areas where bottom trawling takes place are generally also suited to Danish seining which generally operates in the same inshore areas as trawling, especially in depths <50m. Like inshore trawling, Danish seining also predominantly targets snapper.

MPI commercial catch data (www.nabis.govt.nz) indicates that trawlers take about 25% of the total snapper catch in MPI's Fisheries Statistical Area 003 (Figure 5) and Danish seiners take about 15%.

In summary, Whangarei based trawl and Danish seine fishers indicate that they fish throughout Bream Bay wherever the seabed does not prevent their gear from being used. The area to the east of 3 Mile Reef is actively fished by both methods, principally targeting snapper but there is no evidence that it is a trawling hotspot. Trawlers and Danish seiners based in Auckland also fish Bream Bay from time to time as part of their overall fishing activity.

3.4.4 Trawling and Danish Seining in or near Proposed Dredging and Disposal Sites

Figure 16 shows the main areas of commercial fishing activity by trawlers in Bream Bay (>3-5 trawls commencing annually per 1 nm^2), interpolated from the MPI plots in Figures 14 and 15 and discussions with fishers. Danish seine vessels also operate in similar areas as trawlers including part of proposed Disposal Site 3-2.

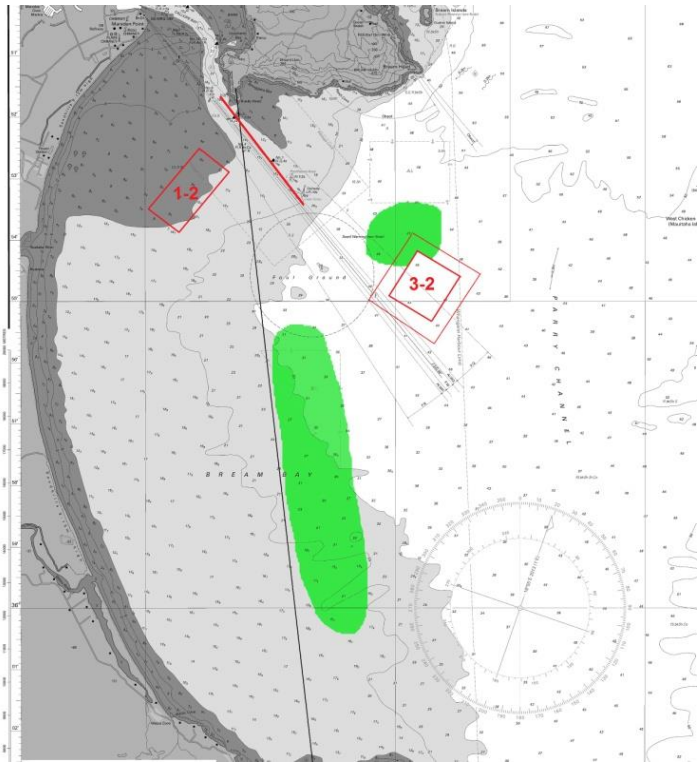

Figure 16: Main areas of bottom trawl fishing activity in Bream Bay.

The area with the most trawl fishing effort and that also has the highest catches in Bream Bay appears to lie along the trawl limit line. Another area with higher trawl effort overlaps proposed Disposal Site 3-2. Less information is available on the distribution of Danish seining which is not included in Figure 16.

3.5 Bottom Longline Fishery

3.5.1 Target Species

The bottom longline fishery predominantly targets snapper with gurnard an important bycatch.

3.5.2 Longline Method

Bottom longlines for snapper fishing have a mainline up to several kilometres in length anchored on the seafloor at either end with buoy lines marked by flags (Figure 17). Baited traces are clipped to the main line. Once on the seabed, the longline is stationary.

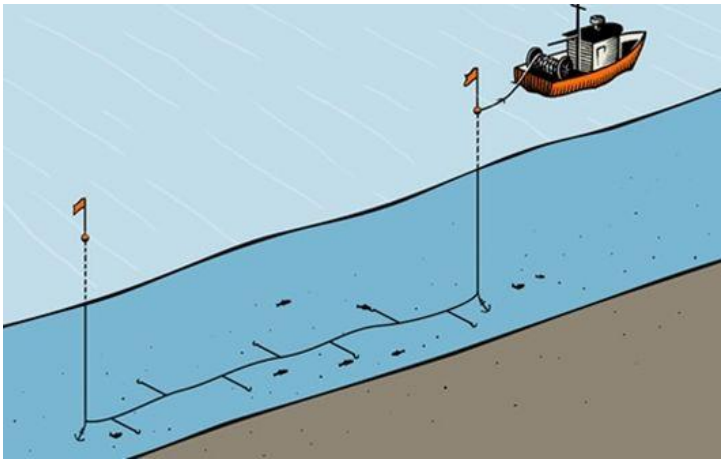

Figure 17: Image of a typical bottom longline.

Bottom longlining can take place over both soft and hard seabeds and is therefore more spatially extensive along the coast than trawling or Danish seining. There are also no areas closed to bottom longlining in Bream Bay or Whangarei Harbour. Bottom longline fishing takes nearly 60% of the total snapper catch in MPI's FSA 003.

3.5.3 Where Longline Fishing Takes Place in Bream Bay

MPI maps in Figures 18a and 18b show the spatial distribution of the starting positions of longline fishing effort and catch respectively plotted in 1 nm grid over a five-year period from 1 October 2008 to 30 September 2013. Longline gear may be set in any direction from the start point and may extend for up to several kilometres. However, as the grid cells in Figure 18 are $1nm^2$ (1 nm = 1.85 km) the plots provide a reasonable picture of the true distribution of catch and effort along the coast. Note that the insets in Figures 18a and 18b indicate that only about 70% of all longline fishing sets or events is incorporated in these figures. Therefore these figures slightly underestimate the average annual effort in each grid cell although the degree of underestimation may vary from 1 nm^2 grid to grid.

LONGLINE PLOT NOTES: Care is needed in interpreting these plots. The following notes are provided to assist in correctly interpreting the information presented in the MPI longline plots.

Intensity Scale: The legend (top right corner on Figures16a and 16b) indicates the effort and catch range for each colour. As with the trawl effort and catch plots, the plots are skewed and the same caveats apply as for the trawl plots. Most of the effort range is compressed into the top effort category of >5 to 30. However the top longline category is narrower than the top trawl category so there appears to be less skew than in the trawl plots.

Effect of Longline Length: Longline gear is stationary. The plots of longline effort are based on the starting position of the longline. The length of longlines may exceed 1nm but often not much more than that. Therefore, the grid plots of longline effort give a reasonable picture of the vicinities where the greatest fishing effort occurs.

Overall: The MPI longline trawl plots in Figures 16a and 16b provide a reasonable picture of the distribution of longline effort and where the greatest catches are made. However, Figure16a will slightly underestimate the true average annual effort because only about 70% of all longline fishing is reported by latitude and longitude.

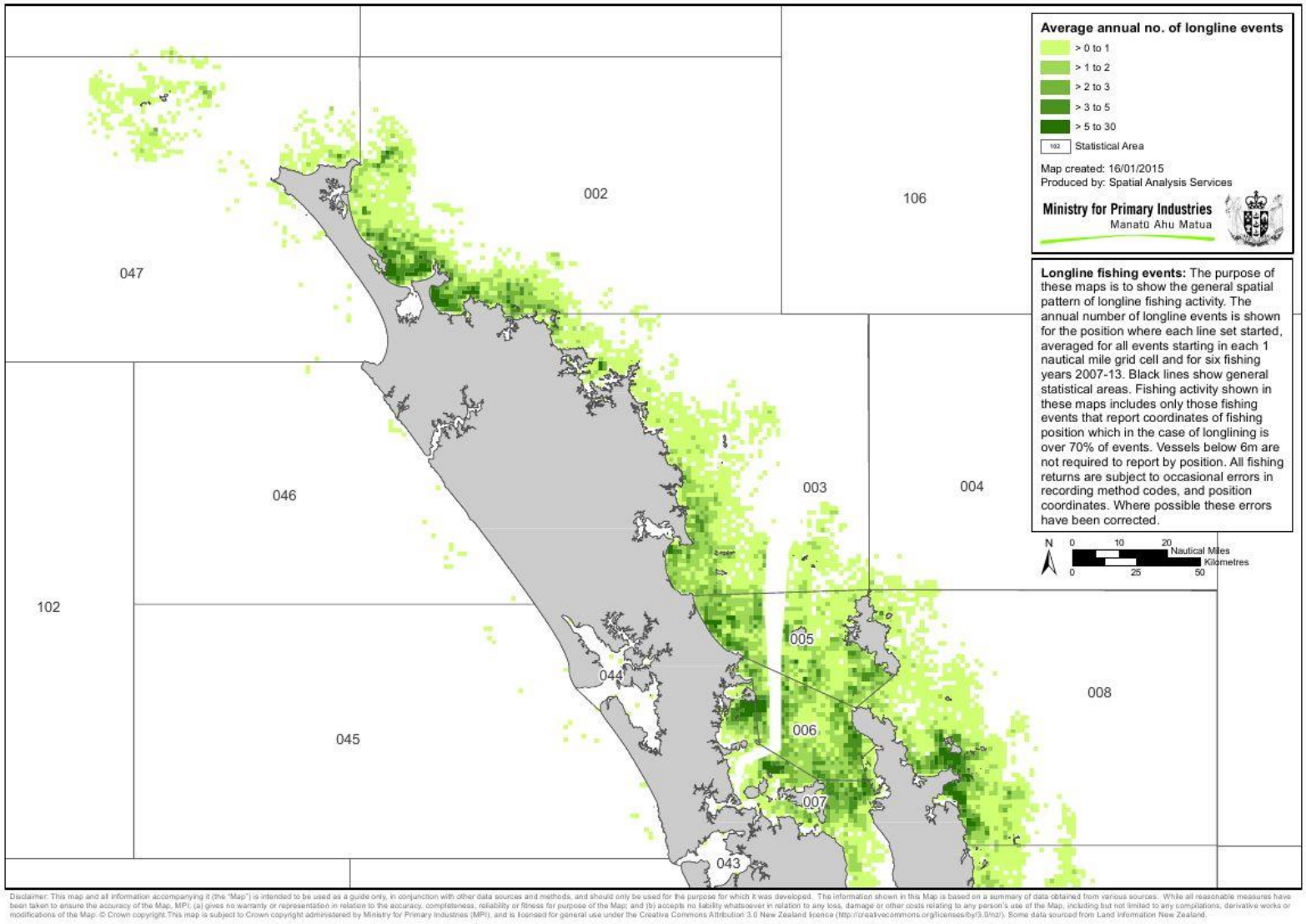

Figure 18a: Annual average no. of longline events or sets. See inset for legend and other details

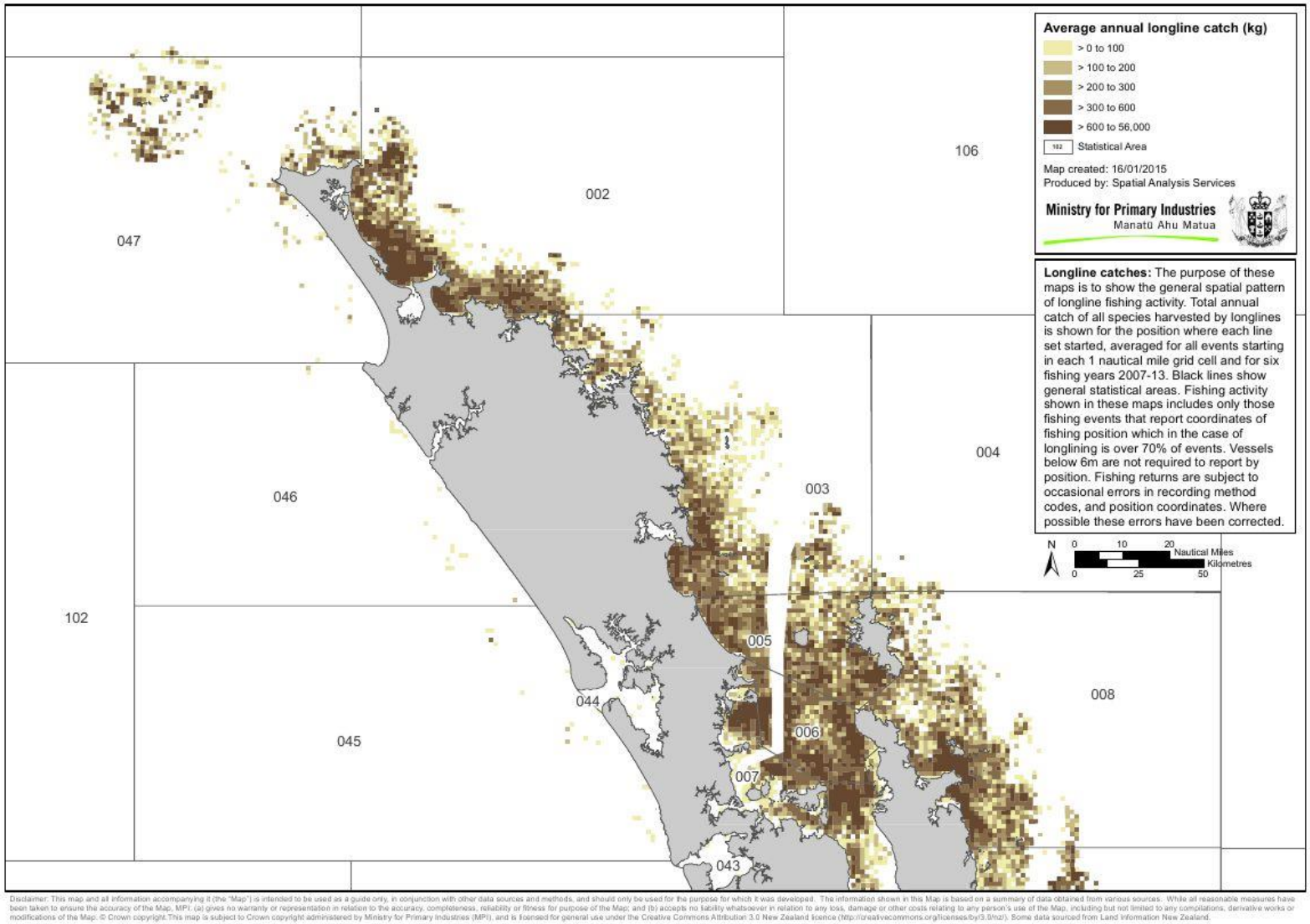

Figure 18b: Annual average annual longline catch, all species combined. See inset for legend and other details.

3.5.4 Longlining in or near Proposed Dredging and Disposal Sites

Figures 19a and 19b below are magnified images of longline effort and catch in Bream Bay plotted in 1nm^2 grid cells taken from Figure 18. The plots are based on the starting position of longline sets.

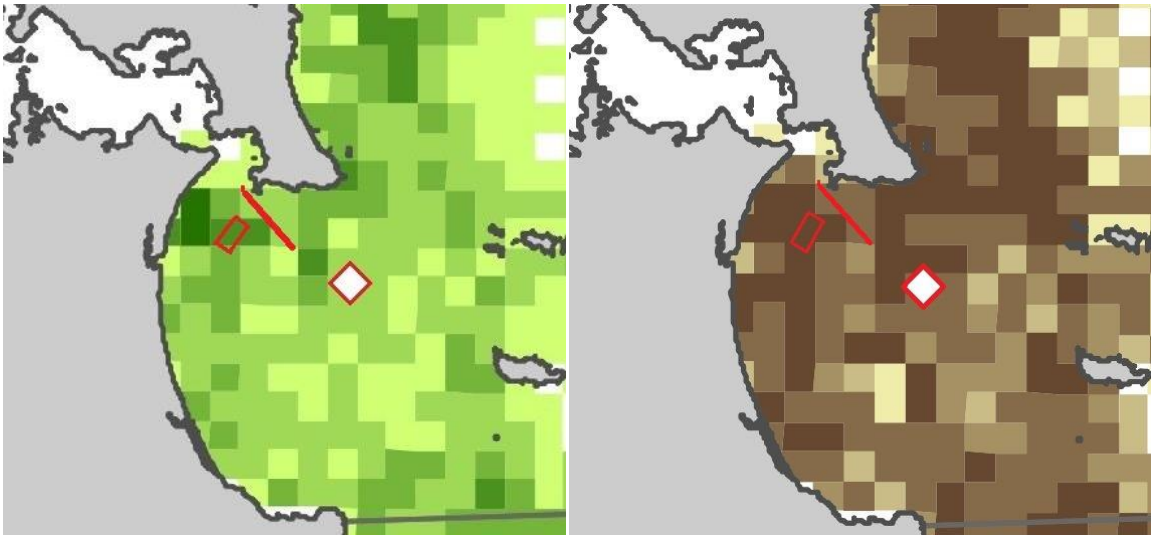

Figure 19a, 19b: Location of proposed outer dredging footprint (solid red line) and Disposal Sites 1-2 (red rectangle) and 3-2 (red and white diamond) in relation to spatial distribution (1nm^2 grid) of the average annual number of longline sets and average annual catch respectively in Bream Bay (magnified images from Figures 18a and 18b). The plots are based on an average of 6 fishing years 2007-2013. Refer to insets in Figure 18 for the legend and other information. The advisory notes on interpretation of the MPI longline plots provided earlier need to be kept in mind.

Figure 19a indicates that commercial longline fishing occurs throughout Bream Bay. The MPI plots show that the average annual number of longline sets in each 1nm^2 grid is low to moderate (>0-5) in most of Bream Bay. Effort is highest at grids adjacent to the coast south of Marsden Point. Catch is high in a number of areas but there appears to be little correlation between the distribution of longline effort and the distribution of catch. Because the MPI plots only account for 70% of all longline events the figures may slightly underestimate longline effort in Bream Bay.

Fishers indicate that they fish throughout Bream Bay targeting different depths and locations according to the time of year and fish movements.

Figure19a indicates that the highest longline effort in Bream Bay lies inshore of proposed disposal Site 1-2 and generally longline effort is highest in Bream Bay around and near Site 1-2. Effort was low (>1-2 longline sets annually) at Site 3-2. There is little if any longlining in the channel dredging footprint.

3.5.6 Longline Fishing in or near Proposed Dredging and Disposal Sites

Figure 20 shows the main area of commercial longline effort in Bream Bay interpolated from discussions with fishers and the MPI longline plots.

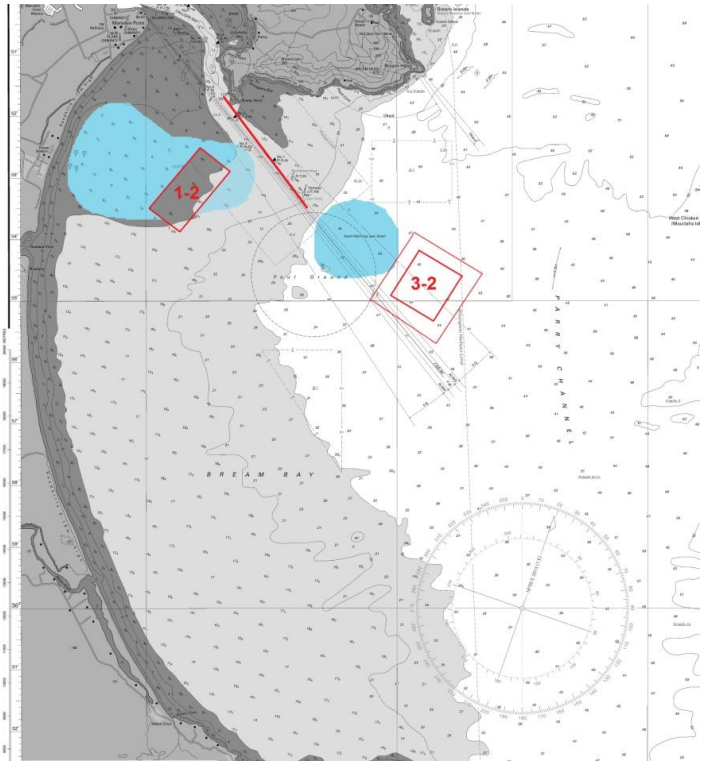

Figure 20: Main areas of longline fishing activity in Bream Bay

The commercial longline fishing areas with the most fishing effort lie over the shoals along the coast south of Mair Bank and north east of Three Mile Reef. Proposed Disposal Site 1-2 lines in one of the areas where longline effort in Bream Bay is more concentrated.

3.6 Set Net Fishery

3.6.1 Target Species

There are essentially two distinct set net fisheries targeting different species and using different types of set nets.

In the upper harbour the set net fishery principally targets flatfish and grey mullet in very shallow water. This inner harbour set net fishery extends into and up the upper harbour channels and intertidal flats. The nets used in this fishery are typically no more than a few hundred metres in length and often much shorter than that.

In the harbour mouth, outside the harbour entrance and throughout the shallower waters of Bream Bay, gill nets or set nets are used to catch coastal species including sharks, snapper, trevally, and kahawai. The set nets used in this fishery may be up to 1,000m or more in length.

3.6.2 Set Net Method

Set nets are anchored to the seabed with floats along the top of the net (Figure 21). They are usually marked with floats or buoys at each end. Set nets can be used over soft and rocky seabed.

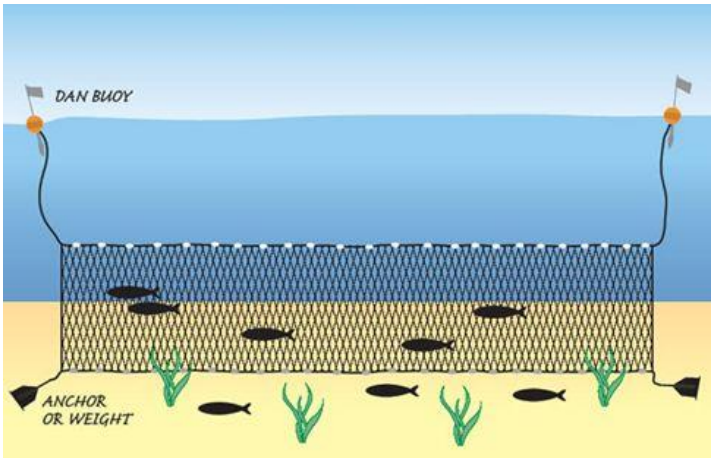

Figure 21: Image of a typical set net.

3.6.3 Where Set Net Fishing Takes Place in Whangarei Harbour and Bream Bay

MPI maps in Figures 22a and 22b show the spatial distribution of the starting positions of set net events or sets and catch respectively plotted in a 1nm^2 grid over a five-year period from 1 October 2008 to 30 September 2013. As the length of set nets are relatively short compared to the 1 nm grids, the plots provide a reasonably accurate picture of the distribution of the fishery. However as noted above, the insets in Figures 22a and 22b indicate that only about 33% of all set netting is reported by latitude and longitude. This means that these figures may considerably understate the average annual numbers of sets and may not give an accurate estimate of average annual catch.

The underestimate of set net effort may vary from location to location around the country depending on what proportion of set net vessels operating in an area report their latitude and longitude coordinates. Vessels that do not provide coordinates report their effort and catch by Fisheries Statistical Area only.

SET NET PLOT NOTES: Care is needed in interpreting these plots. The following notes are provided to assist in correctly interpreting the information presented in the MPI set net plots.

Intensity Scale: The legend (top right corner on Figures19a and 19b) indicates the effort and catch range for each colour. As with the previous MPI plots the scale is highly skewed. The same caveats apply to their interpretation. Most of the effort range is compressed into the top effort category which for set netting is an average of >5 to 210 sets annually.

Effect of Longline Length: Set net is stationary. In harbours nets are rarely more than 100-200m long. Outside of harbours they may be up to 1000m. Therefore, the grid plots of set net effort give a reasonably accurate picture of where the greatest fishing effort occurs.

Incomplete Data: The legend on the MPI set net plots indicates that only about 33% of all set net events are incorporated in these figures. Therefore total effort will therefore be much higher than the set net plots indicate. Catch rates may not be representative.

Overall: Because only 33% of set net events are included in these figures, plots in Figures 19a and 19b will provide only an approximate picture of the intensity of average set net effort and average catch.

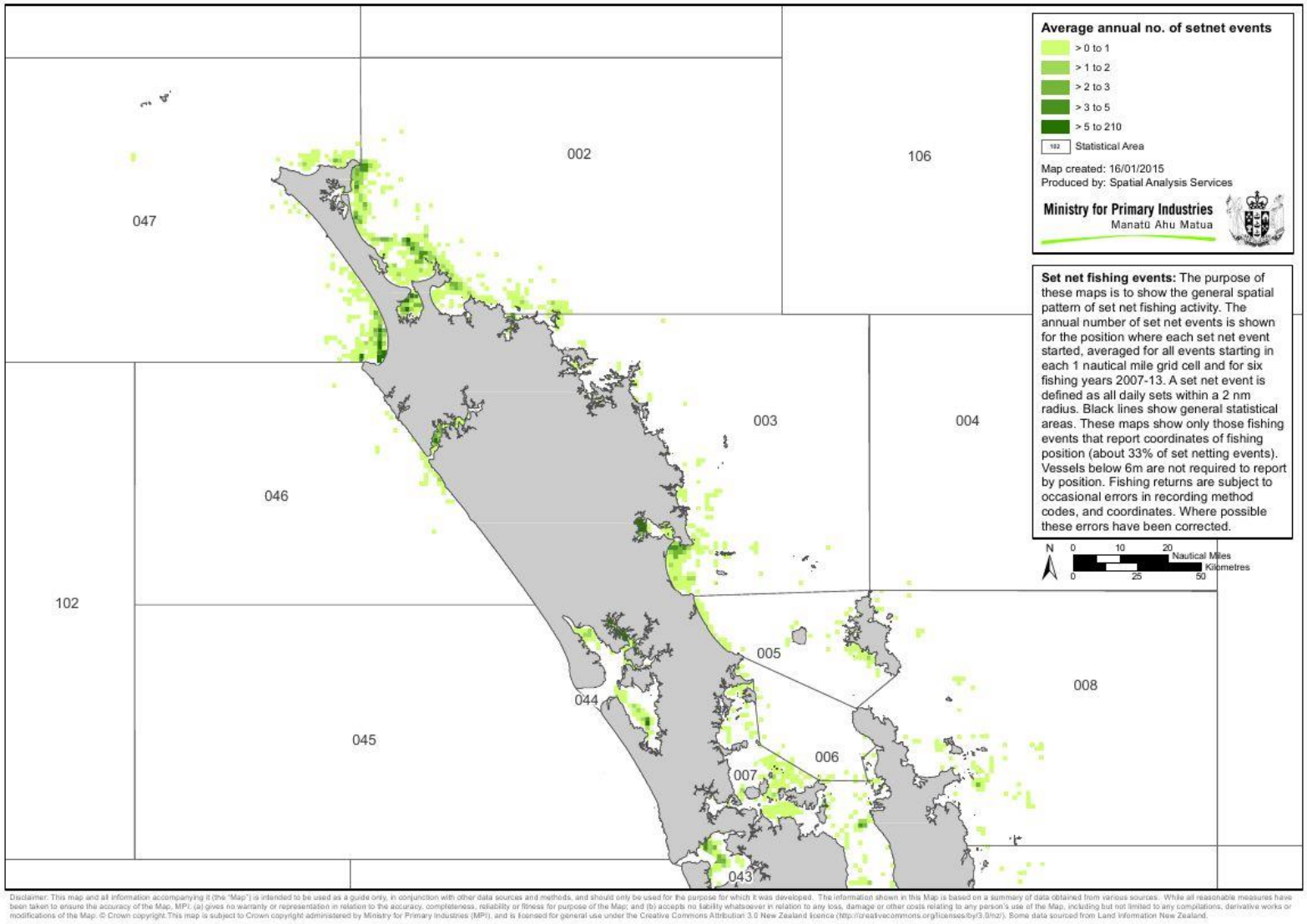

Figure 22a: Annual average annual number of set net events or sets. See inset for legend and other details.

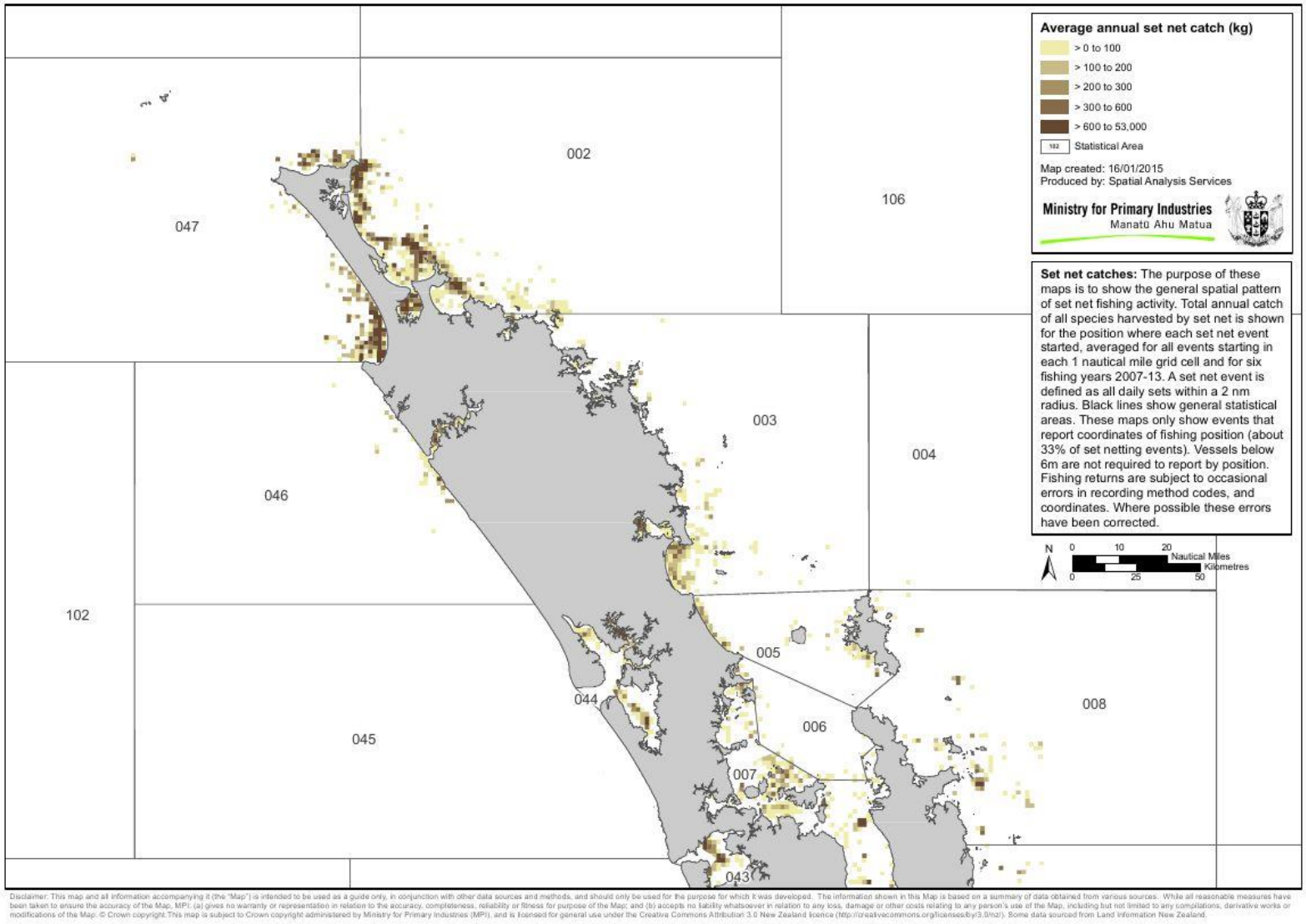

Figure 22b: Annual average annual catch by set net, all species combined. See inset for legend and other details.

Figures 23a and 23b below are magnified images of set net effort and catch in Bream Bay in nm^2 grid cells taken from Figure 22. As the length of a set net is generally not more than 1,000m, the images provide a relatively good picture of where set netting occurs. However, note again that only about 33% of all set netting is captured in the MPI plots in Figure 22.

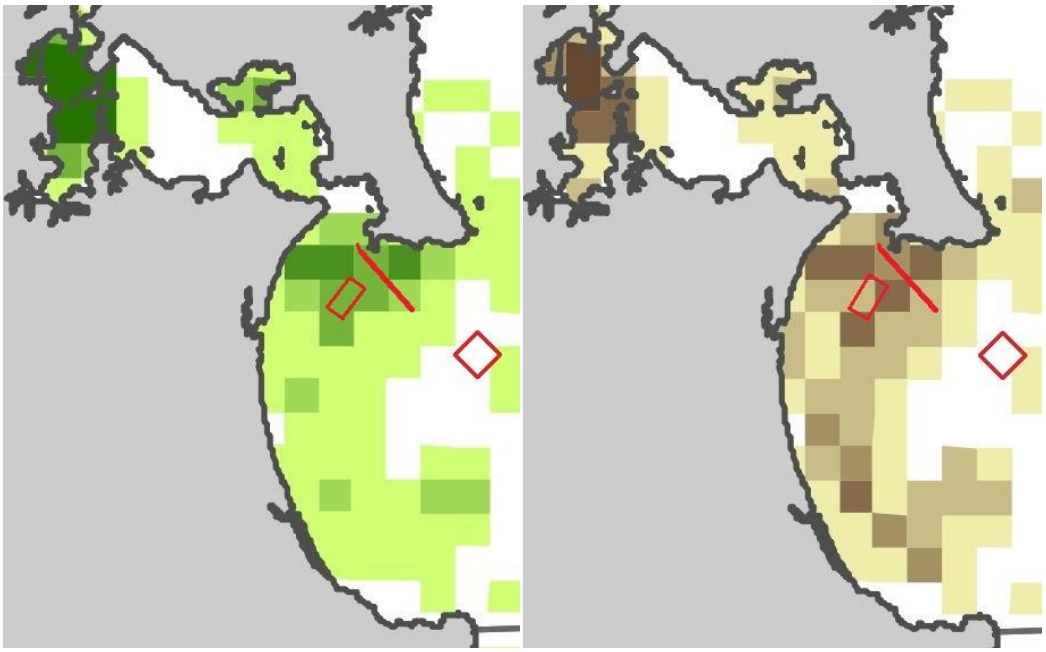

Figure 23a, 23b: Location of proposed outer dredging footprint (solid red line) and Disposal Sites 1-2 (red rectangle) and 3-2 (red and white diamond) in relation to spatial distribution (1nm^2grid) of the average annual number of set net sets and average annual catch respectively in Bream Bay (magnified images from Figures 22a and 22b). The plots are based on an average of 6 fishing years 2007-2013. Refer to insets in Figure 22 for the legend and other information. The advisory notes on interpretation of the MPI set net plots provided earlier need to be kept in mind.

The most concentrated set netting occurs in the upper reaches of Whangarei Harbour. Set netting also occurs around the outer entrance to the Harbour, including the area south of Mair Bank and the coast from Smugglers Cove to Peach Cove.

Figure 22a suggests that set net effort tends to be higher on either side of the shipping channel and proposed dredging footprint and not within it.

Outside the Harbour entrance and within Bream Bay, most set net effort is concentrated on the shoals in the northwest of Bream Bay and around the vicinity of proposed Disposal Site 1-2.

Because only 33% of all set net effort is included in the MPI plots it is difficult to reach any firm conclusions about the true importance of the area to set netters. However the plots are consistent with information provided by fishers, which provides some additional confidence to the data available. In addition, catch data presented earlier in Table 2 indicates that set net catches of coastal open water species in MPI's FSA003 (which includes Bream Bay) are very modest.

Figures 21 and 22 indicate that no set net activity occurs at or around proposed Disposal Site 3-2.

3.6.4 Set Net Fishing in or near Proposed Dredging and Disposal Sites

Figure 24 highlights where there is the most commercial set net fishing activity in Whangarei Harbour and Bream Bay interpolated from MPI plots and discussion with fishers.

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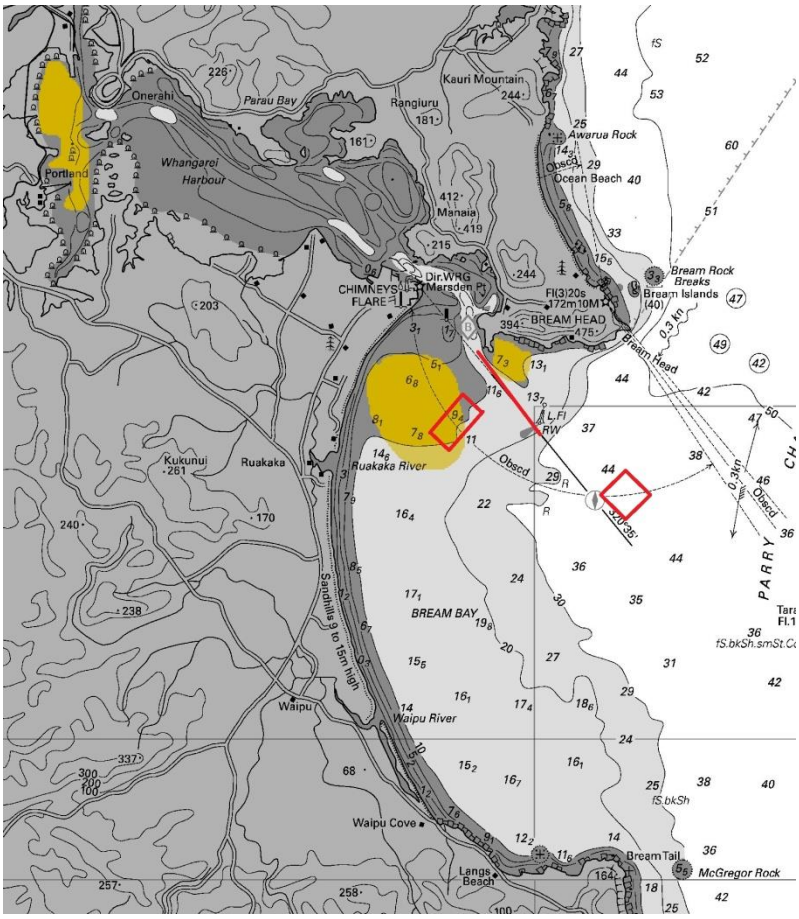

Figure 24: Main areas of commercial set net activity in Whangarei Harbour and Bream Bay.

Proposed Disposal Site 1-2 overlaps one of the main set net fishing areas at the entrance to Whangarei Harbour. There is little or no set netting around the proposed dredging footprint and proposed Disposal Site 3-2.

3.7 Paddle Crab and Whelk Fisheries

3.7.1 Paddle Crabs

The paddle crab *Ovalipes catharus* is found off sandy beaches, and in harbours and estuaries throughout New Zealand. It is most abundant from the lower intertidal zone to at least 10m depth although it is known to occur down to 100m (Ministry for Primary Industries 2016a). Diet studies from central and northern New Zealand indicate that *O. catharus* is an opportunistic, versatile and generalist predator and scavenger feeding on molluscs or crustaceans including tuatua, pipi, burrowing ghost shrimp, isopods and amphipods (Wear & Haddon 1987). The diet varies with location around New Zealand indicating that it adapts its diet according to the available prey. Although paddle crabs sometimes prey on adult shellfish, they more commonly prey on shellfish spat which are found in abundance on many sandy shores.

Mating generally occurs during winter and spring (May to November) in sheltered inshore waters when female paddle crabs are soft-shelled (Armstrong 1988). Female crabs are thought to migrate to deeper water to spawn over the warmer months (September to March). After spawning the eggs are incubated until they hatch and then have an extended larval life. The larvae are thought to live

offshore before migrating inshore where the megalopa settle in the summer and autumn (Ministry for Primary Industries 2016a).

3.7.2 Paddle Crab Traps

Paddle crabs are targeted in Bream Bay using baited crab traps (Figure 25) set to lie on the seabed and marked with a rope connected to a float at the surface. The traps are usually set to fish overnight.

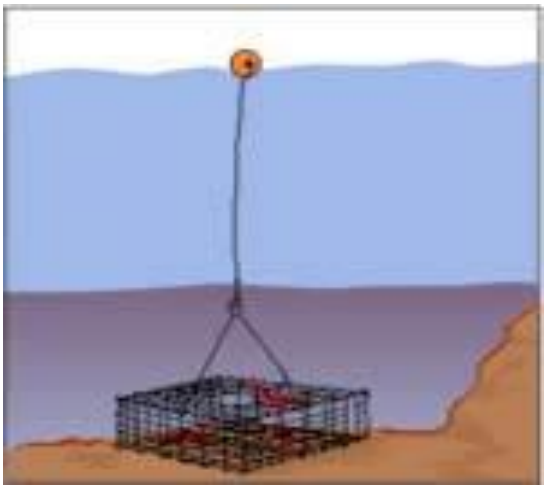

Figure 25: Image depicting a typical type trap used for paddle crabs

3.7.3 Paddle Crab and Whelk Fisheries in Bream Bay

The Bream Bay paddle crab fishery is regionally significant and in most recent years has generated between two thirds and 100% of all commercial catches of this species throughout the country (www.nabis.govt.nz). Whelks are not targeted but attracted to the bait in the traps and are a saleable minor bycatch.

All the annual paddle crab catch from MPI's Fisheries Statistical Area 003 is taken in Bream Bay and the area around the entrance to Whangarei Harbour. Table 3 gives recent annual catches. Official landings data (www.nabis.govt.nz) shows that paddle crabs are caught throughout the year with no clear seasonal peak. There are no currently available statistics for the catch of whelks but based on information from local fishers the total catch is possibly in the order of 1-2 tonnes annually.

In 2010-11 and 2011-12 paddle crabs were not present in commercial quantities in Whangarei Harbour/Bream Bay and commercial catches fell to negligible amounts. The reason for their reduced abundance in these years is not known but may be related to variable reproductive success or larval survival. Commercial fishers report that in recent months, paddle crabs have again become less abundant.

Table 3: Annual catches of PAD1 (paddle crab) in MPI's FSA 003 (source www.nabis.govt.nz)

PAD1	FSA 003 annual catch (kg)
2006-07	20,660
2007-08	66,958
2008-09	45,979
2009-10	19.291
2010-11	Data withheld by MPI

2011-12	362
2012-13	<500
2013-14	1,987
2014-15	54,058
2015-16	68,614
2016-17 (6 months 1 Oct to 31 Mar)	29,252

There are no MPI maps showing the distribution of the paddle crab fishery. Discussions with paddle crab fishers indicate that they fish throughout Bream Bay from shallow water to at least 15m depth. Their area of operation includes Calliope Bank and Urquhart's Bay, Lort Point to Home Point, the shoals to the southeast of Mair Bank, and all of Bream Bay south to Bream Tail. About five Whangarei commercial fishers are believed to operate in the crab and whelk fisheries.

A typical crab fisher deploys about 40 baited traps set at about 50m apart. Fishing locations in Bream Bay vary according to the movements and distribution of the crabs which move about throughout the year. Whelks that are attracted to the bait in the crab traps are also caught as a bycatch and are sold primarily in Auckland markets.

As well as being a bycatch of the paddle crab fishery, whelks are also targeted on their own, especially when there are few crabs present. Prevailing weather conditions often confine whelk fishing activity to northern Bream Bay, from Ruakaka north, inshore of proposed Disposal Site 1-2 around the fringes of the 5m depth contour. In these circumstances, especially when crabs are not present, some commercial crab fishers advise that their ability to catch whelks in this area is critical to their livelihood.

3.7.4 Paddle Crab and Whelk Fishing at or near Proposed Dredging and Disposal Sites

Figure 26 shows the distribution of the paddle crab fishery in Bream Bay and the entrance to Whangarei Harbour based on discussions with fishers. Crab fishers operate around proposed Disposal Site 1-2 as well as throughout Bream Bay.

Whelk fishers also operate throughout the same waters. The shoals inshore of Disposal Site 1-2 around the 5m depth contour are particularly important to whelk fishers, especially when weather and sea conditions constrain where they can safely operate. There is insufficient information to definitively show the areas receiving the most fishing effort overall.

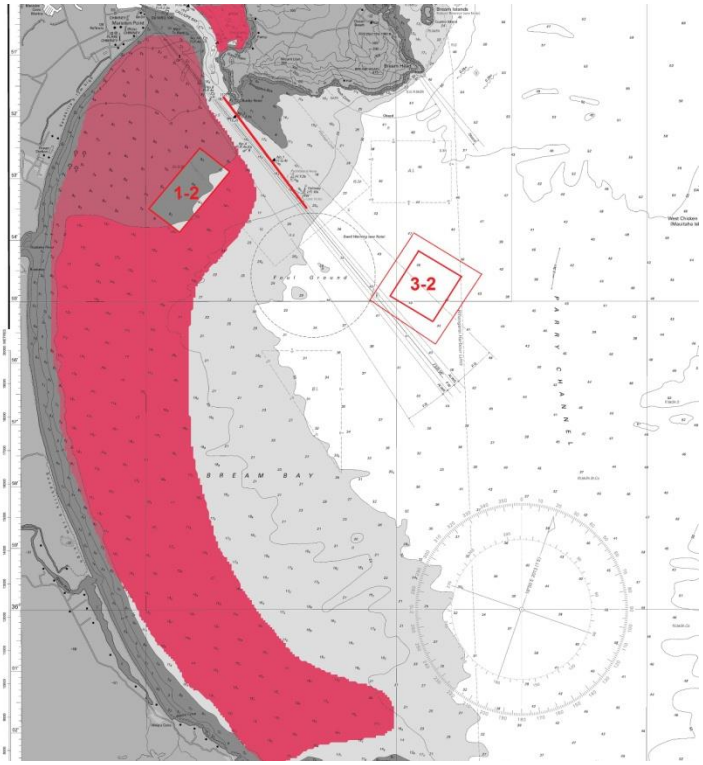

Figure 26: Area of paddle crab and whelk fishing activity in northern Bream Bay.

3.8 Scallop Fishery

3.8.1 Scallops

The scallop (*Pecten novaezelandiae*) is most common in depths from 10-60m on sand, shell and gravel substrates and occurs all around New Zealand. Scallops tend to be patchily distributed in small and large beds, some of which are persistent and others ephemeral (Hartill & Williams 2014). Whilst considered to be a sessile species, it is capable of rapid short distance movement i by clapping its shells to jet water that propels it over the seabed. Scallops tend to be present in enclosed and semi-enclosed harbours and bays where it is thought that circulating currents tend to retain larvae. Larvae remain pelagic for about three weeks and in Northland the main spat settlement occurs in January (Ministry for Primary Industries 2014).

3.8.2 Bream Bay Scallop Fishery

All commercial scallop fishing is by dredge, with most fishers in Northland using self-tipping box dredges (Ministry for Primary Industries, 2014). The legal fishing year is from 1 April to the following 31 March but the Northland commercial scallop season runs from 15 July to 14 February. The minimum legal size (MLS) is 100 mm and the base-level total allowable commercial catch (TACC) for the entire Northland fishery is 40 tonnes meatweight. This is the smallest scallop fishery in New Zealand. When it appears that abundance may support larger catches, scallop biomass surveys are undertaken to provide the data required to support an increase in the annual catch limit for the fishery (Cryer & Parkinson 2006).

Hartill & Williams (2014) provide a detailed characterisation of the Northland scallop fishery from 1989 to 2011. This includes the fishery in Bream Bay. Relatively high catches in the Northland scallop fishery occurred from its inception in the 1970s until the early 1990s. Since then scallop catches throughout Northland have been very much smaller and sporadic.

In the Bream Bay fishery, the scallop population has only supported a fishery lasting one or two years at about 10 year intervals with no fishery in the intervening years. Scallops can usually be found in low densities throughout Bream Bay from shallow waters to depths of 50m. In recent years commercial fishing for scallops has only occurred in an area south of the Ruakaka River mouth.

Reported catches from Scallop Statistical Area 1R from 2002-03 to the present are given in Table 4. The Bream Bay scallop fishery has supported commercial catches greater than minor amounts in just five of the past 15 years. Bream Bay scallops tend to grow more slowly and be in poor condition compared to scallops from Rangaunu and Spirits Bays. Many Bream Bay scallops never reach the 100mm minimum legal size. The environmental factors causing this are not known.

Table 4: Annual catches of scallops from MPI's Scallop Statistical Area 1R (Bream Bay) (source: www.nabis.govt.nz).

Fishing year	Area 1R reported scallop catch (kg meatweight)
2002-03	9,013
2003-04	0
2004-05	99,362
2005-06	174,421
2006-07	72,433
2007-08	<1
2008-09	0
2009-10	0
2010-11	0
2011-12	0
2012-13	0
2013-14	<1
2014-15	68,585
2015-16	46,459
2016-17	1,480

Issues faced by scallop fishers in Bream Bay are low scallop densities in most of the area with only small patches of higher density worth fishing, poor condition, and a high proportion of the population falling below the minimum legal size of 100mm, requiring considerable sorting at sea (Hollings pers. comm.). Overall, operating costs are high and returns from the scallop fishery are modest even though scallops are a high value product. In recent years 6 or fewer vessels have actively fished for scallops throughout Northland even in those years when stocks are abundant enough to support a fishery.

3.8.3 Scallop Fishery at or near Proposed Dredging and Disposal Sites

Figure 27 shows the main areas of scallop dredging activity in Bream Bay based on discussion with the scallop industry. Scallop beds can develop in different areas from year to year but generally commercially viable beds are found in patches in a band along the coast from Ruakaka south to Bream Tail.

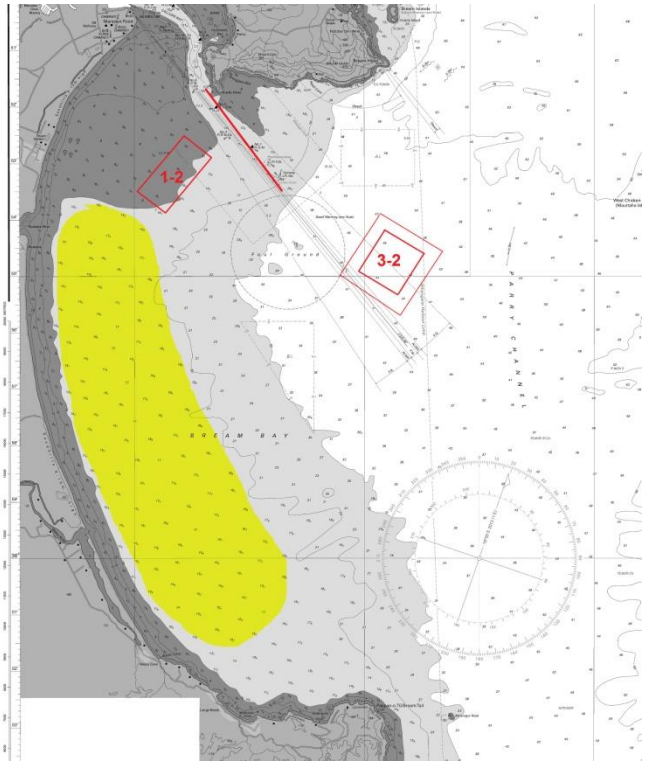

Figure 26: Main area of commercial scallop dredging in Bream Bay.

3.9 Commercial Cockle and Pipi Fisheries

3.9.1 Snake Bank Cockle Fishery

Snake Bank supported a commercial cockle fishery from the early 1980s until 2012 when the fishery was closed. It was the only cockle bed open to commercial fishing in Whangarei Harbour. Catches exceeded 500 t in the early years of the fishery but dropped progressively to less than 50 t in the year before its closure in 2012 due to low biomass (Ministry for Primary Industries 2016a).

Although the Snake Bank cockle fishery is currently closed, there is the potential for the fishery to resume in the future depending on a recovery in the stock biomass.

3.9.2 Mair Bank Pipi Fishery

A commercial fishery for pipi took place on Mair Bank for at least five decades until the fishery was closed on 1 October 2012 due to low biomass levels. Catches exceeded 250 t annually in some years but fell to very low levels after 2010 (Ministry for Primary Industries 2016a).

Although the Mair Bank pipi fishery is currently closed, there is potential for the commercial fishery to resume in the future if biomass levels recover.

3.10 Rock Lobster Fishery

Rock lobster are taken by potting on or near rocky shores or rocky reefs and seabed from the shallows and out to at least 100m depth on suitable substrates (Ministry for Primary Industries 2016b). Rock lobsters occur along the northern shores of Bream Bay from the entrance to Whangarei Harbour to Bream Head. Kerr & Moretti (2015) found sub-legal rock lobsters in the Motukororo Marine Reserve.

The northern shore of Bream Bay lies at the southern end of MPI Rock Lobster Area 904 (RLA 904) as shown in Figure 7. RLA 904 includes the coast from Waipu to the Bay of Islands. Most of the rocky habitats and reefs suitable for rock lobster in this area lie north of Bream Head. Recent annual catches in the whole of RLA 904 are modest at about 10t annually (www.nabis.govt.nz). It is likely that the commercial catch of rock lobster taken from along the northern coastline of Bream Bay is very small. Because rock lobsters are mainly found on subtidal rocky habitat most of the commercial catch in this area is taken very close to the coast. Rock lobsters are known to move onto sandy seabeds adjacent to rocky reefs to feed on shellfish (Kelly et al. 1999, Langlois et al. 2005) but the distances involved are small.

4.0 Discussion and Assessment of Potential Impacts of Refining NZ's Proposed Crude Project on Commercial Fishing

4.1 Overall Factors to Consider

Finfish are highly mobile. As noted in Section 2.1 the species of most significance to commercial fishing in Bream Bay are very widely distributed along the coast. Commercial fishing for snapper and associated species is also widespread as shown in the MPI plots of trawling, longlining and set netting.

On a coastwide basis, the wide distribution of commercial fishing effort indicated in the MPI plots shown in Figures 14a, 18a and 22a is reflective of both the mobility of fishes and commercial fishers that catch them. The MPI plots and information provided by commercial fishers also indicate that commercial fishing by trawl, longline and set net occurs throughout most of Bream Bay, including in and around proposed Disposal Sites 1-2 and 3-2.

Whilst commercial fishing is widespread in Bream Bay, the MPI plots and MPI Nabis data also indicate that Bream Bay is not amongst the most important and intensively fished areas in the wider coastal fishery. Any potential impacts of the Project on commercial fishing in Whangarei Harbour or Bream Bay will primarily be local rather than being of regional or national significance.

Overall, the commercial fishery in Whangarei Harbour and Bream Bay is comprised of several essentially discrete and unrelated fisheries using different methods or targeting different species and each may be impacted differently.

4.2 Impacts Relevant to Commercial Fishing

There are a number of project impacts that may potentially affect commercial fishing and need to be evaluated. These include the following:

i. Direct mortality of commercial fish and shellfish species.
ii. Loss of or ecological changes to habitats that fish use that may result in loss of commercial fishing opportunities.
iii. Physical changes to habitats that may affect the operation of fishing methods or gear and/or prevent fishing.
iv. The availability of alternative locations for commercial fishing.
v. Whether any of the impacts are permanent or temporary, and if temporary the duration of recovery of any ecological or physical changes to habitat.

Each of these potential impacts is briefly considered below, prior to an overall assessment of impacts on each of the individual commercial fisheries described earlier in section 3.0 of the report.

4.2.1 Direct Mortality of Commercial Fish and Shellfish Species

Finfish are highly mobile and commercial species such as snapper, gurnard and John dory are able to avoid the disturbance caused by active dredging and disposal activity. These species will be able to move to undisturbed nearby areas. Paddle crabs are also very mobile. Both finfish and paddle crabs may be attracted to areas that are disturbed during dredging and disposal to scavenge for benthic organisms exposed during the works. Both the dredging activity and disposal of dredged material is highly unlikely to result in mortality of mobile fish species which naturally avoid physical disturbance (Coffey 2017).

Sessile bottom dwelling species such as scallops are unlikely to survive either dredging or being buried by dredged sediments at the disposal sites (Coffey 2017). Except for whelks, commercial densities of sessile bottom dwelling species are not known to occur within the dredging and disposal footprints. Whelks are present at both the dredge and disposal sites (West & Don 2016a, 2016b, Coffey 2017) and would be unlikely to survive burial.

Overall, there is expected to be no mortality of mobile commercial fish species as a consequence of the dredging or disposal. Some whelks at Site 1-2 may be buried and not survive but the any temporary effect on their reduced availability to the commercial whelk fishery in Bream Bay is expected to be negligible. They are part of the benthic faunal community that will re-establish within 6-12 months.

4.2.3 Loss of or Ecological Changes to Fisheries Habitat

In the assessment of ecological effects, Coffey (2017a,b) indicates that the combined capital dredging and disposal would impact benthic communities from a total area of 4.37km^2 for a period of 6-24 months. However, ecologically constructive benthic communities are expected to progressively re-establish within a period of not more than 12 months. There will be no permanent loss of fish feeding habitat. Any reduction in availability of benthic fauna that fish feed on will be temporary and confined to the dredging and disposal sites.

4.2.4 Physical Changes to Habitat

Both bottom trawling and Danish seining can only occur on 'soft' seabeds – such as mud, sand or gravels. There could be longer term impacts on bottom trawl and Danish seine methods if any long term or permanent changes to the seabed were to occur at proposed Disposal Site 3-2. This disposal site lies within an area where both methods operate from time to time. For example, a reduction in the density of the seabed and/or large mounds of dredged material could make it more difficult or impossible for these methods to operate at the disposal site in the future.

A review of the likely surface elevation and contours by Tonkin & Taylor (2017) considered both numerical modelling and information from the completed dredging and disposal at the Port of Tauranga. This indicates that expected changes in average depth at Disposal Site 3-2 will be in the order of 0.5m with an initial maximum height of 2.8m and maximum slopes of around 1:40 (V:H) but more typically 1:120 (V:H). Large mounds will not develop at the disposal site and these slopes are very gentle. Based on the experience at Tauranga and the modelling at Site 3-2 the seabed surface will progressively smooth over time as a result of storm wave activity. The review indicated that densification of the deposited sand is likely to occur quickly, matching that of the adjacent seabed density within weeks, with no significant lowering.

In summary, the review indicates that once disposal at the site finishes, the seabed form and density at Site 3-2 will have physical characteristics similar to its present state and like adjacent areas where trawling occurs. Therefore the disposal is not expected to materially affect the continued use of Site 3-2 for trawling and Danish seining. Other methods are much less dependent on seabed form and density. Overall, any effects on the future use of Site 3-2 for commercial fishing will be negligible.

4.2.4 Availability of Alternative Sites for Commercial Fishing

The MPI plots of commercial fishing activity and average catches show that commercial finfish fishing is very widespread. The total area impacted by dredging and disposal is very small in comparison to the total area where commercial fishing activity takes place. Individual fishers may operate anywhere throughout Bream Bay and the wider region subject only to having the right to commercially harvest the particular species they target.

4.2.5 Duration of Impacts – Permanent and Temporary

The proposed project will result in a number of permanent changes to the environment in which commercial fishing takes place. These include:

- A deeper and re-aligned shipping channel into Marsden Point.
- Altered navigational aids.
- Shallower seabed depth within proposed Disposal Site 3-2.
- Areas of shallower depths where dredged material is deposited within proposed Disposal Site 1-2.

Neither the deeper and realigned shipping channel nor the altered navigational aids are expected to have any adverse impacts on commercial fishing. They are more likely to be beneficial, both in terms of reducing risk to the fisheries environment from oil tankers visiting the port and aiding fishing vessels entering and departing Whangarei Harbour.

A shallower seabed depth at proposed Disposal Site 3-2 is unlikely to adversely affect commercial fishing provided its density, sediment type and slope remain such that commercial trawl and Danish seine vessels are able to continue to fish the area in the future. Density, texture and slope have been addressed in section 4.2.4. The reduction in depth by 4m at this site is not significant in a commercial fishing context. Inshore commercial trawl and Danish seine vessels operate their gear at a range of depths from very shallow water to more than 100m depth. Other fishing methods that use static fishing gear (longline, set net, pots) are unlikely to be affected in any way by reduced seabed depth as they also operate over a wide range of depths.

At proposed Disposal Site 1.2, only 10% of the area (0.25km^2) is expected to be used for disposal of capital dredging. The small area impacted here is unlikely to result in measurable impacts to commercial fishing when compared to the very wide area where commercial vessels now operate in this part of Bream Bay.

Coffey (2017) concludes that all of the adverse ecological and environmental effects of the capital and maintenance dredging work, such as the reduced food supply for fishes, will be localised and temporary. The affected areas are expected to progressively recover within a relatively short time frame, with ecologically constructive benthic communities able to provide feeding grounds for fish occurring in all affected areas within 12 months. The volumes from maintenance dredging are about 5% of the capital dredging and the impacts correspondingly less.

4.3 Impacts on Commercial Trawl and Danish Seine Fishing

There are two potential adverse impacts on bottom trawl and Danish seine fishing. Both are temporary. One is the loss of access to all or part of the area of proposed Disposal Site 3-2 during the period of active disposal from both capital and periodic dredging work. This impact arises from the change to the physical seabed which may make trawling or Danish seining activity impossible or result in loss or danger to fishing gear. Based on the Tonkin and Taylor (2017) assessment, the physical attributes of the seabed will recover. The recovery of the seabed to pre-disposal conditions is expected to be rapid – in the order of weeks. However, as disposal activity from capital dredging will be continuous and spread systematically throughout the full area of the disposal site, a very conservative assessment is that trawling and Danish seining may not be physically possible at Site 3-2 for the full duration of the capital dredging programme plus a few weeks.

The second potential adverse impact is the displacement of commercial fishes at Disposal Site 3-2 as a result of both physical disturbance and the loss of benthic fauna on which fishes feed. This adverse effect is temporary and may last for a period of 6-12 months (Coffey 2017). How far fish will be displaced is uncertain but a literature review of fish behaviour in response to dredging and disposal found that fish tend to exhibit avoidance behaviour for about two to three hours after dredged material placement and fish community densities generally return to pre-disposal levels after about three hours (ECORP Consulting Inc. 2009). The degree of displacement of benthic commercial fish species from the temporary loss of benthic food items is likely to last longer. However the progressive nature of disposal means than only small areas of Disposal Site 3-2 will be affected at any one time. Adopting the assumption that once disposal commences fish will be instantaneously displaced from the entire area of Site 3-2 for a period of 6-12 months would be extremely conservative. Although this entire area will be progressively affected over a period of up to 6 months, the immediate impacts will be over a smaller area at any one time and thus spread out over the duration of capital dredging.

Based on MPI data, the average number of trawls commencing in the area of the dredging footprint is very low (>0-1 per 1nm^2 grid or 3.43km^2) annually. The average number of trawls commencing in the immediate vicinity of Site 3-2 is higher but still no higher than >3-5 per 1nm^2 grid annually. At 2.5 km^2, Site 3-2 is smaller than a single 1nm^2 grid. Any fish temporarily displaced will still be available to catch outside of the affected areas. Overall, any adverse effect on trawling and Danish seining can be expected to be negligible.

4.4 Impacts on Longline Fishing

Commercial fish species that longliners target will be displaced as a result of both physical disturbance and the temporary loss of benthic fauna on which fishes feed. This potential adverse effect arises at both Sites 1-2 and 3-2. Little longline fishing takes place around the dredge footprint. The adverse effects on longlining from displacement of fishes at both disposal sites can be expected to be very small, if any, for the same reasons as given above for trawling and Danish seining. Additionally, although Site 1-2 lies within or near the area of greatest longline activity (Figure 20), placement of dredged material there will be localised. Overall, any adverse effects of dredging and disposal on commercial longline fishing can be expected to be negligible.

4.5 Impacts on Set Net Fishing

Adverse effects on set net fishing at Site 1-2 are the same as for longline fishing and are expected to be negligible for the same reasons.

4.6 Impacts on Paddle Crab and Whelk Fishing

Paddle crabs are mobile and can also swim, but are not able to move as fast as fishes and may be unable to avoid dredged material when it is deposited. Some individuals are likely to be buried by the disposal of dredged material as they normally reside on the seabed. Disposal Site 3-2 does not lie within the area where paddle crab fishers indicate they fish but Site 1-2 is within the area most actively fished. Commercial fishers report that the paddle crabs they fish for appear to regularly move or migrate to different areas in Bream Bay over the course of the year. At other times they are not abundant at Site 1-2. Whelks move very slowly over the seabed and some will be buried by the disposal of dredged material at Site 1-2.

Both paddle crabs and whelks are predators and scavengers. They may initially be attracted to the benthic fauna exposed in the dredge deposits and this may make them more vulnerable to repeated deposition. Disposal at Site 1-2 is proposed to be distributed in relatively small amounts at a number of different sites throughout the overall area over a relatively short period of time to facilitate a range of wave conditions gradually moving sediment. Under this scenarioany such attraction is unlikely to be significant.

Overall, adverse effects of the disposal of dredged material at Site 1-2 on paddle crab fishing is expected to be negligible. They are very mobile and the impacted area at Site 1-2 is very small ($0.25km^2$) when compared with the area where paddle crab fishing takes place in Bream Bay.

Some loss of whelks will occur within proposed Disposal Site 1-2 as they have a limited capacity to escape and survive burial. The area most important to whelk fishers when weather and sea conditions constrain where they operate lies inshore of Site 1-2 around the fringes of the 5m depth contour. This is more than 1km from proposed disposal Site 1-2. As the disposal at Site 1-2 will be localised and of relatively small amounts, any effect on whelk fishing is expected to be negligible.

4.7 Impacts on Scallop Fishing

Although low densities of scallops occur throughout Bream Bay, in recent years commercial densities of scallops have only ever been present south of Ruakaka. No adverse effects on commercial scallop fishing are expected from the proposed dredging or disposal.

4.8 Impacts on Other Commercial Fishing.

As noted earlier in the report, significant commercial cockle and pipi fisheries occurred at Snake Bank and Mair Bank in the recent past. Both are now closed to commercial fishing due to declines in biomass. Neither of these areas lies within the dredging footprint although Mair Bank lies relatively near the inner harbour channel where capital dredging will take place. Coffey (2017) discusses the recent decline in the pipi population at Mair Bank. No adverse effects on commercial fishing for cockle or pipi are likely.

Limited commercial rock lobster fishing occurs along the rocky northern shores of Bream Bay. The distance between the proposed dredging footprint and Disposal Site 3-2 means that no adverse impacts on the rock lobster fishery are likely.

4.9 Maori Commercial Fishing

Maori have extensive commercial fishing interests arising from the settlement of Treaty of Waitangi fisheries claims. To provide further context, these Maori commercial fishing interests include:

- Ownership interests in the fishing company Moana New Zealand that many Whangarei-based commercial fishers fish for or supply fish to.
- Direct ownership of commercial fisheries quota, including inshore quota stocks, by local Iwi.

The shellfish resources at Snake Bank (cockle) and Mair Bank (pipi) have particularly significant customary and commercial fishery values. In relation to commercial fishing, both areas are currently closed to all harvesting due to low biomass. Recovery of the biomass of both the cockle and pipi populations and future commercial shellfish harvesting will depend on how the populations respond to natural environmental conditions. The current shellfish closures are aimed at assisting in this recovery.

No capital dredging or disposal will occur at either Snake Bank or Mair Bank. There is no contaminated sediment to be dredged or disposed of. In the assessment of the Crude Shipping Project's ecological effects, Coffey (2017) concludes that there will be no ecological issues associated with sediments being placed at Disposal Site 1-2. Adverse effects on plankton are predicted to be negligible. Both cockles and pipi are very tolerant of higher turbidity that may be generated for short periods during dredging and disposal. Neither species is likely to be negatively impacted in any way, including recovery of biomass, by the relatively short duration of dredging or disposal activity. In summary, it is expected that there will be no short or long effects of the proposal on the Snake Bank cockle population or the Mair Bank Pipi population.

In the wider commercial fishing sector, Maori commercial fishing interests include both inshore and offshore species. The commercial harvesting rights held by local Iwi are mostly made available to Maori fishing companies such as Moana New Zealand which operates throughout Northland waters. There may be some short-term displacement of commercial fishing activity at the two disposal sites but this will be temporary and is expected to have a negligible effect, if any, on commercial fishing. Overall, the proposal will not inhibit or preclude commercial fishing within Bream Bay – including by Maori –in the future.

4.10 Marine Farming

One existing oyster farm is present just east of Kirikiri Point in Parua Bay. No other consented marine farms are present elsewhere in Whangarei Harbour or Bream Bay. At the time of the preparation of this report, Northland Regional Council advise that they have received no applications for any new marine farms in Whangarei Harbour or Bream Bay.

Based on its distance from the proposed work associated with Refining NZ's proposed dredging and disposal, it is expected that there will be no effects of the proposal on the oyster farm at Parua Bay.

5.0 Summary and Conclusions

Commercial fishing by a variety of methods and for many different target species is widespread in Bream Bay and near the entrance to Whangarei Harbour. MPI data and commercial fishers indicate that both proposed disposal sites lie within or near areas most actively fished by some methods and/or some species.

Trawling and Danish seining methods involve towing their fishing gear over the seabed. Both methods are actively used at Site 3-2 although it does not appear to lie completely within the area most actively fished by these methods. Long term impediments to continued bottom trawling or Danish seining at Site 3-2 post-disposal as a consequence of physical changes to seabed density or form appear to be very unlikely. Adverse effects on trawling and Danish seining from temporary displacement are expected to be negligible.

Disposal Site 1-2 lies near and partly within the areas of most active fishing by both longlining and set netting. However, due to the localised nature of proposed disposal at Site 1-2 and the temporary effects of the displacement of mobile fishes, any adverse effects on fishing by both methods are expected to be negligible.

There is a regionally significant paddle crab fishery throughout Bream Bay on the outer edges of Mair Bank and around the entrance to Whangarei Harbour. Potting for paddle crabs takes place year-round. Commercial fishers move around the area to fish in a range of depths over the course of the year depending on where they find the crabs are most abundant. Given the wide distribution of the fishery and the localised disposal proposed at Site 1-2, any adverse effects on paddle crab and whelk fishing are expected to be negligible.

In some years when scallop abundance and density are high enough a small commercial scallop dredge fishery takes place as far north as Ruakaka in central and southern Bream Bay. Commercial fishing for scallops occurs well away from the influence of both dredging and disposal. No adverse effects on commercial scallop fishing are expected.

There will be no adverse effects on commercial fishing for other species and no impact on the oyster farm in Parua Bay.

Commercial fishers navigate and fish throughout the area where the proposed dredging and disposal will occur. It is recommended that they be kept advised of all operations throughout the project, especially disposal activity at both the proposed disposal sites.

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