NIWA
Taihoro Nukurangi

South Taranaki Bight Commercial Fisheries

1 October 2006 – 30 September 2015

Prepared for Trans-Tasman Resources Ltd

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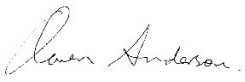
Owen Anderson	Reviewed by:	
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Executive summary

In 2016 Trans-Tasman Resources Ltd (TTR) intends to re-apply for a consent to annually recover up to 50 million (M) t of iron sands from the sea-bed in the South Taranaki Bight (STB) over an area of 65.76 km^2 lying 22 to 36 kilometres offshore of Patea, at water depths of 19 to 42 metres.

Existing users of this area include commercial fisheries for a range of species using a variety of methods. In this report we summarise the effort and catch for each fishing method over the period 2006 to 2015 and for the principal methods of capture we indicate the spatial distribution of the fishery in the STB. The spatial distribution of the effort and catch is then compared to the estimated area in which the suspended sediment concentration (SSC) derived from seabed iron sand recovery operations will be above a 2 mg/l threshold avoided by marine fish, 50% and 1% of the time.

Midwater trawling (mainly for jack mackerel), bottom trawling (for a variety of species), and set netting (mainly for rig, school shark, flatfish, and blue warehou) account for 98% of all commercial fishing events recorded in the STB with position data, over the nine fishing years examined from 2006/07-2014/15. Purse seining, bottom longlining, hand-lining, trolling, potting, drop lining, fish trapping, and some minor catch methods together account for the remaining 2% of catch.

The lowest levels of overall fishing effort were in the offshore, central-south regions of the study area and in shallow areas along the Taranaki coast north of Opunake and north and south of Whanganui. The highest levels of fishing effort (mainly bottom trawling and set netting) were between New Plymouth and Cape Egmont, relatively close to the shore, along the coast south of Hawera, and south and east of the proposed mining area near the 50 m contour.

The distribution of set-netting catch and effort in the STB does not appear to have changed much before and after the introduction of set-netting restrictions in 26 July 2012 but overall catch by this fishing method decreased by about 20% since 2012.

The fisheries with the greatest overlap with the proposed iron sand extraction operations are the bottom trawl fisheries for leather jackets and trevally, and the set-net fisheries for rig, carpet sharks, trevally, school shark, snapper, and spiny dogfish. Between 5% and 17% of the total catches in the study area for these species occur in the area where SSC exceeds the 2 mg/l threshold for fish avoidance 1% of the time. However, the area where SSC exceeds the 2 mg/l threshold for fish movement 50% of the time is negligible compared to the scale of these fisheries. In addition, the greatest effort and catch in these fisheries in the STB is to the south and east of the area where iron sand extraction is proposed.

1 Introduction

In 2016 Trans-Tasman Resources Ltd (TTR) intends to re-apply for a consent to annually recover up to 50 million (M) t of iron sands from the sea-bed in the South Taranaki Bight (STB) over an area of 65.76 km^2 lying 22 to 36 kilometres offshore of Patea, at water depths of 19 to 42 metres (see Figure 1-1).

Commercial fisheries for fish and invertebrates currently occur in the STB region using a variety of methods including bottom trawling, mid-water trawling, set-netting, bottom long-lining, squid jigging, purse seining, trolling, potting or trapping, and drop lining. Some fishing methods are excluded from parts of the STB (Figure 1-1). In 1986 trawling by vessels larger than 46m was prohibited from an area in the STB just outside the territorial sea boundary. From 26 July 2012 regulations prohibiting set-netting from the coast out to two nautical miles offshore in the area from Pariokariwa Point (top of the map) to Hawera came into effect. At the same time set-netting was prohibited from an area up to seven nautical miles offshore unless a Ministry for Primary Industries (MPI) Fisheries Observer was on board the vessel.

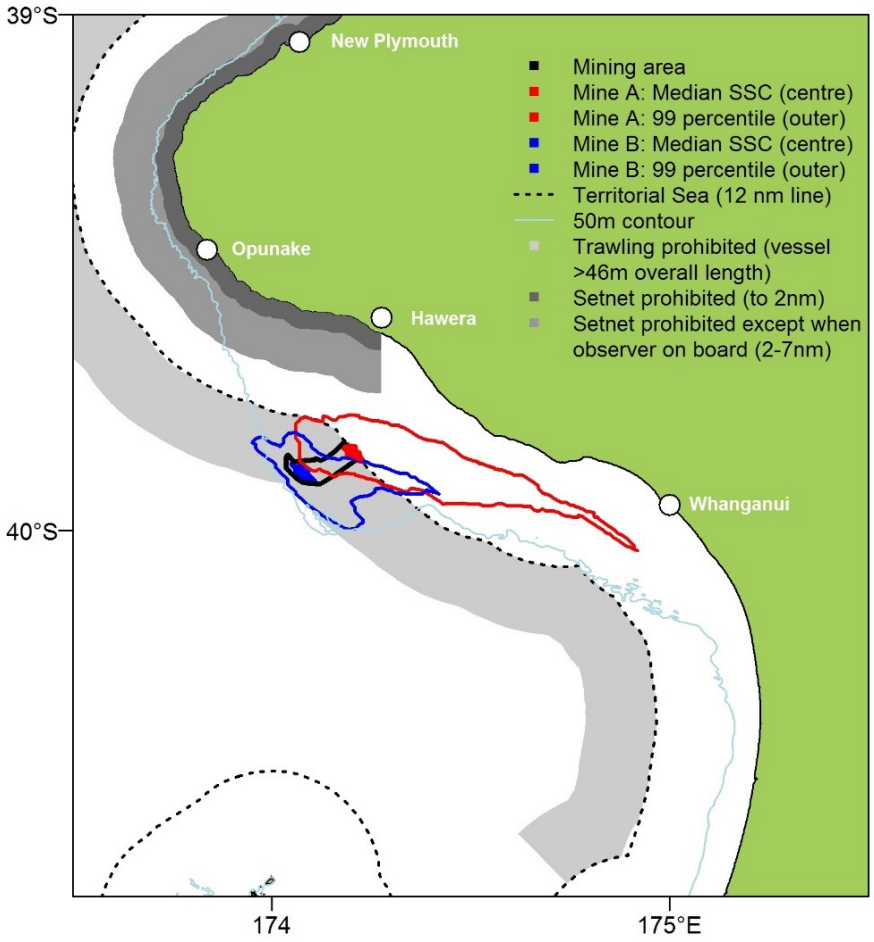

Figure 1-1: Distribution of commercial fishing restrictions in the South Taranaki Bight. The light blue line represents the 50 m contour and the dashed black line the offshore boundary of the Territorial Sea. Also shown is the proposed mining area, and the contours where the suspended sediment concentration (SSC) is above the threshold at which marine fish avoid sediments (2mg / l) 50% (median) and 1% (99th percentile) of the time when mining occurs at the innermost (A) and outermost (B) points of the mining area.

Iron sand recovery operations may overlap with, and thus directly or indirectly impact these fisheries to some extent. It is proposed that over a period of 20 years, the mining vessel will recover iron sands from the whole of the mining area (Figure 1-1). It is likely that all other vessels including fishing vessels will only be excluded from an area 2km in radius around the mining vessel. In the meantime the rest of the mining area will be open to all vessel traffic.

Lowe (2013) and Page (2014) identified 2 mg/l and 3 mg/l as the lowest suspended sediment concentration (SSC) that would be avoided by pelagic and demersal fish respectively. Acute and chronic impacts would be expected to be at much higher levels. In a recent study on juvenile snapper in estuaries Lowe (2013) reported 35-40 mg/l as the level that started affecting foraging strategies, and declining condition. Page (2014) provides a very comprehensive list of published threshold concentrations with most species only impacted beyond avoidance or a reduction in feeding, at levels well over 500 mg/l. Such levels would not be encountered even right at the source and near the seabed. Figure 1.1 shows the contours where SSC is above the 2mg /l threshold at which marine fish avoid sediments 50% (median) and 1% (99th percentile) of the time when mining occurs at the innermost (A) and outermost (B) points of the mining area.

In this report we summarise the effort and catch for each fishing method over the last nine completed fishing years (1 October – 30 September) using the methods developed by Starr (2007) and for the principal methods of capture we indicate the spatial distribution of the fishery in the STB. The spatial distribution of the effort and catch is then compared to the estimated area where the SSC will be above the 2 mg/l threshold 50% and 1% of the time.

2 Methods

Catch and effort data, daily processing data, and landings data were requested from the Ministry for Primary Industries catch-effort database “warehou” as extract No. 10518. The data consist of all fishing and landing events associated with a set of fishing trips that reported a positive catch or landing of any species in the area bounded by 173° 30′ E to 175° 20′ E and 39° 00′ S to 40° 40′ S between 1 October 2006 and 30 September 2015. Fishing forms that provide positional data include the Trawl, Catch, Effort, and Processing Return (TCEPR), the Trawl, Catch, Effort Return (TCER), Netting Catch Effort Landing Return (NCELR), Lining Catch Effort Return (LCER), Lining Trip Catch, Effort Return (LTCER), and the Squid Jigging Catch Effort Return (SJCER). For Catch, Effort, Landing Return (CELR) records (which typically lack positional information), data was based on fishing events within standard New Zealand fisheries statistical areas 037, 039, 040 (Figure 2-1), and specific paua and rock lobster management areas (P238, P239, P240, 934, and 935).

The extracted data were groomed and re-stratified to derive the datasets required for the area characterisation using a variation of the data processing method developed by Starr (2007). The method allows catch-effort and landings data collected using different form types that record data with different spatial and temporal resolutions to be combined. It also overcomes the main limitation of the CELR and TCEPR reporting systems (frequent non-reporting of species that make up only a minor component of the catch). The procedure has been developed for monitoring bycatch species in fisheries managed under Adaptive Management Programmes.

The major steps are as follows. The fishing effort and landings data are first groomed separately. Outlier values in key variables that fail a range check are corrected using median imputation. This involves replacing missing or outlier values with a median value calculated over some subset of the data. Where grooming fails to find a replacement, all fishing and landing events associated with the trip will be excluded. The fishing effort within each valid trip is then re-stratified by statistical area,

method, and target species. The green-weight landings by species are then allocated to the effort strata using the total estimated species catch in each effort stratum as a proportion of the total estimated species catch for the trip. If estimated catches for a species are not recorded for the trip, but a landing was recorded for that species and trip, then the total fishing effort in each effort stratum as a proportion of the total fishing effort for the trip is used to allocate the green-weight landings for that species.

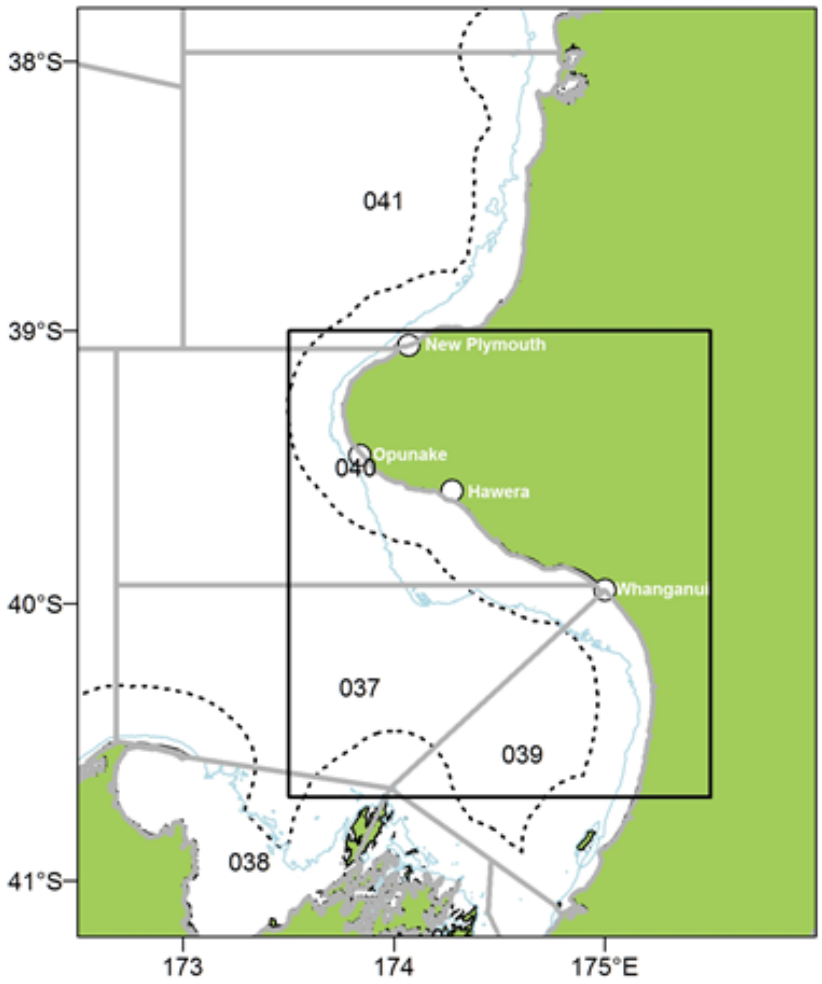

Figure 2-1: Overlap of labelled finfish statistical areas (grey lines) with the study area (black box).

3 Results

3.1 Fishing methods

Bottom trawling was the most common fishing method used in the STB over the last nine years and is no longer recorded using CELR forms (Table 3-1). Midwater trawling was the second most common fishing method used with a relatively consistent number of tows each year over the entire nine years. Midwater trawling was not recorded on CELR forms in the study area during this period. The total catch from midwater trawling was about ten times that from bottom trawling, due to the different species targeted and caught. Set netting was the third most common fishing method where locational data were available and the most common method of fishing used in the study area where CELR data only are available. Rock lobster potting and crab potting were both common commercial fishing activities in the area of interest over the last nine years but are recorded only by statistical area (Table 3-1 b). Over the last nine fishing years recording of effort data from bottom longlining was evenly split between locational data forms and CELR forms.

Other fishing methods reported in the region by statistical area only occurred at a relatively low level, with fewer than 300 events per year and some totalling fewer than 100 events over the nine years summarised. These include trolling, drop lining, hand-lining, cod-potting, pole and line fishing, Danish seining, purse-seining, diving, dredging, fish trapping, and hand gathering (Table 3-1 b).

Table 3-1: Summary of commercial fishing effort in the South Taranaki Bight by fishing year and fishing method for the period 2006-2015 where a) locational data are available and b) data are for statistical areas only. Fishing year is 1 October–31 September (e.g. 2007 is 1 Oct 2006 to 30 Sep 2007). Also shown are total fishing events and catch. Locational data available from TCEPR, TCER, LTCER, LCER, NCELR, and SJCER forms. For CELR forms data are only available by statistical area (037, 039, 040, and 935).

	Number of fishing events										
Fishing method	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**Total catch (t)**
a) Locational data											
Bottom trawling	321	979	1 055	916	1093	982	802	762	624	7534	9 559
Midwater trawling	523	391	457	765	447	553	558	641	603	4938	94 523
Set netting	335	507	456	462	439	458	370	371	383	3781	4 166
Bottom longlining	-	66	86	59	85	84	78	75	195	728	392
Squid jigging	-	4	1	3	3	3	-	2	3	21	-
b) CELR data											
Set netting	256	275	377	322	371	322	379	316	419	3037	303
Rock lobster potting	466	367	228	351	224	165	109	96	135	2141	437
Crab Potting	165	115	170	267	311	279	286	293	119	2005	110
Trolling	127	111	139	35	52	100	196	160	290	1210	989
Bottom longlining	182	96	127	93	98	94	73	67	77	907	846
Drop lining	48	53	62	49	71	56	61	68	58	526	189
Hand lining	16	42	55	42	51	72	51	48	36	413	61
Bottom trawling	306	6	55	12	-	-	-	-	-	379	908
Cod pot	47	52	19	26	53	26	20	25	24	292	160
Pole and line	23	12	31	46	33	25	18	20	24	232	381
Danish seine	20	28	29	7	26	20	18	1	1	150	384
Purse seining	8	9	13	3	19	2	3	7	1	65	2504
Diving (DI)	-	1	1	1	1	3	31	10	3	51	5
Diving (UBS)	-	-	-	-	-	-	-	-	22	22	3
Dredging	1	-	-	-	-	5	15	-	-	21	10
Fish traps	5	-	1	1	-	-	3	6	3	19	1
Hand gathering	-	-	-	-	-	-	1	-	9	10	6
Ring net	1	2	-	-	-	-	1	1	3	8	2
Octopus Potting	-	-	-	-	4	4	-	-	-	8	<1

The lowest levels of overall fishing effort in the region were in the central south sector, offshore of the coastline south of Whanganui, and also very close to the shore north of Opunake and north and south of Whanganui (Figures 3-1 and 3-2). The highest levels of effort were off the coastline between New Plymouth and Cape Egmont, between Hawera and Whanganui especially near the 50 m contour, and just north of D'Urville Island.

The distribution of total catch was quite different to that of effort and was dominated by the large, offshore, midwater trawl fishery for jack mackerel (*Trachurus* spp.) focussed on the western central and southern sectors of the STB. This was not reflected in the CELR data as mid-water trawling was not recorded on this form (Figure 3-2).

The proposed iron-sand mining area lies in an area of overall moderate effort and low overall catch.

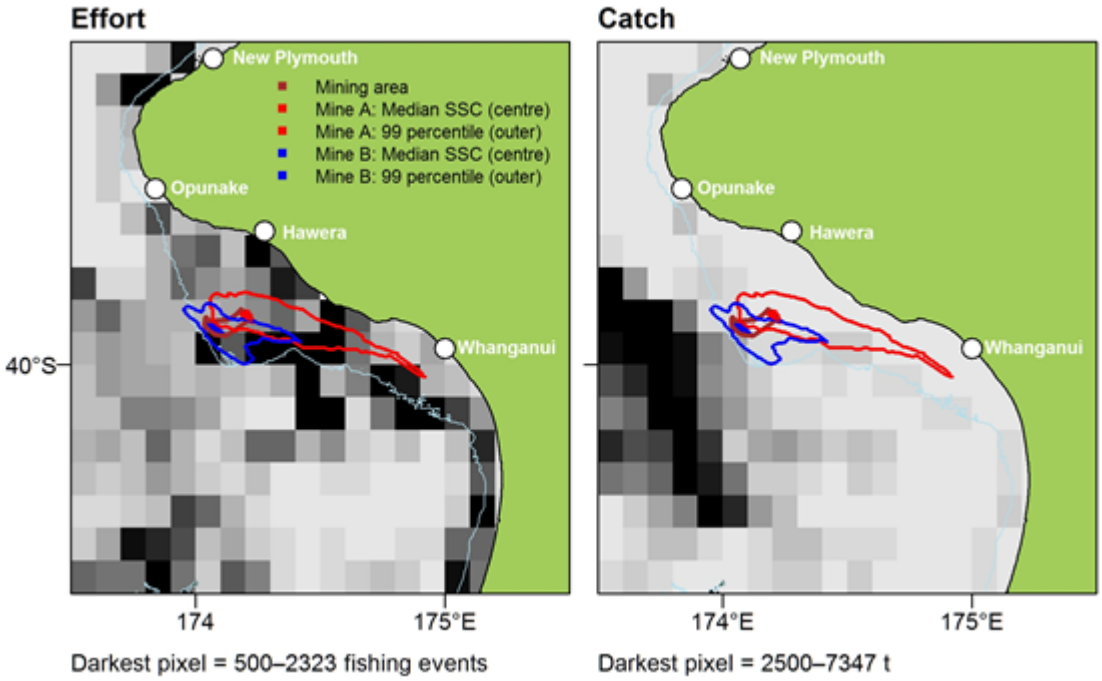

Figure 3-1: All commercial fishing methods - effort and catch where locational data were available from TCEPR, TCER, LTCER, LCER, and NCELR forms. Density plots showing the spread of commercial fishing effort (number of fishing events) and total catch within the study area between 1 October 2006 and 30 September 2015. Pixels are 0.1° x 0.1° rectangles. The light blue line represents the 50 m contour. Also shown is the proposed mining area, and the contours where SSC is above the threshold at which marine fish avoid sediments (2mg / l) 50% (median) and 1% (99th percentile) of the time when mining occurs at the innermost (A) and outermost (B) points of the mining area.

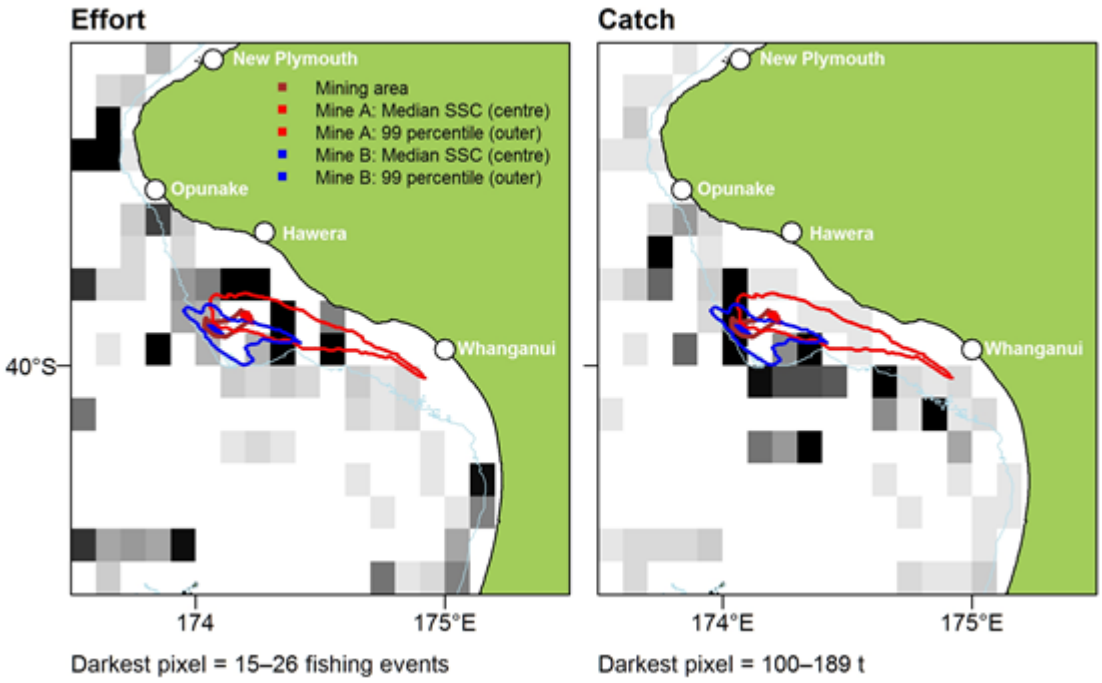

Figure 3-2: All commercial fishing methods - effort and catch from a subset of CELR data where positions exist. Note: as the majority of CELR data lack positional data these figures represent only a fraction of the effort and catch recorded on these forms. For an explanation of other features see the caption for Figure 3-1.

3.2 Bottom trawling

The main species caught by bottom trawling in most years was red gurnard (*Chelidonichthys kumu*), with 150–324 trawls per year and an average total catch of over 260 t per year for the period (Table 3-2a). Several other species were consistently caught, including tarakihi (*Nemadactylus macropterus*), blue warehou (*Seriolella brama)*, trevally (*Pseudocaranx dentex*), John dory (*Zeus faber*), flatfish (several species), leather jacket (*Meuschenia scaber*), barracouta (*Thyrsites atun*), and snapper (*Pagrus auratus*). Target bottom trawling for jack mackerel, although less common than for these other species, produced a total catch for the period of 895 t, similar to that of leather jacket and barracouta.

Table 3-2: Bottom trawling effort and total catch. Summary of commercial fishing effort in the South Taranaki Bight by target species and fishing year (1 Oct–31 Sep, e.g. 2007 is 1 Oct 2006 to 30 Sep 2007), and total catch by target species for the period 2007-2015, a) where locational data are available, b) CELR data only. +, catches available but confidential as less than 3 vessels.

	Number of trawls										
Target species	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**Total catch (t)**
a) Locational data											
Red gurnard	118	154	252	265	324	244	225	208	185	1 975	2 397
Tarakihi	22	102	153	153	198	147	143	125	79	1 122	949
Blue warehou	50	65	130	52	146	119	131	61	73	827	980
Trevally	44	67	75	104	125	85	104	108	55	767	1 475
John dory	+	59	41	73	59	70	83	82	108	581	382
Flatfish	+	154	171	44	44	45	17	55	37	579	341
Leatherjacket	+	44	56	118	37	126	39	31	15	497	872
Barracouta	21	215	71	43	22	64	18	34	11	499	887
Snapper	+	51	45	63	87	54	30	14	36	382	218
School shark	+	+	12	+	10	13	13	22	19	96	77
Jack mackerel	11	51	13	-	+	+	+	-	-	81	895
Dark ghost shark	-	-	8	17	15	12	+	+	-	68	53
Red cod	-	5	+	4	+	3	+	+	-	22	15
Rig	-	+	+	+	+	-	-	+	+	15	6
Moki	-	-	+	+	+	+	+	-	-	+	4
Hapuka/Bass	-	+	+	+	+	-	-	-	+	+	7
Silver warehou	-	-	-	-	+	-	-	-	-	+	+
Alfonsino & long-finned beryx	-	-	-	-	-	-	-	+	-	+	+
Kahawai	-	+	-	-	-	-	-	-	-	+	+
Pipefish	-	-	-	-	-	-	-	-	+	+	-
b) CELR data											
Barracouta	24	+	+	-	-	-	-	-	-	26	83
Flatfish	72	+	+	-	-	-	-	-	-	82	142
Dark ghost shark	+	-	-	-	-	-	-	-	-	+	+
Red gurnard	62	-	+	-	-	-	-	-	-	76	189
John dory	+	-	-	-	-	-	-	-	-	+	+
Leatherjacket	+	-	+	-	-	-	-	-	-	17	105
Moki	+	-	-	-	-	-	-	-	-	+	+
Red cod	+	-	-	-	-	-	-	-	-	8	19
School shark	6	-	-	-	-	-	-	-	-	+	+
Snapper	15	-	-	-	-	-	-	-	-	15	25
Spiny dogfish	+	-	-	-	-	-	-	-	-	+	+
Tarakihi	59	-	+	+	-	-	-	-	-	89	191
Trevally	8	-	-	+	-	-	-	-	-	15	79
Common warehou	3	-	-	-	-	-	-	-	-	3	9

Bottom trawling was spread out over much of the study area, with the main areas of effort and catch near the 50 m depth contour, particularly adjacent to New Plymouth, between Opunake and Hawera, south of Wanganui, and in the southwest corner of the study area, to the north of Tasman Bay (Figure 3-3). The percentage of species catch for the study area falling within the area where SSC is above the 2mg / l threshold at which marine fish avoid sediments 1% (99th percentile) of the time when mining occurs at the innermost (A) and outermost (B) points of the mining area, is on average over the period less than 5% for most species (Table 3-3). For leather jackets and trevally about 5-10% and 7-12% of the total catch respectively fall within the 99th percentile area. The proportion of species catches for the study area falling inside the areas where SSC is above the 2mg / l threshold at which marine fish avoid sediments 50% (median) of the time is less than 1% for all species.

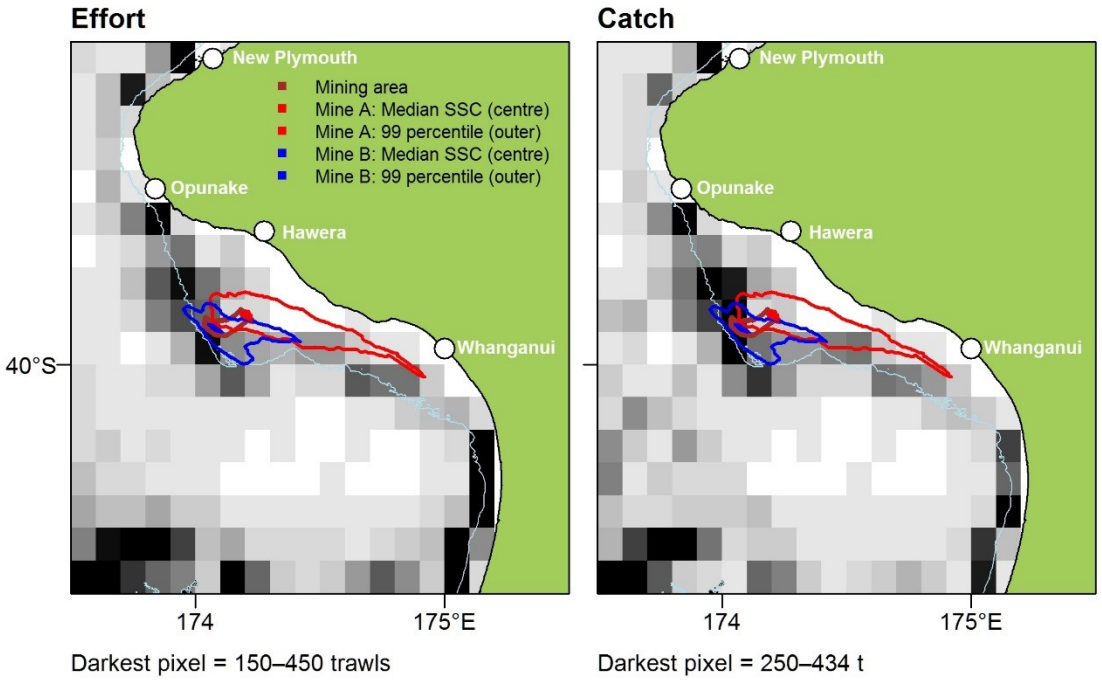

Figure 3-3: Bottom trawling - effort and catch. Density plots showing the spread of commercial fishing effort (number of fishing events) and total catch within the study area between 1 October 2006 and 30 September 2015. For an explanation of other features see the caption for Figure 3-1.

Table 3-3: Bottom trawling catch. Summary catches (rounded to 1 t) by main species and fishing year for the study area and percentage of catch of each species in the mine A and B 99 percentile areas for TCEPR and TCER forms. *, percentage < 0.1; -, no data; +, catches available but confidential as less than 3 vessels.

		Fishing year									
Species		2007	2008	2009	2010	2011	2012	2013	2014	2015	Total catch
Barracouta	Catch	217	316	269	105	98	107	97	110	95	1 414
	A %	0.9	+	+	+	+	+	*	0.9	-	-
	B %	2.3	0.3	0.7	3.8	4.1	+	2.1	0.9	2.1	1.6
Flatfish	Catch	6	25	24	10	19	10	4.0	15	9	122
	A %	-	-	-	-	-	-	-	-	-	-
	B %	-	+	-	+	+	+	+	-	-	-
Dark ghost shark	Catch	9	34	28	30	47	41	33	26	9	257
	A %	-	-	-	-	-	-	-	-	-	-
	B %	-	-	-	-	-	-	-	+	-	-
Red gurnard	Catch	73	77	110	118	106	98	79	72	83	816
	A %	5.5	+	+	1.7	+	+	1.3	1.4	+	1.3
	B %	5.5	+	2.7	1.7	6.6	3.1	5.1	4.2	2.4	3.6
John dory	Catch	6	24	22	24	33	27	27	23	28	214
	A %	-	+	-	+	+	-	+	-	-	-
	B %	-	+	+	*	*	+	*	-	+	-
Jack mackerel	Catch	152	394	117	21	9	16	23	8	8	748
	A %	+	-	+	-	-	+	+	+	+	-
	B %	+	-	+	-	+	+	+	+	+	-
Leatherjacket	Catch	122	182	189	325	209	190	65	43	22	1347
	A %	4.1	+	+	9.5	+	2.1	3.1	+	+	5.6
	B %	10.7	+	12.7	3.7	24.4	9.5	9.2	9.3	4.5	9.8
Tarakihi	Catch	15	56	59	43	40	46	33	43	31	366
	A %	-	-	+	2.3	+	+	-	-	-	-
	B %	-	-	+	*	*	+	+	-	-	-
Porcupine fish	Catch	<0.5	17	9	14	17	15	8	10	13	103
	A %	-	-	+	+	-	+	+	+	+	-
	B %	-	-	11.1	+	+	+	+	+	+	-
Rough skate	Catch	4	14	22	23	22	8	7	8	10	118
	A %	-	-	+	+	-	+	-	-	+	-
	B %	+	-	4.5	+	+	+	+	*	+	-
School shark	Catch	31	35	42	24	39	35	33	36	43	318
	A %	9.7	-	+	+	-	+	+	+	+	-
	B %	+	+	+	+	+	+	+	+	+	3.1
Snapper	Catch	31	75	86	85	107	89	100	101	99	773
	A %	3.2	+	+	+	+	4.5	1.0	+	+	2.1
	B %	3.2	+	1.2	*	14.0	4.5	8.0	2.0	2.0	4.4
Spiny dogfish	Catch	16	22	45	41	100	80	44	21	16	385
	A %	+	-	+	2.4	+	+	+	+	+	-
	B %	+	-	4.4	+	+	2.5	6.8	28.6	6.2	-
Rig	Catch	6	12	13	15	20	15	14	18	18	131
	A %	*	+	+	6.7	-	+	+	5.6	+	-
	B %	+	+	*	*	5.0	6.7	*	5.6	5.6	3.1
Trevally	Catch	57	48	126	161	252	122	158	107	35	1 066
	A %	12.3	+	1.6	1.9	+	9.0	1.3	1.9	+	6.9
	B %	8.8	+	3.2	4.3	25.4	4.1	19.0	10.3	8.6	12.1
Common warehou	Catch	54	141	140	45	114	77	54	26	33	684
	A %	-	+	+	+	-	-	-	+	+	-
	B %	-	+	-	-	-	+	-	+	-	-
Other	Catch	24	64	75	73	88	96	74	55	46	595
	A %	+	+	+	+	+	+	+	+	+	+
	B %	+	-	+	+	+	+	+	+	+	-

Midwater trawling

Midwater trawling in the area mostly targeted jack mackerel, with a small amount of barracouta targeting, and single trawls targeting hoki (*Macruronus novaezelandiae*) in three of the years in the period (Table 3-4). In terms of both effort and total catch, midwater trawling for jack mackerel has been the most important fishery in the area, with almost 90,000 t caught during the period, from just over 4500 trawls.

Midwater trawling tends to be in deeper water with most reported trawls well beyond the 50 m depth contour and focussed on a region parallel to the coast between Opunake and Whanganui (Figure 3-4). Fishing effort and catch has been most intense in the northern part of this area.

There is no overlap between midwater trawling in the STB and the areas affected by mining (Table 3-5).

Table 3-4: Midwater trawling effort and total catch. Summary of fishing effort from TCEPR and TCER forms by target species and fishing year (1 Oct–31 Sep), and total catch by target species. +, data available but confidential as less than 3 vessels.

	Number of trawls										
Target species	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Total catch (t)
Jack mackerel	477	426	432	729	443	535	558	540	398	4 538	87 389
Barracouta	34	+	20	+	-	+	+	96	205	391	7 016
Blue mackerel	-	-	-	-	-	+	-	+	-	+	+
Hoki	-	+	-	-	-	+	+	-	-	+	+

Table 3-5: Midwater trawling catch. Summary of catches (rounded to 1 tonne) by main species and fishing year for the study area for TCEPR and TCER forms. No midwater catches fell within in the mining A and B 99 percentile areas. +, catches available but confidential as less than 3 vessels.

Species	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Barracouta	2 765	1 287	1 977	3 316	1 004	1 855	1 928	2 167	2 014	18 313
Blue mackerel	67	334	51	410	437	163	392	302	142	2 298
Frostfish	149	100	181	252	75	372	453	221	357	2 160
Jack mackerel	6 160	7 565	6 983	8 774	7 614	7 114	9 583	7 943	8 341	70 077
Pilchard	20	23	+	+	-	-	+	88	3	144
Silver dory	35	57	49	51	+	+	5	7	-	214
Spiny dogfish	64	14	43	90	42	35	27	38	67	420
Arrow squid	119	3	+	+	+	+	5	2	15	149
Other	69	107	47	55	49	101	32	132	58	650

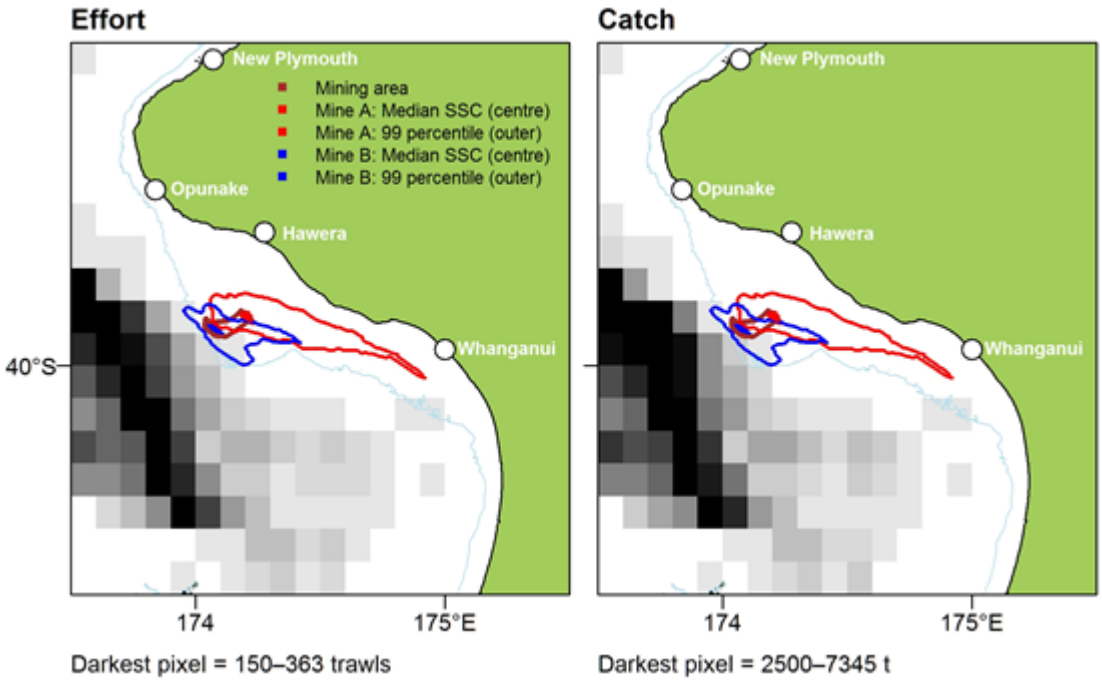

Figure 3-4: Midwater trawling – effort and catch. Density plots showing the spread of commercial fishing effort (number of fishing events) and total catch within the study area between 1 October 2006 and 30 September 2015 for TCEPR and TCER forms. For an explanation of other features see the caption for Figure 3-1.

3.3 Set netting

Set netting in the area targeted four main species or species groups, rig (*Mustelus lenticulatus*), school shark (*Galeorhinus galeus*), blue warehou, and flatfish, with a moderately consistent level of effort in each year (Table 3-6a and b). Other species consistently targeted over the nine years reviewed, but with total catches of 400 t or less, were butterfish, grey mullet, kahawai and yellow-eyed mullet. Several other species were very occasionally targeted.

Table 3-6: Set-netting. Summary of fishing effort from a) the NCELR form and b) the CELR form by target species and fishing year (1 Oct–31 Sep), and total catch by target species. +, data available but confidential as less than 3 vessels.

	Number of records										
Target species	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Total catch (t)
a) NCLER											
Rig	192	279	170	220	208	203	115	196	224	1 807	1 765
School shark	57	123	127	107	125	111	137	124	140	1 051	1 747
Common warehou	77	+	+	+	+	+	+	+	14	800	590
Flatfish	-	-	+	+	+	+	-	+	-	57	11
Trevally	+	+	12	+	+	+	+	+	+	56	47
Spiny dogfish	-	-	-	+	+	-	-	-	+	+	+
Butterfish	-	-	-	-	-	-	-	-	+	+	+
Elephantfish	+	-	-	-	-	-	-	-	-	+	+
Red gurnard	+	-	-	-	-	-	-	-	-	+	+
Hapuka/Bass	+	-	-	-	-	-	-	-	-	+	+
Kahawai	-	-	+	-	-	-	-	-	-	+	+
Tarakihi	-	-	-	-	-	-	-	+	-	+	+
b) CELR											
Butterfish	+	+	29	25	20	27	16	+	10	159	19
Flatfish	105	116	104	134	184	193	196	191	200	1423	64
Grey mullet	+	+	+	+	+	+	+	+	+	196	7
Red gurnard	-	-	+	-	-	-	-	+	+	13	2
Kahawai	38	33	13	10	26	6	8	20	39	193	12
Moki	-	-	+	+	+	+	+	+	-	+	+
School shark	+	+	+	-	-	-	-	-	+	18	22
Rig	35	39	150	47	55	37	51	22	59	495	158
Trevally	-	-	-	-	-	+	+	-	+	29	2
Yellow-eyed mullet	29	+	+	41	66	34	45	+	+	352	13
Other	+	11	+	44	+	-	+	5	21	130	3

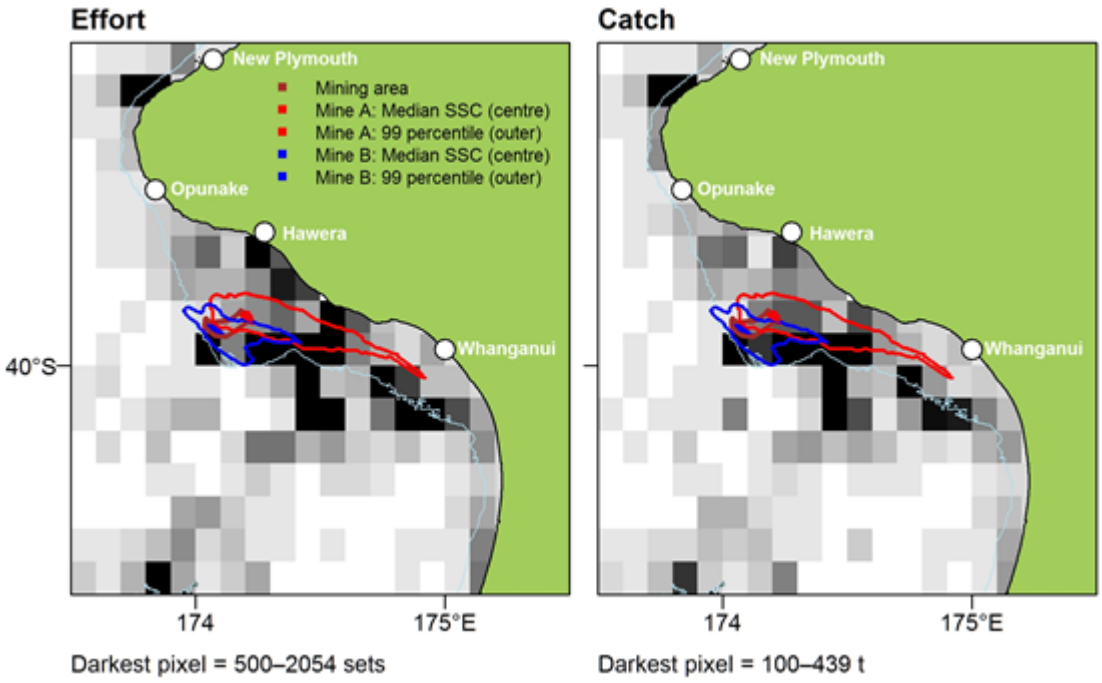

Figure 3-5: Set netting 2006–07 to 2014–15. Density plots showing the spread of fishing effort and total catch within the study area over the whole period considered from NCELR forms. For an explanation of other features see the caption for Figure 3-1.

Set netting was widespread throughout the study area, but with a focus on the coastline around New Plymouth and between Hawera and Whanganui, around or within the 50 m depth contour (Figure 3-5). There was a lower level of set netting effort recorded between this latter area and Tasman Bay and also along other parts of the coastline, but no effort or catch recorded in the central south region of the area. The distribution of set-netting catch and effort in the STB does not appear to have changed much before and after the introduction of set-netting restrictions (Figures 3-6 and 3-7). However, the total catch for all set netting combined in the study area averaged 500 t per year before the set-netting restrictions came into effect and 400 t per year thereafter; a decrease of about 20% (Table 3-7).

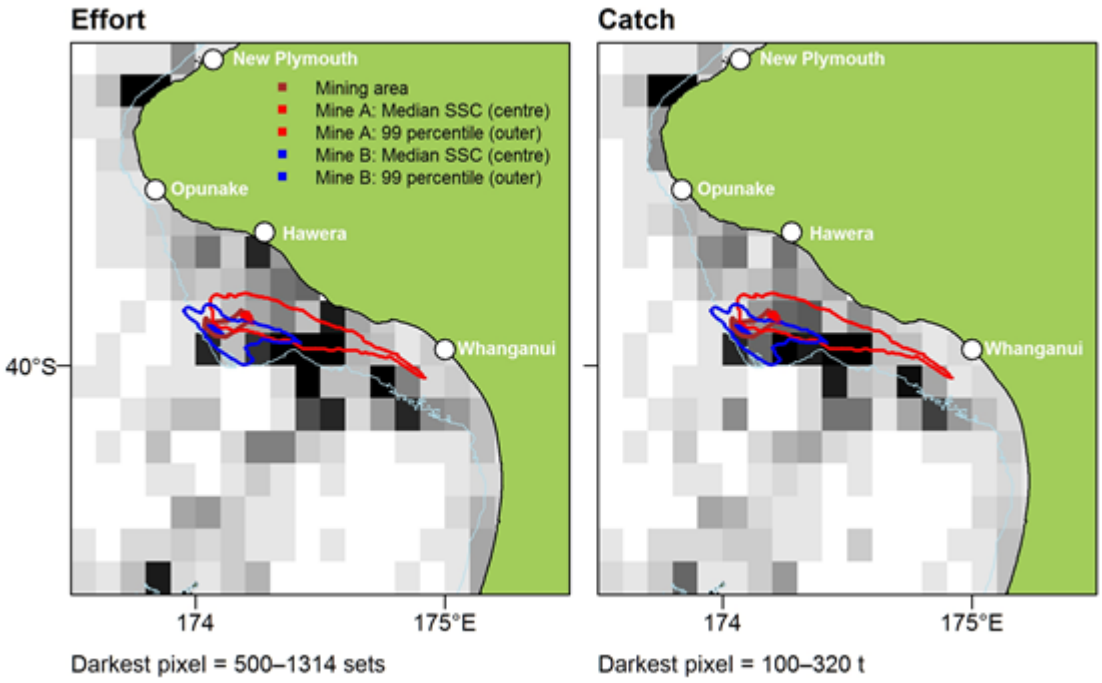

Figure 3-6: Set netting 1 October 2006 to 25 July 2012. Density plots showing the spread of fishing effort and total catch within the study area from NCELR forms before the set-netting restrictions came into effect. For an explanation of other features see the caption for Figure 3-1.

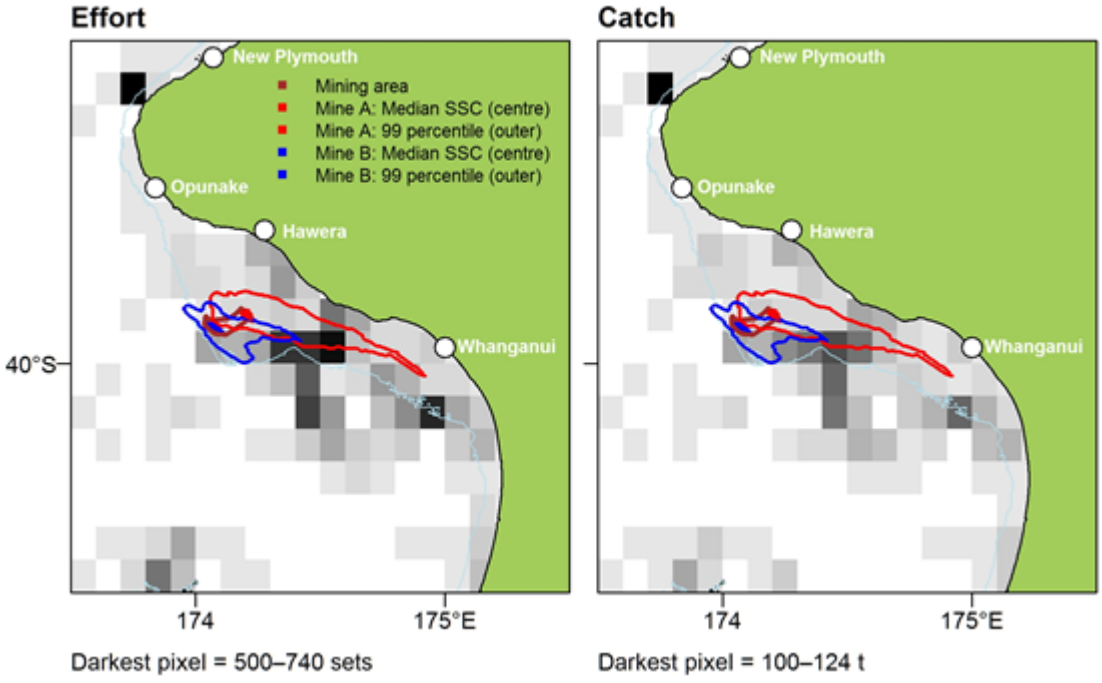

Figure 3-7: Set netting 26 July 2012 to 30 September 2015. Density plots showing the spread of fishing effort and total catch within the study area from NCELR forms after the set-netting spatial restrictions came into effect. For an explanation of other features see the caption for Figure 3-1.

The percentage of species catch for the study area falling within the area where SSC is above the 2mg / l threshold at which marine fish avoid sediments 1% (99th percentile) of the time when mining occurs at the innermost (A) and outermost (B) points of the mining area, is provided in Table 3-7. The percentage of regional catch within this area is 17% for rig, 13% for carpet sharks and trevally, 10% for school shark, 8% for snapper, 7% for spiny dogfish, insignificant levels for northern spiny dogfish and common warehou, and 13% for other species combined. The proportion of species catches for the study area falling inside the areas where SSC is above the 2mg / l threshold at which marine fish avoid sediments 50% (median) of the time is less than 1% for all species. There were no CELR data with positions falling within the 99th percentile areas for mining at locations A or B.

Table 3-7: Set netting catch. Summary catches (rounded to 1 t) by main species and fishing year for the study area and percentage of catch of each species in the mine A and B 99 percentile areas for the NCELR forms. *, percentage < 0.1; -, no data. +, catches available but confidential as less than 3 vessels.

		Fishing year									
Species		**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**
Carpet shark	Catch	12	33	25	28	33	27	23	22	30	233
	A %	+	12.1	+	14.3	15.2	14.8	8.7	9.1	16.7	12.9
	B %	+	+	-	7.1	6.1	11.1	4.3	+	6.7	-
Northern spiny	Catch	4	13	24	22	24	21	11	6	5	130
dogfish	A %	-	-	+	-	+	-	+	-	+	-
	B %	+	-	+	-	-	-	+	-	+	-
Schoolshark	Catch	150	207	230	188	196	150	166	135	195	1617
	A %	11.3	8.2	5.2	5.9	10.7	7.3	5.4	4.4	6.7	7.2
	B %	12.7	5.3	+	13.3	11.2	12.7	10.2	4.4	9.7	9.8
Snapper	Catch	18	10	18	12	14	15	15	13	11	126
	A %	5.6	10.0	5.6	8.3	14.3	*	6.7	7.7	18.2	7.9
	B %	*	+	+	8.3	+	*	6.7	*	9.1	2.4
Spiny dogfish	Catch	11	30	52	39	44	55	27	22	16	296
	A %	*	10.0	+	5.1	4.5	12.7	3.7	+	12.5	7.1
	B %	+	+	-	2.6	+	14.5	18.5	4.5	6.2	-
Rig	Catch	97	135	113	146	119	119	65	124	127	1045
	A %	10.3	17.0	15.9	17.8	17.6	12.6	13.8	17.7	22.8	16.6
	B %	1.0	1.5	+	3.4	6.7	2.5	4.6	0.8	3.1	2.7
Trevally	Catch	15	13	15	16	17	14	13	11	11	125
	A %	*	7.7	6.7	12.5	29.4	7.1	7.7	27.3	18.2	12.8
	B %	*	+	+	6.2	5.9	*	7.7	*	9.1	3.2
Common warehou	Catch	44	44	71	72	29	62	43	15	11	391
	A %	+	*	+	+	+	+	-	*	+	-
	B %	+	+	-	-	+	+	-	-	+	-
Other	Catch	12	33	25	28	33	27	23	22	30	233
	A %	+	+	+	+	+	+	+	+	+	12.9
	B %	+	+	-	+	+	+	+	+	+	-

3.4 Bottom longlining

Several species were targeted by bottom longlining in the area during the past nine years, particularly school shark, red gurnard, and hapuka and bass (*Polyprion* spp) (Table 3-8 a and b). A total of almost 1240 t was caught over the period. About one third of the total catch was recorded with positional data on LTCER and LCER forms with the majority (68%) recorded only to statistical area using the CELR forms.

Table 3-8: Bottom longlining catch. Summary of fishing effort from a) LTCER and LCER and b) CELR forms by target species and fishing year (1 Oct–31 Sep), and total catch by target species. +, data available but confidential as less than 3 vessels.

	Number of records										
Target species	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**Total catch (t)**
a) LTCER and LCER forms											
School shark	-	14	20	29	39	44	38	53	88	325	262
Red gurnard	-	+	+	+	21	28	21	+	+	208	50
Hapuka/Bass	-	21	11	16	17	10	14	+	31	126	64
Snapper	-	+	11	+	+	+	-	-	-	27	4
Blue cod	-	+	+	-	-	-	+	+	+	24	8
Tarakihi	-	+	-	-	-	+	-	-	+	+	+
Ling	-	-	+	+	-	-	+	+	+	+	2
Albacore	-	-	-	-	-	-	+	-	-	+	0
b) CELR form											
Blue cod	41	+	35	28	+	+	+	+	+	289	31
Red gurnard	+	+	+	+	-	-	+	+	+	34	13
Hapuka/Bass	27	-	+	11	+	+	-	-	+	57	36
Ling	+	-	-	-	+	+	-	-	-	5	5
School shark	85	56	74	43	59	52	40	+	+	496	752
Snapper	+	+	-	+	+	-	-	-	+	16	8
Tarakihi	+	-	-	-	-	-	-	-	-	+	+
Other	-	-	+	-	-	-	-	-	+	+	+

Bottom longlining effort and catch occurred at low levels through much of the study area but was most strongly concentrated on the area of coastline from New Plymouth to Cape Egmont, and also north of D'Urville Island (Figure 3-8). Little of bottom longlining catch for any species fell with areas impacted by mining activities (Table 3-9).

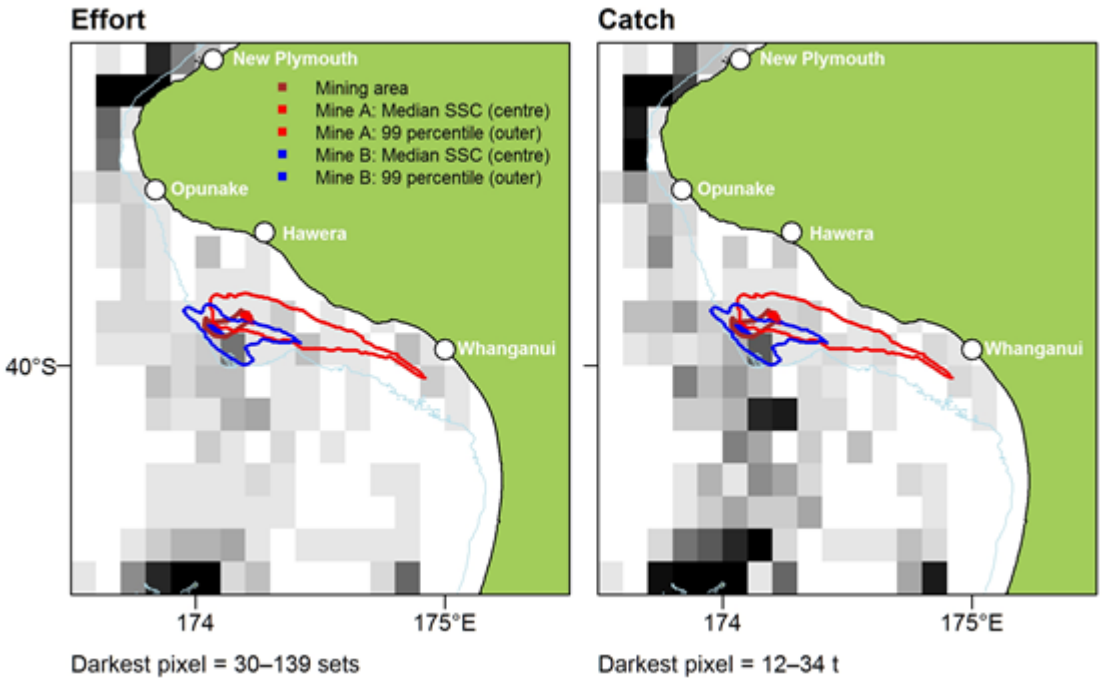

Figure 3-8: Bottom longlining - effort and catch. Density plots showing the spread of commercial fishing effort (number of fishing events) and total catch within the study area between 1 October 2006 and 30 September 2015 from LTCER and LCER forms. For an explanation of other features see the caption for Fig 3-1.

Table 3-9: Bottom longlining catch. Summary catches (rounded to 1 tonne) by main species and fishing year for defined box and percentage of catch of each species in the mine A and B 99th percentile areas from LTCER and LCER, forms. *, percentage < 0.1; -, no data. +, catches available but confidential as less than 3 vessels.

		Fishing year								
Species		2008	2009	2010	2011	2012	2013	2014	2015	Total
Carpet shark	Catch	+	+	+	+	-	-	+	+	12
	A %	+	-	-	-	-	-	-	-	-
	B %	-	-	-	-	-	-	-	+	-
Red gurnard	Catch	4	8	1	3	4	3	2	7	32
	A %	+	+	-	-	+	+	-	-	-
	B %	-	-	-	-	+	-	-	+	-
Hapuku and bass	Catch	7	3	8	3	6	2	3	20	52
	A %	-	-	-	-	-	-	-	-	-
	B %	-	-	-	-	-	-	-	-	-
Northern spiny dogfish	Catch	+	+	+	2	6	+	2	7	19
	A %	-	-	-	-	-	-	-	-	-
	B %	-	-	-	-	-	-	-	+	-
School shark	Catch	21	13	23	20	11	23	39	56	206
	A %	+	-	-	-	+	+	-	-	-
	B %	-	-	-	-	+	-	-	+	-
Snapper	Catch	3	3	1	3	3	1	1	6	21
	A %	+	+	-	-	+	+	-	-	-
	B %	-	-	-	-	+	-	-	+	-
Spiny dogfish	Catch	3	1	5	3	+	<0.5	+	11	30
	A %	-	-	-	-	-	-	-	-	-
	B %	-	-	-	-	-	-	-	+	-
Other	Catch	+	+	+	+	+	+	+	+	+
	A %	+	-	-	-	-	-	-	-	-
	B %	-	-	-	-	-	-	-	+	-

3.5 Cray-fishing

Commercial catch data for rock lobsters (*Jasus edwardsii*) are available only on a fishing statistical area basis, and as so few fishermen are involved in this fishery in the study region the data cannot be partitioned on a smaller spatial scale due to commercial sensitivity. The majority of the catch in the study area (Table 3-10) is caught in Area 935 that runs from just south of New Plymouth to near Bulls, a distance along the coast of about 240 km (Figure 3-9). The average total commercial catch of rock lobsters along this stretch of coast over the last nine fishing years has been 18.8 t (Table 3-10). This is about 40% of the Total Allowable Commercial Catch (TACC) of rock lobsters (47 t) in the whole of the CRA9 Fisheries Management Area (FMA) that extends along the west coasts of the South and North Islands from Hokitika to the Kaipara Harbour (Ministry for Primary Industries 2014).

Figure 3-9: Crayfish statistical areas. Rock lobster statistical area 935 runs from just south of New Plymouth to near Foxton Beach.

Table 3-10: Annual (fishing year 1 April – 30 March) commercial catch of rock lobsters from statistical areas and the proportion in area 935.

	CRA estimated catch (kg)		
Fishing year	Statistical area 935	Statistical areas 037, 039, 040, and 935	Percentage catch in statistical area 935
2007–08	24 759	35 530	0.70
2008–09	14 222	19 428	0.73
2009–10	15 123	18 034	0.84
2010–11	27 041	32 855	0.82
2011–12	17 442	20 607	0.85
2012–13	10 959	13 793	0.79
2013–14	15 741	16 621	0.95
2014–15	25 777	26 370	0.98

Because rock lobsters spend most of the year associated with subtidal reefs most of the commercial catch is likely to be taken at these localities. However, in winter and summer larger (>1.5 kg) rock lobsters may move offshore to depths >25 m to feed on shellfish such as dog cockles (*Tucetona laticostata),* scallops (*Pectin novaezealandiae*) and horse mussels (*Atrina zelandica*) (Kelly et al. 1999, Kelly and MacDiarmid 2003, Langlois et al 2005. Commercial fishermen may seasonally target rock lobsters on these shellfish beds (e.g. Kelly et al. 2002).

It is highly likely that most, if not all, commercial rock lobster fishing takes place close inshore outside the areas affected by iron sand recovery operations and the suspended sediment plumes.

4 Discussion

Commercial fishing operations within the STB have been dominated in recent years by three main fishing methods, midwater trawling (mainly for jack mackerel), bottom trawling (for a variety of species), and set netting (mainly for rig, school shark, flatfish, and blue warehou). Together these methods have accounted for 98% of all fishing events recorded with position data, over the nine years examined. Purse seining, bottom longlining, hand-lining, trolling, potting, drop lining, and fish trapping together account for the remaining 2% of catch.

The lowest levels of fishing effort were in the offshore, central-south regions of the study area and in the shallowest parts of the southern and western coastlines. The highest levels of fishing effort (mainly bottom trawling and set netting) were between New Plymouth and Cape Egmont, relatively close to the shore, and between Hawera and Whanganui near the 50 m contour.

The fisheries with the greatest overlap with the proposed iron sand extraction operations are the bottom trawl fisheries for leather jackets and trevally, and the set-net fisheries for rig, carpet sharks, trevally, school shark, snapper, and spiny dogfish. Between 5% and 17% of the total catches in the study area for these species occur in the area where SSC exceeds the 2 mg/l threshold for fish avoidance 1% of the time. However, the area where SSC exceeds the 2 mg/l threshold for fish avoidance 50% of the time is negligible compared to the scale of the fishery. In addition, the greatest effort and catch in these fisheries in the STB is to the south and east of the area where iron sand extraction is proposed.

5 Acknowledgements

We thank Helen Macdonald of NIWA for calculating the contour lines for suspended sediment concentrations above the 2 mg/ l threshold for fish movement. We also thank Alana Corney of MPI for information about fisheries restriction areas and dates, and Suze Baird of NIWA for helpful advice. Thanks to David Middleton and Paul Star of Trident Systems for providing useful advice on coding the analysis method. Lastly we thank Owen Anderson for reviewing the report.

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