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Benthic habitat classes and trawl fishing disturbance in New Zealand waters shallower than 250 m

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EXECUTIVE SUMMARY

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Habitat classifications provide tools to aid in managing the environment. Available information on the benthic habitats in New Zealand waters shallower than 250 m was used to identify 108 benthic habitat classes. The classes were defined by three main data sources used as GIS layers: the Benthic-optimised Marine Environment Classification (BOMEC) generated from modelling relevant distributions of environmental variables and groups of benthic organisms; a broad sediment type layer indicating areas of sand, mud, and gravels; and three depth zones to distinguish waters less than 50 m, 50–100 m, and 100–250 m. These habitat classes are presented on a 1 km^2 grid that represents about 232 235 km^2 of seafloor in the study area defined by waters shallower than 250 m around North Island, South Island, and Stewart Island. The nature of the underlying data, including the different scales at which the data were constructed and combined, means that there are very broad descriptions of these habitat classes and that they will not capture the spatial heterogeneity that is likely to exist, to varying degrees, within each one.

Testing of distributions of benthic organisms from two independent sources (biodiversity research surveys and trawl surveys) showed little support for a difference in sensitivity to, or recovery from, trawling of any of the habitat classifications trialled. Operational Taxonomic Units (OTU – a standardised unit of taxonomy across both data sources) were assigned sensitivity and recoverability scores based on relevant biological traits. Both sensitivity and recoverability were expressed as number of OTU, then tested using Two-way Permanova, SIMPER analyses and generalised linear modelling. These tests all indicated a low degree of consistency in sensitivity or recoverability between the two data sources. Subsets based on the depth zone or sediment type did not have lower variability in sensitivity levels. When the benthic habitat classes were combined with the fishery management Statistical Areas to provide a more geographic-based analysis, there was evidence of difference in sensitivity values of different BOMEC classes. Analyses of the recoverability data indicated different categorisation of habitat classes according to the source of the data. These inconsistent results may result from problems of scale, the underlying data used to generate the BOMEC, the nature of the biological data from the different collection sources, or the lack of abundance data.

Bottom-contact trawl data for five fishing years, 2008–2012, were summarised in terms of the number of tows and the area swept by the trawl gear to provide a means of determining how much of each habitat class had been fished. Trawl effort from two different data sources were used – one which had reported start and finish positions (Trawl Catch Effort Processing Returns) and one that had only tow start positions (Trawl Catch Effort Returns). For the former, the tow trackline was generated as a straight line between the start and finish. For the latter, tow endpoints were estimated using the bearing to the next tow and the distance measure calculated from the tow duration and the tow speed. Individual tow swept areas were generated from generic doorspread values and the tracklines and applied to a 5 × 5 km grid to provide summary statistics of the number of tows, the aggregated swept area, and the trawl contact area (footprint) by target species, year, and fisheries management Statistical Areas. The trawl effort targeted about 48 different species or species groups and similar amounts of effort were reported each year, with little overall difference in the estimated annual swept areas. The primary target species were flatfish, tarakihi, snapper, red gurnard, jack mackerel, barracouta, trevally, and John dory.

The trawl footprint for each year and for all five years combined was created for all target species and overlaid on the habitat classes to get a measure of the coverage of habitat classes by trawl gear. The total five year trawl footprint contacted about 113 800 km^2. Annual trawl footprints were in the range

of 45 000–48 000 km^2, and the percentage change from year to year was generally between -4.2 and 4.9% due to a peak year in 2010, mainly as a result of an increase in effort for red gurnard.

About 48% of the area covered by all the habitat classes was contacted by the five year trawl footprint. About 59% of the seafloor in depths of less than 50 m and 50–100 m were contacted by the five year trawl footprint compared with 39% of the 100–250 m depth zone. The percentage of the sediment types covered by the footprint varied, with about 50–58% of the three main sediment types (sand, mud, and gravel) contacted over the five years, 31% of calcareous sand, and about 19% of calcareous gravel. Five of the largest BOMEC classes (with areas between 25 000 and 89 500 km^2 within the study area) had between 30 and 64% of their total area contacted by the five year trawl footprint.

Fishing effort for other bottom-contact fishing methods used within the study area are broadly summarised as the number of dredge tows for dredge oyster and shellfish fisheries by fishery-specific statistical areas and as the number of Danish seine sets by General Statistical Area.

Supplementary maps, tables, and GIS outputs from the work described in this report are available on request from the Ministry of Primary Industries.

1. INTRODUCTION

Within the New Zealand 200 n. mile Exclusive Economic Zone (EEZ) and 12 n. mile Territorial Sea, trawling, shellfish dredging, and Danish seining are the main fishing methods that contact the seafloor when used to target a wide variety of commercial fish, squid, and shellfish species. Trawling is carried out throughout the EEZ in waters shallower than 1600 m, whereas shellfish dredging is confined to localised oyster and scallop beds, and Danish seines are used by a small number of fishers for discrete target fisheries.

Understanding the risks posed to benthic habitats in New Zealand's coastal zone from physical disturbance by mobile bottom-contact fishing gear, requires an understanding of: the type and range of benthic habitats; the taxa that exist in those habitats and knowledge of the biological traits that determine their chance of survival after disturbance; and the distribution of dredging and trawling in relation to the habitats.

To describe and understand fishing disturbance, base information that allows measures of intensity and frequency of fishing effort, by different methods, is necessary to determine the spatial and temporal distribution of the fishing effort. The effect of the fishing effort on the underlying substrates and benthic habitats, requires information on the way in which the different fishing gears modify the environment; for example, the width of the effective bottom-contact gear components and the way in which these components contact, or dig into, the seafloor substrates.

This study was designed to investigate risk to benthic habitats – through descriptions of their spatial distribution in the coastal zone; identification of key taxa or features within the habitats and ranking of their functional importance and vulnerability; and an assessment of the overlap of coastal habitats with patterns of mobile demersal fishing effort. This is reflected in the project objectives given below and the structure of this report. Although the spatial patterns of all the bottom-contacting commercial fishing methods are described, the overlap with benthic habitat classes is presented for the bottom trawl effort only. The objectives were:

1. To use existing information and classifications to describe the distribution of benthic habitats throughout New Zealand's coastal zone (0–250 m depth).
2. To rank the vulnerability to fishing disturbance of habitat classes from Objective 1.
3. To describe the spatial pattern of fishing using bottom trawls, Danish seine nets, and shellfish dredges and assess overlap with each of the habitat classes developed in Objective 1.

The study area

This extent of this work is defined by the 250 m contour – the depth generally accepted by marine geologists to represent the edge of the coastal shelf – restricted to around the main islands where the shelf is continuous: North Island, South Island, and Stewart Island (Figure 1).

The study area covers about 238 668 km^2. About 24% is in depths of less than 50 m, 27% in 50–100 m, and 49% in 100–250 m. The east-west extent varies from about 240 km in a horizontal plane from the 250 m contour to the coast at about 40° S to about 620 m off the Fiordland coast at about 45° S. The study area contains most of the Territorial Sea waters which extend 12 n. miles from the coast, apart from waters where the shelf is narrow (for example, off the Fiordland coast). The Territorial Sea waters within the study area cover about 129 906 km^2 of the seafloor – about 24% of the study area. Fishing vessels over 46 m long are prohibited from using trawl gear in the Territorial Sea (Fisheries (Commercial Fishing) regulations 2001). Other restrictions on trawl fishing within the Territorial Sea relate to gear size or fishing season.

Areas in which trawling cannot take place within the study area include where the use of trawl gear or the take of finfish is prohibited (about 10 577.6 km^2), the 14 areas closed to all fishing because of the placement of cables and pipelines (about 1768 km^2), and areas within marine reserves (475.3 km^2) or where marine farms exist (229.9 km^2). There is some overlap between these areas, and in total, the seafloor area that is not available to trawling is approximately 12 371.4 km^2. Figures 1.1–1.3 in Appendix 1 indicate where the closures are, based on the data from the MPI NABIS website. This website provides the background regulation and description for each closure or restriction.

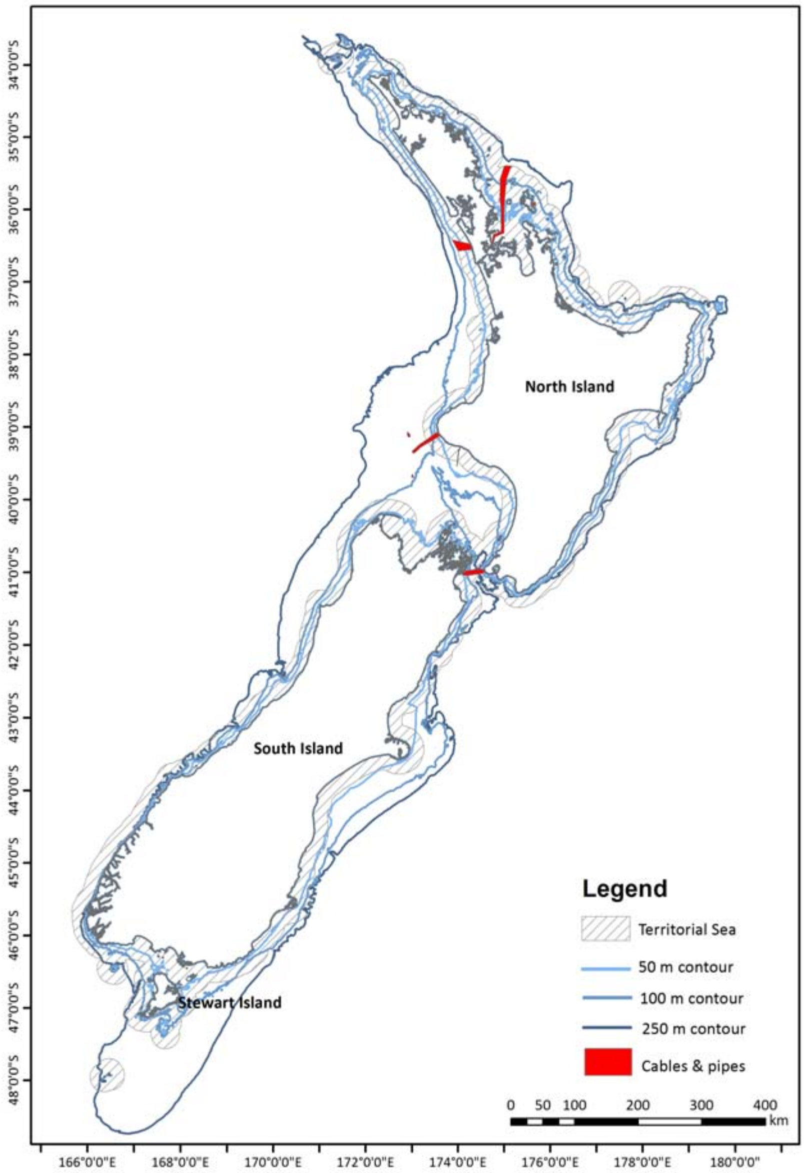


Figure 1: The study area, as defined by the 250 m contour, and its relationship with the Territorial Sea and where the existence of cables and pipelines currently prohibit any fishing.

2. COASTAL BENTHIC HABITAT CLASSES

2.1 Introduction

Many aspects of the coastal marine environment, both within the Territorial Sea and continental shelf waters within the 200 n. mile Exclusive Economic Zone (EEZ), have been studied (for example, see MAF 2011). In recent years there has been an emphasis on understanding communities, habitats, and ecosystems in regional coastal environments (such as the Bay of Islands, Foveaux Strait, Spirits Bay, Tasman Bay and Golden Bay) and the effects of human activities on these environments. Research has been directed at both land-based and marine impacts on these coastal environments (e.g., Morrison et al. 2009b, Tuck & Hewitt 2013), and at identifying important habitats for many commercial fish species (Morrison et al. 2014a, 2014b)

Classification of habitat within an environment defined by area, depth, or substrate may vary according to the requirements. Usually there is a management need to identify areas of high diversity or 'essential fish habitat' which may be at risk from natural or human-based hazards. Generally a classification process uses standard terms and descriptors to define spatially-distinct habitats which can be readily displayed in a Geographic Information System (GIS); to "provide a language through which data and information regarding habitats can be communicated and managed" (see McDougall et al. 2007 in FGDC 2012). These may be based on environmental variables, substrate/sediment types, dominant communities, or more broadly by depth zones and may be at varying scales (very localised, regional, or national).

Globally, there are many classifications that describe the characteristics of benthic habitats (e.g., Brown et al. 2011, Connor et al. 2004, Greene et al. 1999, Madden et al. 2005), with most based on broad descriptions of the physical and oceanographic conditions that support and contain communities and the populations within those communities.

For New Zealand waters, several studies have been directed specifically at developing habitat classifications for defined areas. The Department of Conservation and the then Ministry of Fisheries developed a coastal classification standard with a hierarchy of five layers that classifies the physical environment (Ministry of Fisheries and Department of Conservation 2008) into biogeographic regions, estuarine or marine, depth, exposure, and substrate type. Implementation of this standard method, including a gap analysis, for waters of the Territorial Sea is described by Department of Conservation and Ministry of Fisheries (2011). This classification was developed primarily as a tool for marine reserve planning.

Three other classifications developed in recent years were more broad-scale and based primarily on modelled remote-sensed environmental data: the Marine Environment Classification (MEC, Snelder et al. 2006), a classification optimised for demersal fish (Leathwick et al. 2006), and a Benthic-Optimised Marine Environment Classification (BOMEC, Leathwick et al. 2012). The latter two classifications extended the number of environmental variables modelled for the MEC. The demersal fish classification was derived through a methodology similar to that for the MEC, tuned to discriminate patterns and variation in demersal fish community composition. Three coastal and shelf environments were identified through the demersal fish classification, evident in inner harbours of central and northern North Island, the continental shelf around the North Island and off the west coast South Island, and the shelf from the southwest North Island to around the South Island (except the west coast) and isolated shallower areas near the Chatham Islands and the sub-Antarctic islands (Leathwick et al. 2006).

A more sophisticated approach — Generalised Dissimilarity Modelling which can deal with sparse data and distributions of very large numbers of species — was used for BOMEC, in which the MEC layers were supplemented with some sediment type information and distributional data for eight groups of benthic organisms (Leathwick et al. 2012).

BOMEC is commonly available at a 15-level classification throughout the EEZ to depths of 3000 m. Of the 15 BOMEC classes, 11 are represented (entirely, or in part) in shelf waters out to 250 m. Although BOMEC and its predecessors were developed from the best available data, with the environmental and biological data modelled to 1 km^2 cells, the distribution of many of the biological groups was skewed by data collection from waters beyond 200 m (Leathwick et al. 2012).

After presentation of the above data sources to a meeting of the Aquatic Environment Working Group (AEWG) during June 2013, it was agreed that the best available data as input to a shelf 'benthic habitats classification' should include the BOMEC, depth zones (0–50 m, 50–100 m, and 100–250 m), and broad sediment type (see Leathwick et al. 2012). The extent of the shelf area to be included was limited to the waters around North Island, South Island, and Stewart Island – out to the 250 m contour.

2.2 Habitat class definitions

The primary GIS input for this broad-scale coastal benthic habitat classification definition was the 15-class Benthic Optimised Marine Environment Classification (BOMEC, Leathwick et al. 2012). Although depth and sediment type are included within BOMEC, we explicitly considered potential effects of depth bands and sediment type that may occur across and within BOMEC classes with the inclusion of three depth zone layers representing less than 50 m, 50–100 m, and 100–250 m bands (see Figure 1), and a broad sediment type layer.

These data layers were imported as shapefiles into ArcGIS 10 with a customised Albers Conic equal area projection, with the following spatial data properties: Central Meridian: 175.00; Standard parallel_1: -30.00; Standard parallel_2: -50.00; Latitude of origin: -40.00; Datum: WGS84. All layers were clipped to a shared outer 250 m boundary that contained the North Island, South Island, Stewart Island, and the many small offshore islands around these main islands. Eleven BOMEC classes occur in the study area out to the 250 m contour (Figure 2.1 in Appendix 2). The broad sediment types include calcareous gravel, gravel, calcareous sand, sand, sandy mud, and mud (Figure 2.2 in Appendix 2).

A layer containing the fishery Statistical Areas (Figure 2.3 in Appendix 2) was also included to provide a spatial 'descriptor' for regional and localised habitat classes. For example, a sediment type may be present in a BOMEC class in geographically separate regions, and these regions may provide different environmental condtions that enable or restrict the presence of a taxa or community. The use of a fishery area to further delineate habitat lasses and broadly provide a 'location' for taxa also allows a direct link to the interpretation of the fishing effort distribution. The layers were overlaid and interrogated to provide summary statistics provided below.

2.2.1 Coastal benthic habitat classes

The area covered by each of the 11 BOMEC classes within the study area varied greatly, as did the proportion of the depth zones and sediment types with each BOMEC class (Table 1, Figures 2–4). Of the primary inshore classes (A, B, and D), class A is the most northern shallow class, with most of its 27 377 km^2 around the North Island coast, including Hauraki Gulf and Hawke Bay, and along the South Island northern west coast, including Golden Bay (see Figure 5 and Table 2.1 in Appendix 2). Class A is characterised, relative to the other classes, by high values of temperature, salinity, suspended particulate matter, and dissolved organic matter, and high productivity and sediment resuspension at the seafloor (Leathwick et al. 2012). Class A is shallower than 100 m, and mostly under 50 m, and the main sediment types are gravel, sand, and mud.

BOMEC class B covers less than half the area of class A and is mainly along the western and northern South Island coasts (including Cook Strait) in depths out to 250 m (Table 1 and Table 2.1 in Appendix 2). Compared with Class A, the temperature and salinity is lower, but productivity is slightly higher and the sediments are generally finer (Leathwick et al. 2012), with mud being the predominant sediment type throughout the depth range (see Table 1).

BOMEC Class D is predominantly off the South Island east coast, south to the southernmost coast. Class D is characterised by lower water temperature and salinity values than the other inshore classes, but the sediments are generally coarser (Leathwick et al. 2012). This class is mainly in depths shallower than 50 m, and the main sediment type is sand, then gravel and calcareous gravels (see Table 1, Figures 3 and 4, and Figure 2.2).

Table 1: Coverage (km²) of the seafloor for each BOMEC class-depth zone-sediment type category, where Calc is calcareous. These categories represent 108 benthic habitat classes.

BOMEC	Depth zone (m)	Calc Gravel	Gravel	Calc Sand	Sand	Sandy Mud	Mud	All
Class A	< 50	557.8	6 760.6	375.8	10 756.0	0.0	5 991.3	24 441.4
	50–100	36.8	359.4	30.5	1 262.3	0.0	1 241.8	2 930.8
	100–250	1.9	0.0	0.0	0.3	0.0	0.8	3.1
	< 250	596.5	7 119.9	406.3	12 018.6	0.0	7 234.0	27 375.2
Class B	< 50	6.0	1 111.5	0.0	1 133.9	0.0	2 898.4	5 149.7
	50–100	39.0	286.4	0.0	894.1	0.0	2 924.0	4 143.5
	100–250	5.3	12.2	0.0	115.5	0.0	2 892.5	3 025.5
	< 250	50.3	1 410.1	0.0	2 143.5	0.0	8 714.9	12 318.8
Class C	< 50	72.2	403.7	363.9	1 681.4	0.0	1 656.3	4 177.5
	50–100	711.5	1 240.2	1 583.5	22 749.1	0.0	10 080.0	36 364.3
	100–250	123.6	352.1	546.6	21 947.0	0.0	26 049.3	49 018.7
	< 250	907.4	1 995.9	2 494.0	46 377.5	0.0	37 785.6	89 560.4
Class D	< 50	1 261.5	5 341.6	456.3	7 063.6	0.0	2 459.6	16 582.6
	50–100	156.1	534.6	46.1	5 336.4	0.0	1 830.0	7 903.1
	100–250	285.6	22.9	0.0	476.7	0.0	242.2	1 027.4
	< 250	1 703.2	5 899.0	502.3	12 876.7	0.0	4 531.8	25 513.1
Class E	< 50	95.9	15.6	9.2	79.7	0.0	1.7	202.1
	50–100	1 054.6	1 021.8	403.7	8 115.1	0.0	811.3	11 406.6
	100–250	22 930.5	189.5	2 391.4	8 864.6	182.2	1 019.8	35 578.1
	< 250	24 081.0	1 227.0	2 804.3	17 059.4	182.2	1 832.9	47 186.8
Class F	< 50	1.3	0.0	0.0	0.0	0.0	0.0	1.3
	100–250	380.4	0.0	0.0	0.0	0.0	0.0	380.4
	< 250	381.7	0.0	0.0	0.0	0.0	0.0	381.7
Class G	< 50	17.2	28.3	0.0	67.9	0.0	90.9	204.3
	50–100	22.9	116.3	0.0	103.7	0.0	329.3	572.2
	100–250	33.6	721.0	0.0	676.3	0.0	1 690.9	3 121.9
	< 250	73.7	865.7	0.0	848.0	0.0	2 111.1	3 898.4
Class H	< 50	15.4	0.0	0.2	6.8	0.0	0.004	22.4
	50–100	49.3	0.01	0.0	118.0	0.0	2.5	169.8
	100–250	1 217.6	12.4	555.0	13 014.8	0.1	10 212.3	25 012.2
	< 250	1 282.2	12.4	555.2	13 139.6	0.1	10 214.8	25 204.4
Class I	50–100	0.0	0.0	0.0	0.01	0.0	0.0	0.01
	100–250	124.5	0.0	1.4	325.2	21.1	1.0	473.2
	50–250	124.5	0.0	1.4	325.2	21.1	1.0	473.2
Class J	50–100	0.0	0.0	0.0	0.4	0.0	3.2	3.6
	100–250	0.1	0.0	0.1	41.3	0.0	88.8	130.3
	50–250	0.1	0.0	0.1	41.7	0.0	92.0	133.9
Class L	100–250	188.9	0.0	0.0	0.0	0.0	0.0	188.9
	100–250	188.9	0.0	0.0	0.0	0.0	0.0	188.9
All	< 50	2 027.3	13 661.1	1 205.4	20 789.3	0.0	13 098.2	50 781.3
	50–100	2 070.2	3 558.7	2 063.8	38 579.1	0.0	17 222.1	63 493.9
	100–250	25 292.0	1 310.2	3 494.5	45 461.8	203.4	42 197.8	117 959.8
	< 250	29 389.6	18 530.0	6 763.6	104 830.2	203.4	72 518.1	232 235.0

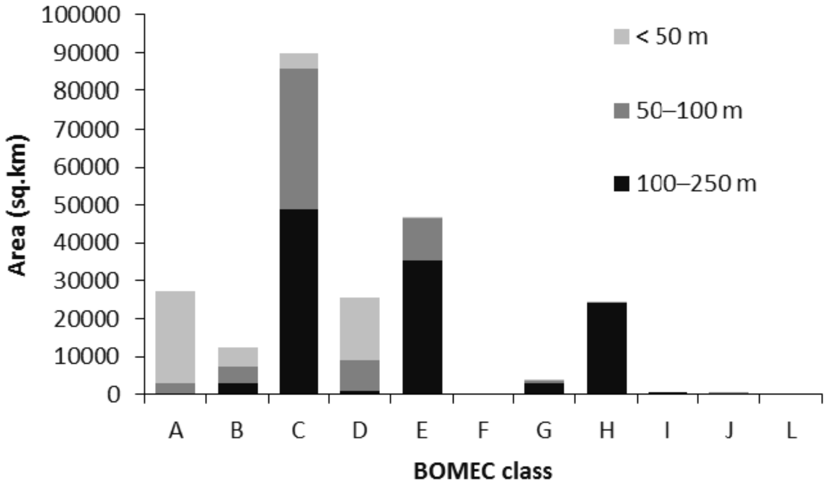


Figure 2: Total seafloor area (km^2) in each BOMEC class (see Figure 1.1 in Appendix 1), within the three depth zones shown in Figure 1.

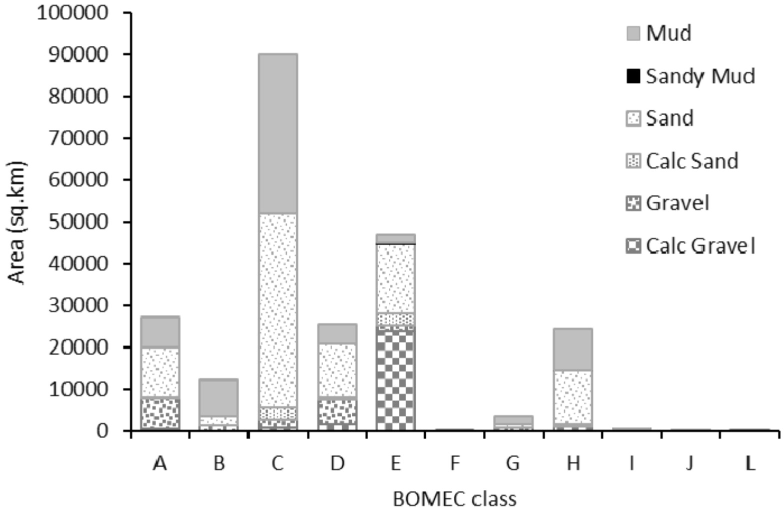


Figure 3: Total seafloor area (km^2) in each BOMEC class (see Figure 1.1, Appendix 1), by dominant sediment type (Figure 1.2, Appendix 1).

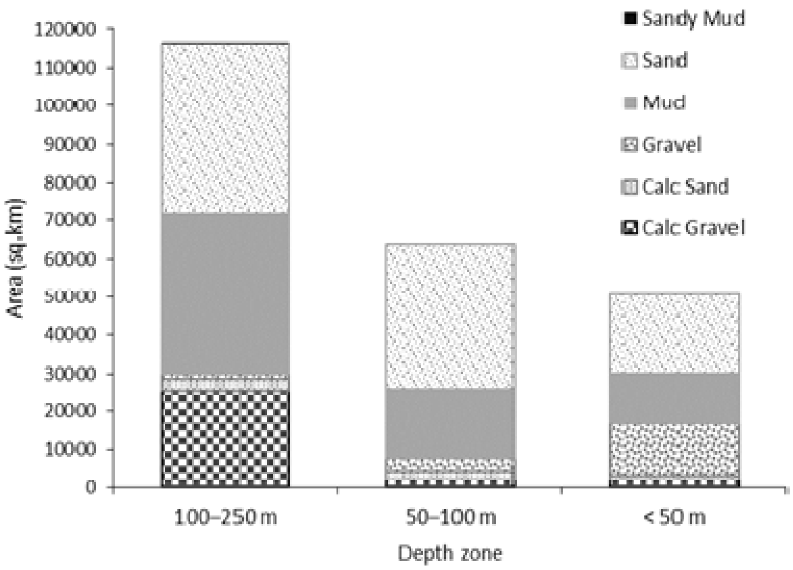


Figure 4: Total seafloor area (km^2) in each depth zone (see Figure 1), by dominant sediment type.

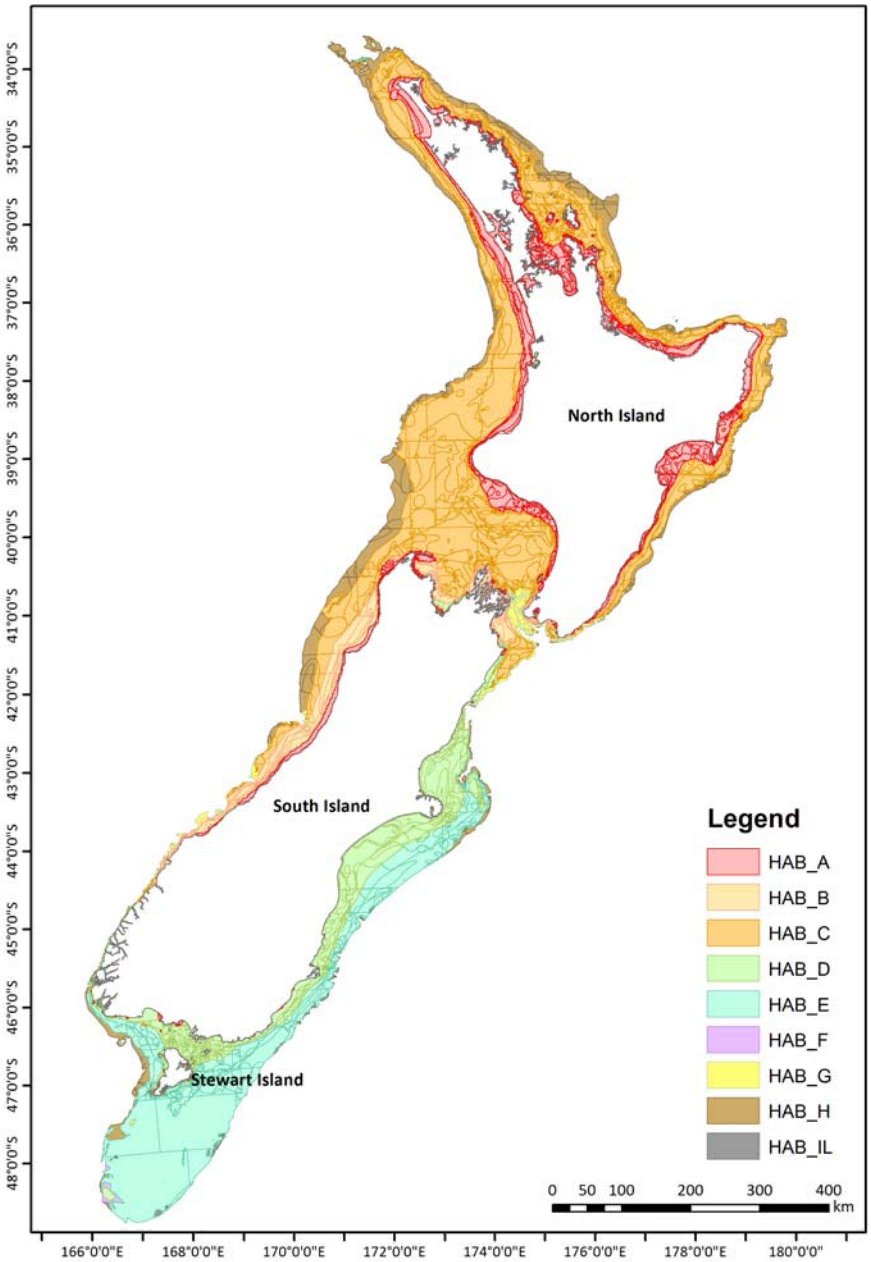


Figure 5: The broad habitat class definitions based on the BOMEC classes, with divisions indicating areas of different sediment, depth zone, and Statistical Area (see also Appendix 2).

BOMEC Class C is categorised as one of the three shelf groups from the 15-class classification, and the offshore location of this class across the shelf around the North Island and the South Island west coast is evident in Figure 5. Leathwick et al. (2012) describe this class as having moderately high temperature and salinity, relatively fine sediments, and lower seafloor resuspension, relative to more inshore classes. It is the largest class in terms of coverage and at about 90 000 km^2, class C represents 39% of the whole study area. Class C primarily occupies depths between 50 m and 250 m and the sediment type is mostly sand and mud (Table 1, Figures 3 and 4).

BOMEC Class E is also more offshore and includes waters from about Banks Peninsula south to the Stewart-Snares shelf, thus encompassing the broadest shelf area south of the South Island (Figure 5). Class E is the second largest class area, at about 20% of the study area. This class is characterised by strong tidal currents and coarse sediments (Leathwick et al. 2012). Most of class E is in the deepest depth zone (100–250 m) comprised mainly of calcareous gravels, with sand present also in this zone, as well as in the 50–100m zone where sand is the dominant sediment type (see Table 1). The geographic area of this class is very similar to that for Class D. However, the location of Class E closer to the shelf edge and the boundary of the sub-tropical and sub-Antarctic waters results in the influence of strong sea surface temperature gradients. Both classes overlap some of the same Statistical Areas.

Of the remaining BOMEC classes, F, I, J, and L occupy very small areas within the study area (see Table 1), in the deepest depth zone at the edge of the continental shelf (see Figure 5). Temperature, salinity, and productivity are generally lower in these classes because they are situated south of the Subtropical Front (Leathwick et al. 2012).

BOMEC Class G is localised to the Cook Strait region where gravel and sand are the main sediment types, and the southern parts of the South Island west coast (in the narrowest part of the study area) where mud is the main sediment type. This class is characterised by steep topography and strong tidal currents. A small area at the edge of the study area in Statistical Area 011 is also classed as Class G.

BOMEC Class H occupies the deeper waters of the study area around the west coasts and the east coast of the North Island, as well as the western edge of the Stewart-Snares shelf (Figure 5 and Table 1). This BOMEC class occurs mainly across the shallower parts of the Chatham Rise, outside the study area, and is influenced by the sub-tropical front, with moderately high temperatures and salinity (Leathwick et al. 2012). Within the study area, sand, mud, and calcareous gravels are the main sediment types in class H.

Overall, the depth zone delineated by 100 m and 250 m contours, includes about 50% of the seafloor area within the study area (Table 1 and Figure 4). Of the remaining 50%, slightly more of the seafloor area is in 50–100 m than less than 50 m. Sand and mud are the dominant sediment types (45% and 31%, respectively, of the total area).

2.3 Sensitivity of the habitat to fishing disturbance

Disturbance, through bottom fishing activities such as dredging and trawling, has impacts not only on the commercially-targeted species, but also on the benthic communities and habitats, the resident biota, and on key ecosystem functions (Thrush & Dayton 2002). These effects include the modification of sedimentary characteristics through sediment removal and turnover (Guerra-García et al. 2003), and damage or destruction of many species, particularly large, habitat-forming epibenthos. These changes to habitats can cause ongoing modification of ecosystem functioning (de Juan et al. 2009). Understanding the ecological role of species or habitats, and their sensitivity to fishing disturbance, is important in understanding the risk to the ecosystem imposed by fishing activity.

An attempt was made to measure the sensitivity and recoverability of the broad benthic habitat classes described above through the use of species data (and associated knowledge on their biological traits) from two comprehensive sources: the MPI research trawl database *trawl* and NIWA's invertebrate collection database *specify*. A full description of the rationale, methods, and results is given in Appendix 3. Testing of distributions of these benthic organisms showed little support for a difference in sensitivity to, or recovery from, trawling of any of the benthic habitat classes. It is likely that the lack of a strong consistent signal from the analysis resulted largely from inadequacies of the data – both the data that contributed to the benthic habitat class descriptions as well as the underlying taxonomic data (see Appendix 3).

3. Spatial pattern of bottom-contacting trawl fishing activity

Fishing effort data provide a means to determine the nature and extent of mobile bottom fishing methods and thus identify areas or habitats that are subject to different levels of modification through fishing pressure. Within the New Zealand waters less than 250 m deep, trawl nets, shellfish dredges, and Danish seine nets are the main mobile bottom fishing methods used to target fish, shellfish, and squid species. This report assesses bottom-contacting trawl fishing activity only.

Fishing effort data collection was not formalised for many species until 1989–90 with the introduction of Trawl Catch Effort Processing Returns (TCEPRs) for vessels over 28 m long and Catch Effort Landing Returns (CELRs) for smaller vessels using a variety of fishing methods. The lack of position data in the CELR data, other than assignment to broad fishery management Statistical Areas (see Figure 2.3 in Appendix 2), confined finer scale spatial analysis to TCEPR data only until October 2007 when the Trawl Catch Effort Return (TCER) was introduced for small trawlers to use instead of the CELR.

The distribution of trawl effort reported on TCEPRs has been analysed using either the number of tows or an estimate of the swept area (Baird et al. 2002, 2006, 2011, Black et al. 2013, Wood & Baird 2010), mostly on an approximate 0.045° longitude- latitude grid (about 5 km × 5 km). These effort measures show the general patterns of intensity and frequency of fishing on or near the seafloor in depths out to about 1600 m. However, they represent a small proportion of the trawl effort reported each year because they ignore the effort reported on CELRs and TCERs (see Baird et al. 2011, Baird & Wood 2012) – effort that is mainly conducted by small trawlers in inshore waters out to the edge of the continental shelf.

Integral to a spatial analysis of the nature and extent of fishing effort is both the provision of accurate and precise location data and an understanding of the gear used, including its dimensions and configuration under tow. The type of gear used for trawling, and the way in which it is rigged, determines the amount of contact the gear has with the seafloor. Bottom trawl gear is fished hard on the bottom and contacts the seafloor from the doors back to the codend, with the trawl doors, the sweeps and bridles and the groundrope gear being the primary ground contacts. Where midwater trawl gear is used to target species close to the seafloor, the points of bottom contact are from the wing-end weights possibly as far back as the codend. Variations in the extent of contact will result from differences in the way the gear is configured. Factors that affect trawl spread and full bottom contact include: the length of towing wire, the bottom depth, the warp:depth ratio, the bottom type, tow speed, currents, trawl design, rigging, vessel size, and drag forces from, for example, increasing codend diameter and decreasing sediment diameter (see Weinberg & Kotwicki 2008). Some general descriptions of trawl gear used in New Zealand are provided by Baird et al. (2002, 2011) and Clement & Associates Limited (2008), but the reality is that much of this kind of descriptive information is not available.

The commercial fishing effort data for trawls on or near the seafloor are limited in their application in spatial analyses, which restricts the results of this study to indicative, rather than absolute, measures of effort. The resolution of the start and finish positions are to one minute of arc at best, which is equivalent to about 1.852 km, and these positions represent the location of the fishing vessel when the net reaches fishing depth, rather than the location of the net. Thus, the effort measures are based on the precision and resolution of the available data, the choice of analysis cell size, and broad assumptions about the gear used and the configuration of each tow.

Unlike trawl gear, dredge gear used to target dredge oysters (*Ostrea chilensis)* or scallops (*Pecten novaezelandiae*) is designed to dig into the seafloor. Within New Zealand waters, various kinds of dredge gear are used, depending on the target species and the substrate (see Baird et al. 2002, Beentjes & Baird 2004). Dredge data are generally reported by fishery-specific Statistical Area. Dredge fisheries tend to target discrete beds (see for example Cryer & Parkinson 2006, Michael 2008), and the actual location of these beds cannot usually be identified within the Statistical Areas, when using commercial fishing data. Danish seine effort is also recorded at the resolution of Statstical Area.

This section provides results based on the analysis of the bottom-contacting trawl effort, based on data collected on TCERs and TCEPRs. It covers five fishing years (1 October to 30 September), from 2007–08 (2008) to 2011–12 (2012), for which there are finer scale position data. The first sub-section describes the methods used to summarise the TCER and TCEPR data within the study area. The second sub-section presents the methodology used for the spatial analysis of seafloor contact by trawl vessels, with a summary of the resulting trends and patterns using indicative measures of swept area derived from generic doorspread values. Through the use of relational databases and Geographic Information Systems to generate polygons of individual trawl tows this current study provides a representation of the seafloor area fished by each trawl, for estimation of both the annual aggregate swept area and the coverage swept area which defines the footprint of the trawl effort. The third sub-section reports on the trawl coverage (footprint) within the study area, and the fourth sub-section presents the final overlay of the trawl footprint with the benthic habitat classes described in Section 2.

A final sub-section provides a broad summary for other bottom-contact fishing effort in the study area, during 2007–08 and 2011–12: dredge effort for oysters and scallops and Danish seine effort for a variety of inshore species. These summaries are based on the number of dredge tows or Danish seine sets only; no attempt is made to get a measure of the area swept by these methods.

3.1 Bottom-contact trawl data

The methods below describe the trawl database development, data exploration and grooming, and preparation of the data for spatial analysis. For a description of the analysis area and the spatial fishing restrictions and management areas relevant to the study area, see Section 1 and Appendix 1. Note that this initial data description includes all the bottom and midwater trawl data for the study area.

The Ministry for Primary Industries (MPI) provided a data extract of fishing activity during fishing years 2008–12 that used bottom-contact fishing methods of trawls (bottom trawls, bottom pair trawls, and midwater trawls within 1 m of the seafloor) in waters over the continental shelf in the study area. These data are based on commercial fishing returns briefly described in Table 2. A second extract provided vessel information, including unique identifier key for each vessel, vessel nationality, length overall (m), and power (kW).

Table 2: Main variables for the commercial fishing effort forms for trawl effort relevant to the study area and fishing years (1 October–30 September) 2007–08 to 2011–12.

Form name	Code	Vessel length	Main characteristics relevant to contact with seafloor
Trawl Catch Effort Return	TCER	6–28 m	Introduced 1 October 2007 to replace CELR for small trawlers. Tow-by-tow data: start position; start and finish date and time; duration of fishing; tow speed; target species; gear type; number of nets.
Trawl Catch Effort Processing Return	TCEPR	> 28 m	Introduced 1 October 1989. Tow-by-tow data: start and finish positions; start and finish date and time; tow speed; target species; gear type; number of nets.

3.1.1 Trawl TCER and TCEPR data

Data from TCERs and TCEPRs for fishing years 2008–12 provided the initial *trawl* dataset (n = 436 756 tows), 56% from TCERs and 44% from TCEPRs. The data were subjected to grooming routines using the *R* Statistical package following the methods used by Baird et al. (2011). Emphasis was placed on the primary variables necessary for determining the extent of the swept area of trawl gear for a tow. Data for each of the main variables were explored to isolate records with invalid codes or values and any obvious transcription or recording errors and to determine the distribution of variables used to characterise the effort (see Baird et al. 2011).

Previous work indicated that vessels of the same (or similar) nationality target certain species, fish in certain depths and geographic locations, and use similar gear in a similar manner; and that vessels of similar sizes use similar gear for a target species. Vessels were assigned to four size categories, based on regulations and prior knowledge of the general distribution of vessels by size in New Zealand fisheries: A, under 28 m; B, 28–46 m; C, 46–80m; and D, over 80 m in overall length. Thus, in the error checking and data exploration we based our approach on the premise that fishing effort would be characterised by the nationality of the vessel and the fishing gear used, species targeted, and the size of the vessel.

The following assumptions were made with respect to grooming the dataset.

- All dates were accepted as reported.
- All gear type data were used as reported: thus "BT" represented use of bottom trawl gear, "BPT" for a bottom pair trawl, and "MW" for midwater trawl net.
- All vessel keys and trip numbers were accepted as accurate.
- Target species were generally accepted as reported, except those that were considered to be typographical errors or those that showed obvious inconsistencies; for example, "SNA" tows in southern waters where "SWA" was the target in tows of the same trip.
- Start latitude and longitude data were used as reported in the initial grooming stages, other than obvious errors. Statistical Area codes (assigned by MPI, based on the start latitude and longitude data) were accepted as provided; although for obvious position errors, the given Statistical Areas were corrected to represent the amended position data, if necessary.

Where possible, any errors were amended. No data were deleted, other than duplicated records, and new fields were created to accommodate changed and new (derived) values. The grooming process was iterative, with 'corrections' made to one field at a time. Data within a defined range of values for each variable were retained as reported and those outside the range were assigned a median value determined from the data. For most variables, changes were made to less than 5% of the data.

The recorded target species code may represent either the species being targeted on a tow, the species which constituted the largest proportion of the catch on a tow, or a generic code for a group of species. There were at least 48 (sensible) target species or broad species groups (for example, flatfish species for which the effort is often reported under the generic code of FLA rather than individual species codes). Thus, all target species codes that represented the different flatfish species were combined into a single code "FLA"; similarly, for oreo species into "OEO"; hapuku/bass as "HPB"; and jack mackerels as "JMA" (see Table 3).

Trip numbers associated with each tow are assigned by MPI. These trip numbers are based on the landing forms completed by fishers; if there is no landing form associated with the effort form, the trip number field on the TCER or TCEPR will be null (M. Vignaux, MPI, pers.comm.). About 1.6% of the total of 243 367 TCER records had no trip number assigned; these tows represented effort by 185 of the 210 vessels which had effort reported on TCERs. About 46% of these tows targeted flatfish species, 14% tarakihi, 12% red gurnard, and 18% targeted red cod, stargazer, trevally, rig, snapper, and John dory. These tows were dropped from the analysis because of the dependency on 'trip' in the spatial analysis (see later section). Another 0.1% of TCER tows were ignored because they had no reported target species.

Another 0.15% TCER records had no start position data and were dropped from the analysis to give a total of 239 227 TCER tows. About 1% of TCERs and 1% of TCEPRs had no Statistical Area code due to start positions being on the boundary of Statistical Areas or on land. Of the 193 389 TCEPR tows, 262 tows were dropped because they had no trip number.

All TCER and TCEPR tow data were matched to the vessel data and loaded into ArcGIS (using the Albers equal area projection) to identify tows within the 250 m contour, based on their start latitude and longitude. The resulting dataset consisted of 289 742 tows (77.7% TCER tows and 22.3% TCEPR tows). Twelve vessels reported effort as 'BPT'. This effort was tabulated and plotted to match the paired vessels and data were retained for the vessel with the highest number of tows reported for that target species, Statistical Area, and fishing year for five of the vessel pairs; this resulted in 2286 BPT tows being dropped from the dataset. The effort by the remaining two vessels could not be readily matched and this effort was retained as 'BT'.

The final analysis dataset of 287 456 tows consisted of 222 787 TCER tows (100% vessel A category) and 64 669 TCEPR tows (43% vessel A; 20% vessel B; 13% vessel C; and 24% vessel D). Vessels in size categories A and B were all from New Zealand. For the size category C vessels, about 86.5% of tows were by Korean vessels, 10.5% by New Zealand vessels, and 3% by Japanese vessels. Ukrainian vessels and Polish vessels accounted for 98.5% and 1.5% of tows by size category D vessels. Fishing effort for at least 48 target species was reported during 2007–08 to 2011–12 (Table 3).

Of the total of 33 834 TCER trips in the dataset (range of 6348–7397 trips per fishing year), 11.3% had 1 tow, 20.4% had 2 tows, and 9.8% had 3 tows (Figure 6, Table 4.1 in Appendix 4). Thus, 41.5% of TCER trips had fewer than 4 tows per trip, compared with 16% of the 3984 TCEPR trips. The maximum number of tows per TCER trip was 146 tows, with effort spread over 3 months and 8 Statistical Areas, and with 11 target species reported. Because trip numbers are allocated on the basis of landings, TCER trip numbers with a large number of tows may represent the effort of a number of actual trips (M. Vignaux, MPI, pers. comm.). The maximum number of tows for TCEPR trips was 121 tows, with one species targeted in one month in 6 Statistical Areas.

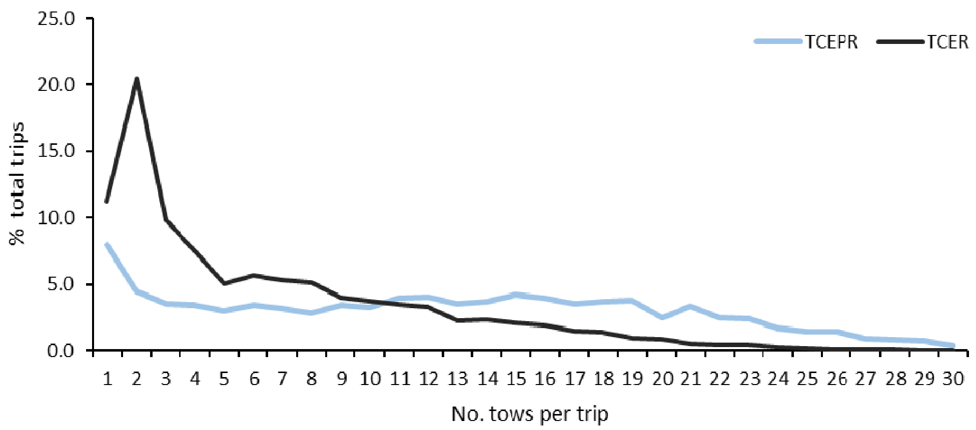


Figure 6: Percentage of TCEPR and TCER trips based on the number of tows per trip, over the five fishing years, where the maximum number of tows per trip shown is 30 tows. The data shown here represent 91.2% of TCEPR trips and 99.9% TCER trips.

3.1.2 Additional variables for spatial analysis

The resolution of the start and finish position data is to the nearest minute (0.01667°) (see Penney 2011). Thus, in an attempt to better represent the spatial distribution of the trawl tracks, particularly in places where fishers may repeat trawl lines, the reported longitude and latitude values were randomly jittered using an offset of ± 0.5 minute and stored as new fields in the dataset.

Table 3: Target species, listed alphabetically by common name, and the number of bottom trawl and midwater trawl tows reported from the study area on TCER and TCEPR forms, 2007–08 to 2011–12.

Common name	Scientific name	Code	TCER	TCEPR
Alfonsino	*Beryx splendens, B. decadactylus*	BYX	2	23
Arrow squid	*Nototodarus sloanii, N. gouldi*	SQU	643	9 401
Barracouta	*Thyrsites atun*	BAR	7 080	4 210
Black cardinalfish	*Epigonus telescopus*	CDL	0	9
Blue cod	*Parapercis colias*	BCO	30	0
Blue mackerel	*Scomber australasicus*	EMA	0	136
Blue warehou	*Seriolella brama*	WAR	4 804	730
Bluenose	*Hyperoglyphe antarctica*	BNS	3	18
Elephant fish	*Callorhinus millii*	ELE	3 451	147
Flatfish	*Rhombosolea retiaria, R. plebeia, R. tapirina, Pelotretis flavilatus*	FLA	83 316	3
Frostfish	*Lepidopus caudatus*	FRO	0	1
Gemfish	*Rexea solandri*	SKI	165	115
Ghost shark	*Hydrolagus novaezealandiae, H. bemisi*	GSH	2 710	7
Hake	*Merluccius australis*	HAK	1	13
Hapuku/bass	*Polyprion oxygeneios, P. americanus*	HPB	164	1
Hoki	*Macruronus novaezelandiae*	HOK	555	1 943
Jack mackerels	*Trachurus declivis, T. murphyi, T.*	JMA	23	10 296
John dory	*Zeus faber*	JDO	6 130	2 930
Kahawai	*Arripis trutta*	KAH	18	4
Kingfish	*Seriola lalandi*	KIN	0	1
Leatherjacket	*Parika scaber*	LEA	792	60
Ling	*Genypterus blacodes*	LIN	425	74
Lookdown dory	*Cyttus traversi*	LDO	6	0
Mirror dory	*Zenopsis nebulosus*	MDO	1	0
Moki	*Latridopsis ciliaris*	MOK	425	10
Oreos	*Allocytus niger, Neocyttus rhomboidalis, Pseudocyttus maculatus*	OEO	0	4
Orange roughy	*Hoplostethus atlanticus*	ORH	2	6
Paddle crab	*Ovalipes catharus*	PAD	119	0
Queen scallop	*Zygochlamys delicatula*	QSC	456	0
Red cod	*Pseudophycis bachus*	RCO	13 253	282
Red gurnard	*Chelidonichthys kumu*	GUR	26 638	2 567
Red snapper	*Centroberyx affinis*	RSN	3	0
Redbait	*Emmelichthys nitidus*	RBT	0	85
Rig	*Mustelus lenticulatus*	SPO	483	1
Rough skate	*Zearaja nasuta*	RSK	171	0
Ruby fish	*Plagiogeneion rubiginosum*	RBY	8	35
Scampi	*Metanephrops challengeri*	SCI	0	102
School shark	*Galeorhinus galeus*	SCH	376	65
Sea perch	*Helicolenus spp.*	SPE	354	9
Silver dory	*Cyttus novaezealandiae*	SDO	1	0
Silver warehou	*Seriolella punctata*	SWA	302	800
Snapper	*Pagrus auratus*	SNA	10 711	9 307
Spiny dogfish	*Squalus acanthias*	SPD	1 302	29
Spotted stargazer	*Genyagnus monopterygius*	SPZ	4	0
Stargazer	*Kathetostoma giganteum*	STA	7 661	64
Tarakihi	*Nemadactylus macropterus*	TAR	44 515	12 297
Trevally	*Pseudocaranx dentex*	TRE	5 682	8 875
White warehou	*Seriolella caerulea*	WWA	1	9
Total (including 1 unknown target TCER tow)			222 787	64 669

The TCEPR data provide both the start and finish latitude and longitude position data. These position data allow the estimation of several measures of fishing effort (see Baird et al. 2011). One such measure is the area of the seafloor contacted by the trawl gear (the swept area). This can be generated from a distance measure and the width of the gear where it contacts the seafloor, where the distance can be the straight-line measure between the start and finish tow positions (trackline) or it can be a value derived from the reported values for tow duration and tow speed. Here, we assume that the vessel has towed the net in a straight line and that the start and end positions in the dataset represent where the net started to fish and where it ended fishing.

The TCER data lack information that describes the finish location. Although a measure of swept area can be calculated, based on the duration of the tow and tow speed, the swept area cannot be spatially represented, other than as a circle centred on the start position.

The following methods were used in an attempt to place the TCER trawl effort in space. These were applied to both TCER and TCEPR data to provide a comparison between those with a reported end position, and those with a generated end position, using the jittered position data. This allowed an assessment (by eye) of the plotted tracklines for each target species and form type to judge the appropriateness of the method.

1. For each trip combination, generate a tow direction from the bearing between the start position of a tow and the following tow.
2. For the TCEPR trips, generate the bearing between the start and finish positions of each tow.
3. Calculate the distance (km) between the start of one tow and the start of the next consecutive tow – *tows distance*.
4. Calculate the distance (km) between reported start and finish positions – *fishing distance* (possible for TCEPR data only).
5. Calculate the duration-speed distance (km).
6. Generate finish co-ordinates based on the estimated bearing and duration-speed distance – *endpoints*.
7. Identify tows that are *last tows* or *only tows* of a trip; i.e., tows that have no following tow in a trip.
    a. Firstly, for each of these tows, estimate a bearing based on the median estimated bearing values from other tows by the same vessel for the same target species within 1/30th of a degree north/south or east/west, using a minimum number of 2 tows.
    b. Then, generate finish co-ordinates for these tows from the estimated bearing and the duration-speed distance – *last_tow_end_longitude_2*, *last_tow_end_latitude_2*.
    c. Secondly, repeat 7 (a) but use tows from all vessels with the same target species, with start positions within 1/30th of a degree north/south or east/west, using a minimum number of 2 tows – *last_tow_end_longitude_targ*, *last_tow_end_latitude_targ*.

Additional columns were created within the dataset to provide four columns of start and finish positions (*lons_fin*, *lats_fin*, *lonf_fin, latf_fin*) for use in the final spatial analysis. For TCEPR data, the jittered start and finish positions were used to populate these fields. For TCER data, the jittered start positions were used for the start positions of all tows; and the estimated end longitude and latitude values were used for the finish positions of all tows, except for the last and only tows of a trip. For the latter group, the latitudes and longitudes derived in 7(c) above were used for the finish positions (*lonf_targ*, *latf_targ*). The TCER data represented 33 834 trips and 3810 of these trips had one one tow (*only tow*) and the remainder all had a *last tow*. Thus, the 33 834 TCER tows with no consecutive tow (in the same trip) accounted for 15.2% of the total TCER tows.

3.1.3 Description of the primary effort variables by main species

Many of the smaller vessels that fish around the North Island have used TCEPR forms since the mid-1990s (see Baird et al. 2011); whereas the vessels fishing around the South Island were more likely to report effort on CELRs and thus their effort is now represented on TCERs. Figures 4.1 and 4.2 in Appendix 4 show the start positions of the tows for the main target species reported on TCERs and TCEPRs. Figure 4.3 in Appendix 4 shows the distribution of the effort reported by form type and Statistical Area. Effort for tarakihi, barracouta and red gurnard are the most widespread, with the TCEPR effort generally in deeper waters. The species with more southern effort distributions include flatfish, elephantfish, red cod, rig, sea perch, arrow squid, giant stargazer, and blue warehou. Species with northern distributions include John dory, snapper, and trevally. Jack mackerel effort was mainly off the west coast of both islands (reported on TCEPRs only), and effort for leatherjacket was primarily in the southern Taranaki Bight and Golden Bay-Tasman Bay.

TCER data

Between about 41 900 and 48 800 tows were reported on TCERs in each fishing year, and annual effort for most target species was reasonably stable during the period 2007–08 to 2011–12 (see Table 4.2 in Appendix 4). Overall, about 38% of the TCER tows targeted flatfish species, 20% tarakihi, and 12% red gurnard. Red cod tows accounted for 6%, snapper for 5%, and giant stargazer, barracouta, and John dory each accounted for about 3% of the tows. In total, 14 target species or species groups accounted for 98% of all the TCER tows. The distribution of this effort by Statistical Area is shown in Figures 4.1 and 4.3 in Appendix 4. Effort reported on TCERs was greatest off the east coast North Island in Statistical Areas 013 and 014; the east coast South Island in 020, 022, 024, and 026; the southern South Island (030); west coast South Island (034); and Golden Bay-Tasman Bay (038) (Table 4.4 in Appendix 4).

The distributions of the groomed values of interest for an estimation of swept area are shown for the main TCER target species in Appendix 4 in Figure 4.4a–4.4g. Over the five fishing years, 208 vessels reported effort on TCERs. All TCER tows were by vessels between 6 and 28m long; the smaller vessels (about 15 m) generally targeted dark ghost shark, elephantfish, flatfish, red gurnard, John dory, and snapper. Most of the remaining top target species were usually targeted by vessels about 20 m long.

Flatfish and elephantfish were targeted in the shallowest depths, with median depth values of about 30 m. Snapper, trevally, red gurnard, leatherjacket, and red cod were targeted in waters about 50 m depth, though red cod effort was deeper in the later years. The main species targeted in 50–100 m were barracouta, John dory, spiny dogfish, and blue warehou. Tarakihi were targeted in about 100 m, and dark ghost shark and giant stargazer in 100–150 m.

Tows were generally about 4 hours in duration, though tows targeting flatfish, dark ghost shark, snapper, and spiny dogfish were more usually about 3 hours long. Trawls were generally towed at about 2.7–3.0 kn.; the slowest tows (about 2.5 kn.) were flatfish and giant stargazer tows and the fastest tows (about 3.5 kn.) were trevally tows. The distance towed, based on the reported duration and speed variables indicated that flatfish, snapper, and spiny dogfish tows were generally about 15 km long; elephantfish, red cod, John dory, giant stargazer were 16–19 km long; and tarakihi, trevally, blue warehou, and barracouta just over 20 km long.

TCEPR data

Effort reported on TCEPRs represented about 22.4% of all the tow records in the study area during the period 2007–08 to 2011–12, with between 12 055 and 13 898 tows reported per fishing year (Table 4.3 in Appendix 4). Tarakihi (19% of all TCEPR tows), jack mackerel (16%), arrow squid (14.5%), snapper (14%), and trevally (13.7%) were the main target species. These target species, with the addition of barracouta, John dory, red gurnard, and hoki together accounted for 95% of the TCEPR tows. As with the TCER target species, the annual effort for each species was reasonably stable.

A total of 71 vessels reported effort on TCEPRs. Of these 22 were small New Zealand vessels (category A, 6–28 m), 17 were New Zealand category B (28–46 m), 23 were category C (46–80 m), and 9 were category D (over 80 m). Category C comprised 13 Korean vessels, 9 New Zealand vessels, and 1 Japanese vessel. Category D comprised 7 Ukrainian and 2 Polish vessels. The primary targets of the category A vessels were snapper, tarakihi, trevally, John dory, red gurnard, barracouta. For category B vessels, most effort was for tarakihi, trevally, hoki, red gurnard, and snapper. The main targets for category C vessels included arrow squid, barracouta, silver warehou, blue warehou, and jack mackerel. Category D vessels mainly targeted jack mackerel, arrow squid, and barracouta.

Most TCEPR tows were in Statistical Areas 005 and 006 off the east coast North Island and the Bay of Plenty (009 and 010) where John dory, red gurnard, snapper, tarakihi, and trevally were targeted; the north Taranaki Bight (041) for jack mackerel; south Canterbury Bight (022) for barracouta; and the southern edge of the Stewart-Snares shelf where squid, jack mackerel, barracouta, and silver warehou were targeted (Table 4.5 in Appendix 4, Figure 4.2).

The distributions of the groomed values of interest for an estimation of swept area are shown for the main TCEPR target species in Figure 4.5a–4.5g in Appendix 4. Of the main target species, red gurnard, John dory, snapper, and trevally were mainly targeted in waters of about 50 m depth. Blue warehou tows were slightly deeper at about 100 m and barracouta, jack mackerel (midwater trawl gear), and tarakihi tows were mainly in the 100–150 m depth range. Red cod tows showed the widest distribution (100–200 m), and the deeper targets were arrow squid and hoki in 150–200 m and silver warehou in over 200 m.

Tows for red gurnard, John dory, snapper and trevally were generally about 3 h long. In a comparison of duration data based on form types, New Zealand vessels under 28 m completing TCERs appeared to tow for longer than those completing TCEPRs (Table 4.6 in Appendix 4). For the other main TCEPR target species tow lengths were about 4–5 h, with longer durations for silver warehou and blue warehou.

Speeds were generally close to 3 kn., apart from the targets in deeper waters such as arrow squid, barracouta, silver warehou and blue warehou, with the fastest speeds used to pull the midwater jack mackerel nets. Few differences were evident in speed data from the small vessels using the different form types.

The distance fished, as calculated from the duration and speed records, indicated that TCEPR tows for hoki, John dory, and snapper were generally about 10 km; tows for red gurnard, red cod, tarakihi, and trevally were about 20 km; barracouta about 20–30 km; and the longest tows were for jack mackerel and arrow squid (30–40 km) and silver warehou (over 40 km) (Figure 4.5c). Distances based on reported start and finish positions were generally shorter than the duration-speed distances for target species such as barracouta, squid, and warehou species (Figure 4.5g).

3.1.4 Differences in the distance measures for the tow trackline

There are two considerations with regard to the distance and spatial placement of a tow in this study. The first is a comparison of the main two methods used to derive a tow distance: the distance between the start and fishing positions, assuming a straight line (only applicable to TCEPR data) and the distance derived from the reported tow duration and tow speed (values available for both data types). The second relates to the generation of the TCER tow endpoint based on the reported start longitude and latitude using the duration-speed distance and an estimated direction.

Firstly, for the small vessels, the longer duration of TCER tows for some species such as red gurnard, John dory, and snapper resulted in substantially longer tow distances than calculated for TCEPR small vessel effort for those species (see Table 4.6 in Appendix 4, Figure 7). However, some of these differences may be artefacts of the disparity in the relative amounts of data: the number of tows for TCER and TCEPR small vessels targeting snapper are similar, over the five year period, but the vessel A TCEPR tows represent less than 50% of the number of TCER tows for John dory, and about 5% of the number of TCER tows for red gurnard.

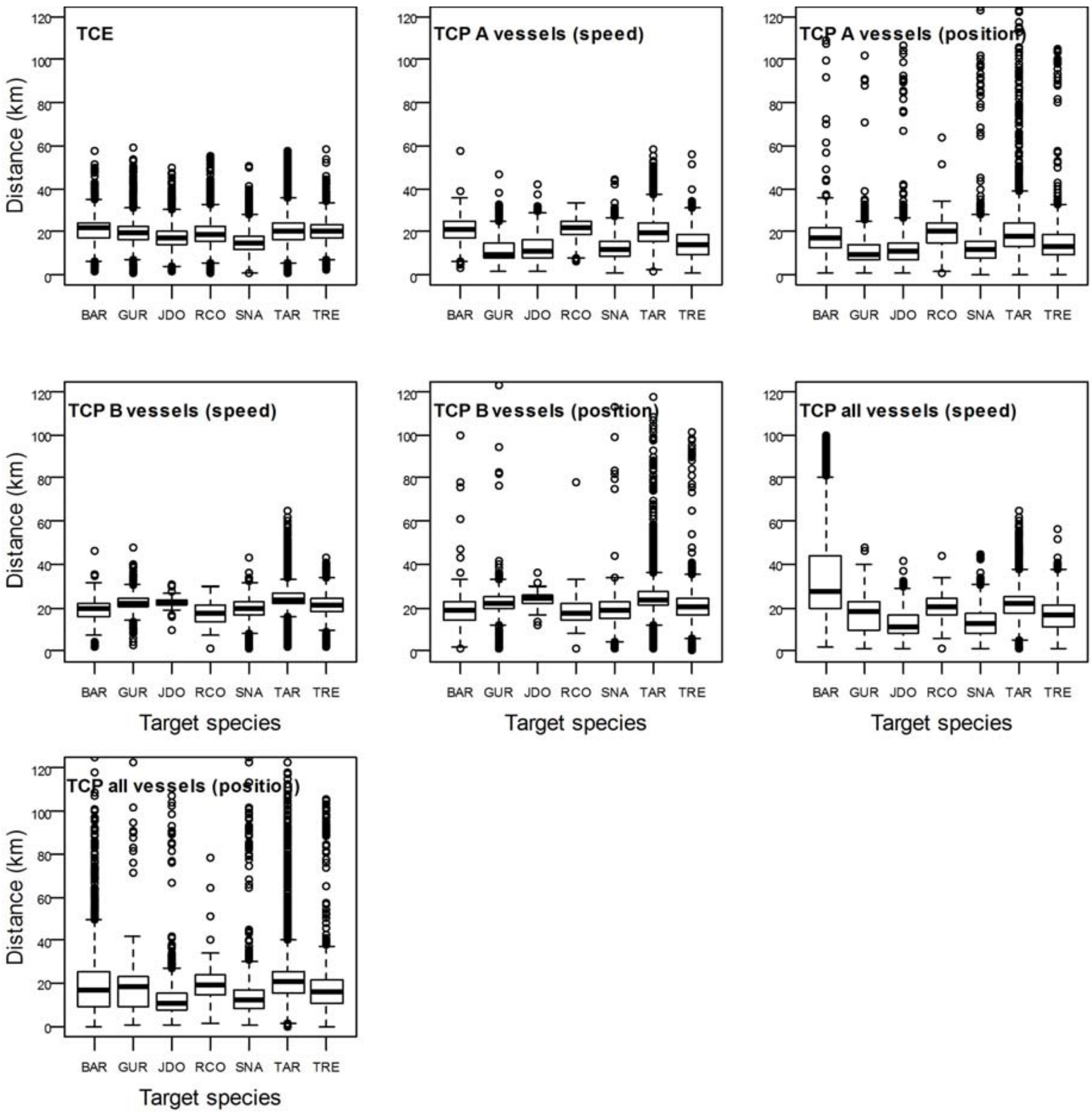


Figure 7: Distribution of duration-speed derived distances for TCER main species and duration-speed (speed) and the position-based (position) distances from TCEPR 'A' vessels, 'B' vessels, and all TCEPR vessels, for the five year period. Target species codes are given in Table 3. Table 4 gives relative numbers of tows for each of the datasets shown above.

The spread of outliers is greater for the TCEPR reported position distances compared with that for the TCEPR duration-speed distances. In a comparison of the two distance measures for some of the main species targeted by category A vessels (vessels of a similar size to those that report on TCERs), the differences are most obvious for barracouta, hoki, arrow squid, and jack mackerel (Figure 4.6 in Appendix 4).

Table 4: Number of tows for each target species by form type and vessel category, 2008–2012.

Form, vessel	BAR	GUR	JDO	RCO	SNA	TAR	TRE	Total
TCER, 'A'	7 080	26 638	6 130	13 253	10 711	44 515	5 682	114 009
TCEPR, 'A'	1 241	1 249	2 866	218	8 041	7 909	5 792	27 316
TCEPR, 'B'	169	1 318	64	63	1 265	4 388	3 083	10 350
TCEPR, total	4 210	2 567	2 930	282	9 307	12 297	8 875	40 468
TCER&TCEPR	11 290	29 205	9 060	13 535	20 018	56 812	14 557	154 577

Secondly, for the generation of TCER tracklines for tows with no following tow, the direction was estimated from appropriate nearby tows – based on the vessel and the target species, or on the target species alone. The bearing values based on the target species alone were based on a larger set of available nearby tows than the more restricted set for the vessel-target derived values. Comparison of the tow lines generated by these estimated directions for the *last tows* and *only tows* indicated that the target-derived bearing appeared to provide a more sensible tow line, whereas the vessel-target derived bearing for the *last tows* and *only tows* tended to put tows at contrary bearings to the mass of tows for a target species (Figure 8 showing tarakihi target effort). The use of the target-based estimate of direction was applied to the TCEPR data and appeared to 'tidy' tows that may have had incorrect position data (Figure 9).

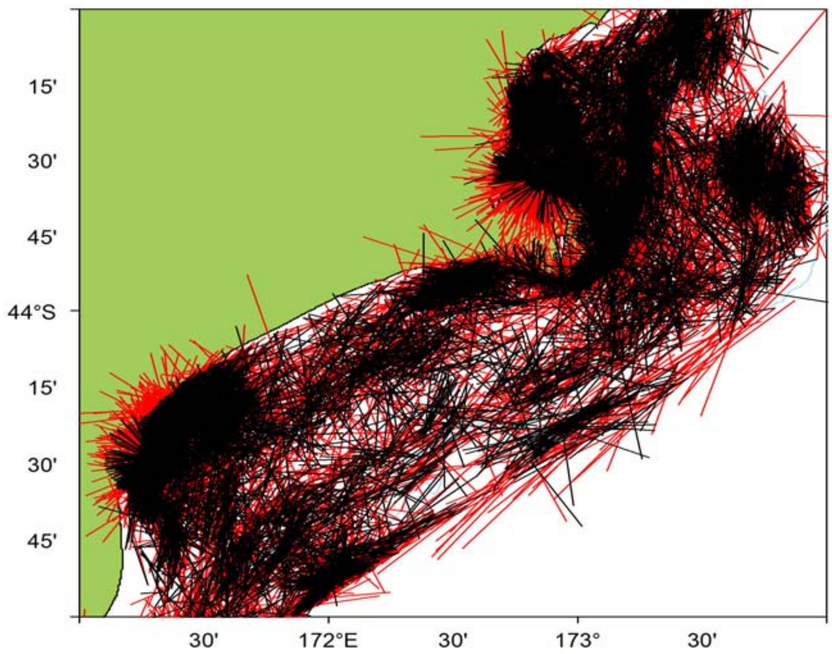


Figure 8: Comparison between the TCER tarakihi tows designated as *last tows* or *only tows* based on the vessel-target estimated bearing (red) and the target estimated bearing (black).

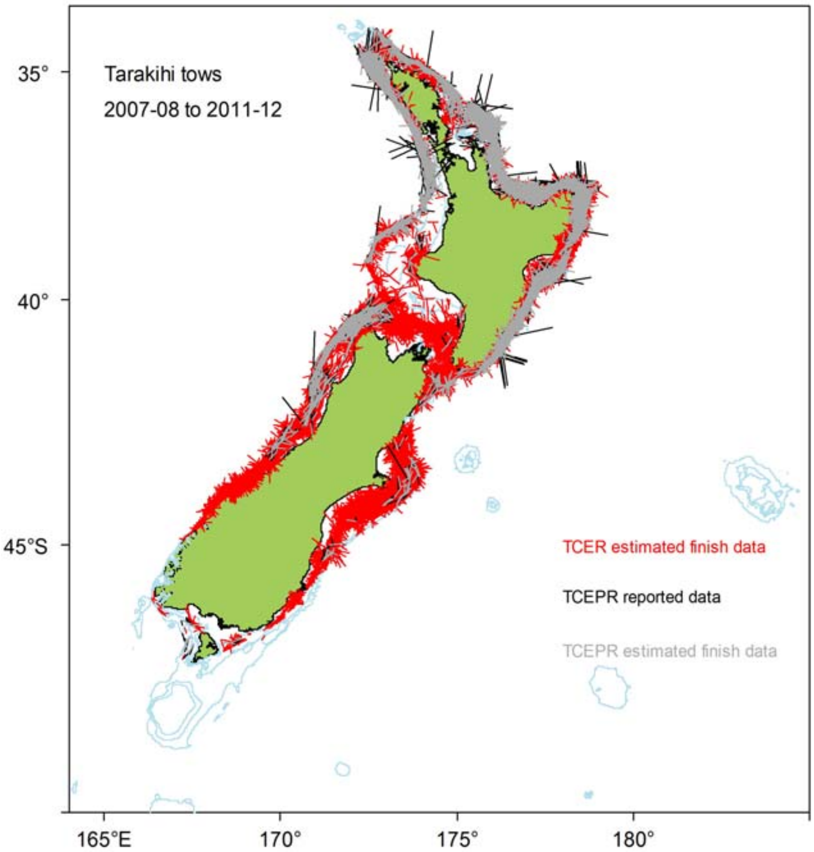


Figure 9: Tracklines for tarakihi effort reported on TCEPR forms, using the reported start and finish position data (black) and the reported start and derived finish positions for TCEPR data (grey) and for TCER data (red).

3.2 Spatial distribution of trawl data

The finalised dataset of 287 456 TCER and TCEPR records, with the generated endpoints and associated information, was imported into an open source PostGIS/PostgreSQL object relational database with Open GIS Consortium compliant spatial data types and query capability. This system was used to develop the dataset with the addition of new fields for spatial analysis, with an associated graphical GIS package with provision to query and display data (QuantumGIS). The spatial aspect of the database was built using a WGS1984 Albers Equal Area projection with the central meridian at 175° E, standard parallels at 30° S and 50° S, and latitude of origin at 40° S.

Additional data layers

Spatial layers were created within ArcGIS and imported into the trawl effort database for spatial overlay analysis to create the footprint area within the study area. These included:

- the area from the coastline to the 250 m contour (*shelf*)
- the New Zealand land area (*land*)
- the areas closed to fishing because of the location of cables and pipelines (*cable*)

The *land* and *cable* layers were buffered by 25 m to cater for overlap that may occur with the trawl effort because of the resolution of the tow position data.

Spatial analysis attributes

New columns were created in readiness for the spatial analysis: for *startpoints* and *endpoints* based on the final reported/estimated position data; distance between the startpoints and endpoints (trackline); estimated doorspread values; geometries representing the area for tows (based on the tracklines); and flags for where effort started or ended on the buffered *land*, buffered *cable*, or outside the *shelf*.

Startpoints and endpoints that were identified as being on *land* or in the *cable* areas were moved to the edge of the *land* and *cable* buffers. Tracklines were then generated between the start and endpoints for each tow, and the distance of each trackline was calculated (as a straight line measured in kilometres). Separate tracklines were generated for the TCER tows that were the only or the last tow of the trip using the target derived finish latitudes and longitudes (*lonf_targ*, *latf_targ*).

Estimated doorspread values were used, based on form type use, vessel category, and reported target species (after Baird et al. 2011). All tows by category A vessels and scampi tows were assigned doorspread values of 70 m; tows by category B vessels were assigned values of 90 m; and tows by category C and D vessels were assigned doorspreads of 150 m, except that the category D vessel tows targeting hoki were assigned 200 m doorspreads.

Swept areas were generated from the doorspread and tracklines and stored as polygons representing each trawl. For those tows with only a start point (that is, tows for which there were no following or nearby tows that could be used to generate bearings, *n* = 572 tows), the swept area was created as a circle around the start point. Trawl polygons that were outside the *shelf* were flagged as 'outside', and those partly inside and outside the *shelf* were clipped to the boundary of the *shelf*. Trawl polygons that were partly inside and outside the *cable* areas were treated similarly. The length of these clipped polygons was calculated and stored as a new distance value.

3.2.1 Measures used to summarise the TCER and TCEPR data

As measures of the fishing intensity, this study used the reported number of tows for TCER and TCEPR data and the estimated swept area for each tow (trawl polygons) for the TCER and TCEPR data (in square kilometres), hereafter referred to as the *swept area*.

1. *Position swept area* is the area (km^2) derived from the tow distance as measured between start and finish positions and the assigned doorspread. This measure was used to summarise the effort and the total for each fishing year is referred to as the *aggregated swept area*.
2. *Speed-time swept area* is the area (km^2) derived from the tow duration as measured between start and finish times, the tow speed, and the assigned doorspread.
3. *Coverage area (footprint)* is the area (km^2) that represents the seafloor area estimated to have been contacted by trawl gear.

Assignment of tow data to a cell grid

To aid in the categorisation and analysis of the data, a grid of approximately 25 km^2 cells was created in another database table. The use of a 5×5 km cell size was agreed to by the Aquatic Environment Working Group to maintain consistency with the EEZ-wide trawl footprint analyses of TCEPR data (Baird et al. 2011, Black et al. 2013). This grid was generated in the same Albers Conic Equal Area Projection and re-projected to latitude and longitude degrees to overlay with trawl effort data as a basis for spatial analysis.

The cell grid table was joined to the effort data table to create a new database table to enable the spatial overlay of the grid with the trawl polygons of swept area. Thus, the effort could be analysed by grid cell to identify and quantify the amount of effort per cell over time and to generate an indicative "footprint" of trawl effort on the seafloor.

For area-based calculations, the data were reprojected to the Albers Conic Equal Area projection to minimise distortions caused by converging lines of longitude with increasing latitude using degrees as the co-ordinate units. For each cell, the sum of the area of all the portions of the estimated doorspread polygons that lie within that cell can be calculated. Thus, a cell in any given fishing year may have an aggregated swept area of 0 (unfished) or 25 km^2 (swept area is similar to the cell size), or perhaps 100 km^2, suggesting that for that year, the swept area was 4 times the cell area.

Further database tables were created and populated to store:

- the number of events per cell and the cell footprint (that is, the area of each cell that was contacted by trawl gear) based on trawl polygons in the entire dataset (for the 2007–08 to 2011–12 fishing years), from which summaries can be generated for different species and years;
- the annual number of events and footprint per cell for all target species;
- the total number of events and the footprint per cell for the five fishing years combined.

For each of these cell coverage areas in these tables, the cell geometries were converted to cell swept areas (km^2) using the equal area projection.

3.2.2 TCER and TCEPR fishing effort: number of tows and aggregated swept area

The final dataset included only those tows considered to have bottom contact – that is, all "BT" tows, and "MW" tows for which the effort depth field value was within 1 m of the bottom depth value. From the total of 282 833 tows, 78.6% were reported on TCERs and the remainder on TCEPRs. These tows represented a total of 368 983 km^2 (69.7% of which was estimated from TCERs). The annual numbers of tows and the estimated aggregated swept areas by target species are given for the two different form types in Tables 5.1–5.4 in Appendix 5. Similar information is given by vessel size in Tables 5.5 and 5.6, and by Statistical Area in Tables 5.7– 5.10.

The spatial distribution of these data, by form type and vessel size category, are shown in Figure 10. The TCER form was used more in the inshore waters around the South Island and off the east coast of the North Island (where fishers mainly continued to use CELR forms rather than change to using TCEPRs) from the mid-1990s on (Baird et al. 2011)). In total, the TCER and TCEPR effort reported by category A vessels (6–28 m) accounted for 87.4% of the numbers of tows and 72.6% of the estimated swept area.

Both form types were used to report most target species in the same Statistical Areas, but the proportion of effort by form type may vary in each area. For example, although about 54% of the snapper tows (and the aggregated swept area) is from TCERs, the proportion from TCERs varies depending on where the fishing took place. Tables 5 and 6 illustrate this point for snapper and tarakihi, with a subset of data for the main Statistical Areas where snapper and tarakihi effort was reported on both form types. Tables 5.11–5.14 show these data for all target species and Statistical Areas.

For red gurnard, a species mainly reported on TCERs, over 88% of effort in the main red gurnard target areas (Statistical Areas 012, 013, and 014 off the lower east coast North Island) was reported on TCERs, as was most effort off the west coast North Island (Statistical Areas 041 and 042); but the relatively small amount of effort off the northern east coast Statistical Areas 003–006 was mainly from TCEPRs. For trevally, which was mainly targeted in Statistical Area 009, the TCER effort accounted for 41% of the 2862 tows and 64% of the estimated 2356.5 km^2 swept area. For barracouta, most effort on both forms was in Statistical Area 022 off the east coast of the South Island: here, TCER data accounted for about 50% of the 3850 tows made during 2007–08 to 2011–12, and 39% of the estimated swept area.

Table 5: Number of tows that targeted snapper and the estimated swept area for the main snapper Statistical Areas around the North Island and the percentage represented by TCER data, 2007–08 to 2011–12. Statistical Areas are shown in Figure 2.3 in Appendix 2. See Tables 5.11–5.14.

Statistical	Snapper tows		Snapper estimated swept area (km^2)	
Area	Total tows	% TCER	Total	% TCER
003	1 867	88.2	1 976.4	85.9
005	3 259	52.7	2 910.6	53.5
006	3 707	40.7	2 462.8	37.0
008	1 358	41.8	1 501.7	40.2
009	1 828	30.5	1 543.2	40.0
010	2 172	32.5	1 902.3	36.6
042	562	23.7	854.6	21.8
045	736	18.2	986.1	15.4

Table 6: Number of tows that targeted tarakihi and the estimated swept area for the main tarakihi Statistical Areas and the percentage represented by TCER data, 2007–08 to 2011–12. Statistical Areas are shown in Figure 2.3. See Tables 5.11–5.14.

Statistical	Tarakihi tows		Tarakihi estimated swept area (km^2)	
Area	Total tows	% TCER	Total	% TCER
002	868	83.4	1 326.2	81.7
003	950	75.1	1 309.1	73.7
004	391	11.0	722.6	11.5
008	1 116	18.3	1 772.5	20.4
009	1 970	33.2	2 223.1	39.8
010	2 870	45.1	3 399.8	51.9
011	4 434	66.9	4 687.6	71.4
012	4 920	72.9	6 611.4	73.2
013	8 906	93.2	11 355.1	90.1
014	4 237	61.6	7 300.6	53.6
015	1 124	56.5	1 809.9	46.5
016	1 184	99.2	1 119.9	99.2
017	1 053	98.7	1 151.3	98.3
018	1 647	97.4	1 912.7	98.0
020	3 002	99.0	4 862.5	99.2
022	2 655	99.2	4 383.4	98.9
033	2 671	99.9	3 251.5	99.9
034	2 488	96.4	3 743.3	95.0
035	821	83.7	1 497.6	79.5
036	1 680	83.6	3 021.3	79.5
037	918	94.6	1 475.3	92.6
038	198	99.5	242.9	97.1
039	1 306	99.5	1 826.5	99.4
040	209	97.6	338.4	97.0
041	564	57.6	993.7	55.0
042	123	9.8	259.9	8.5
045	469	40.5	1 099.9	35.1
046	375	50.1	860.5	45.2
047	1 120	53.9	2 326.5	47.6

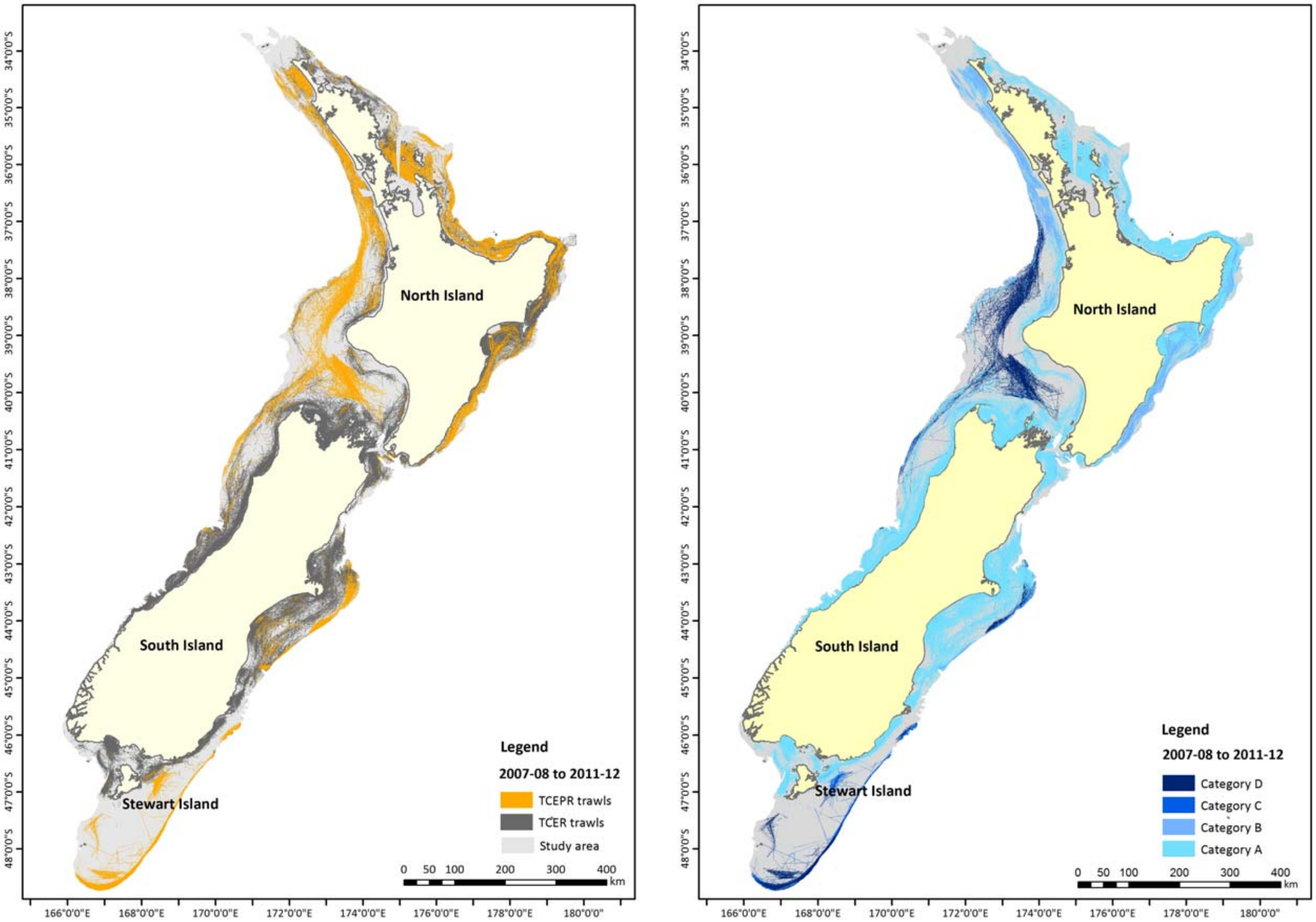


Figure 10: The distribution of trawl effort by form type (left) and by vessel size category (right) within the study area (out to 250 m).

Figure 5.1 in Appendix 5 summarises the annual number of tows and aggregated swept area for the main target species and species groups, by form type. For some target species shown in Figure 5.1, the effort will be on the periphery of a larger fishery that operated beyond 250 m (for example, squid), whereas others should contain most of the target fishing for that species (for example, snapper). Five years is a short period in which to measure a trend in effort, and for most species there is little variation over the five year period, except when the number of tows is relatively low (as for dark ghost shark or hoki, for example). Species that are often fished by the same vessels, such as John dory, red gurnard, snapper, tarakihi, and trevally indicated some differences, with a slight rise overall for tarakihi and red gurnard, little change for snapper, and an apparent decrease in effort for John dory, red cod, and trevally.

The relationship between the number of tows and the aggregated swept area appears to have changed little over the five year period for most species when reported on either form type.

The target species with trawl contact in the greatest number of cells over the five year period are tarakihi, barracouta, red gurnard, and flatfish species. The number of cells contacted by trawl gear for the different target species is influenced by the number of tows for that target species, the extent to which the target species effort is localised, and the relative length of the tow distances for the target species.

3.3 Trawl footprint within the study area

Over the five fishing years, 2007–08 to 2011–12, trawl gear towed by TCER and TCEPR vessels contacted about 113 779.4 km^2 of seafloor (based on the total cell footprint shown in Figure 11). The seafloor area defined by the 250 m contour (the study area) covers approximately 238 668 km^2. Thus the five year footprint contacts about 47.7% of the study area seafloor.

Within the study area, about 12 371.4 km^2 of seafloor area are closed to trawling (see Section 1); this leaves a seafloor area of 226 296.6 km^2 potentially available to trawling. The five year trawl footprint area represents about 50.3% of the seafloor area available to trawling.

The area contacted in each of the five fishing years varied little and ranged between 45 350 km^2 and 48 323 km^2 (Table 6.1 in Appendix 6), with the annual footprint coverage being equal to about 20% of the available seafloor within the study area. The annual footprints are shown in Figure 12.

Of the 10 283 cells with contact by trawl gear (within the study area during 2008–12), 72.9% were contacted by trawl gear in each of the 5 fishing years, 8.9% in 4 fishing years, 5.9% in 3 years, 5.6% in 2 years, and 6.7% had trawl contact in one year only (Table 7, see Figure 12). For cells with trawl contact in one year only, the maximum number of tows was 9, compared with a maximum of 74 for cells with trawl contact in three years, and the 2884 maximum for cells that had trawl contact in each of the five years. There were few differences in the minimum number of tows, based on the number of years a cell had been contacted (1–5 tows), and the very small areas represented by these tows indicates that they may represent an end of a tow or where a tow crosses a small part of a cell boundary.

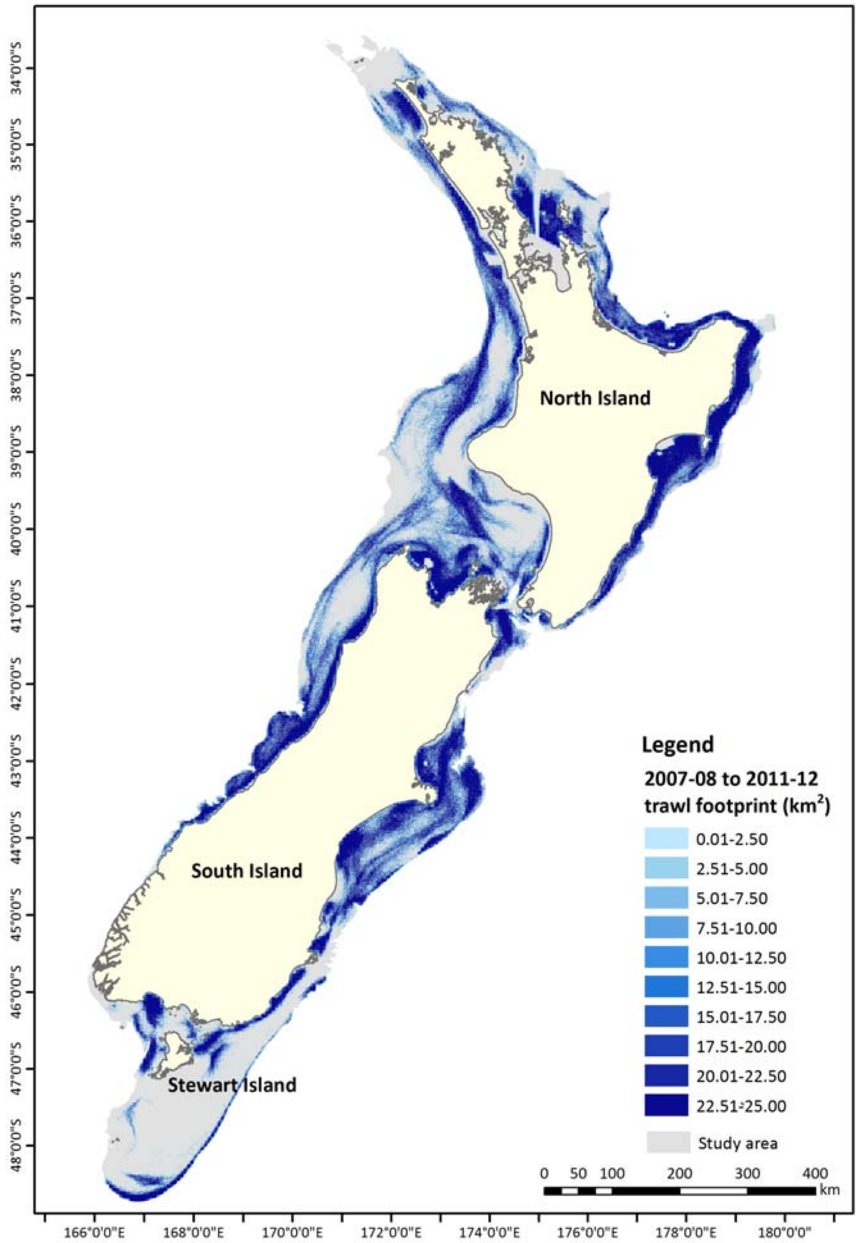


Figure 11: Total five year trawl cell-based footprint for 2007–08 to 2011–12 combined.

Table 7: Number of cells with 1–5 years of trawling contact, based on each fishing year as a starting point.

No.	Fishing years						No. tows per	Footprint area (km^2)	Area
years	2008	2009	2010	2011	2012	All	min–max (mean)	min–max (mean)	(km^2)
1	158	157	131	121	124	691	1–9 (1)	< 0.0001–2.90 (0.30)	212.6
2	249	153	106	64		572	2–22 (3)	< 0.0001–4.40 (0.70)	418.5
3	338	184	89			611	3–74 (7)	0.0002–13.10 (1.60)	953.9
4	727	187				914	4–170 (16)	0.0002–19.60 (3.20)	2 959.7
5	7 495					7 49	5–2884 (205)	0.0028–25.00 (14.60)	109 234.5
All						10 283	1–2884 (152)	0.0001–25.00 (11.06)	113 779.4

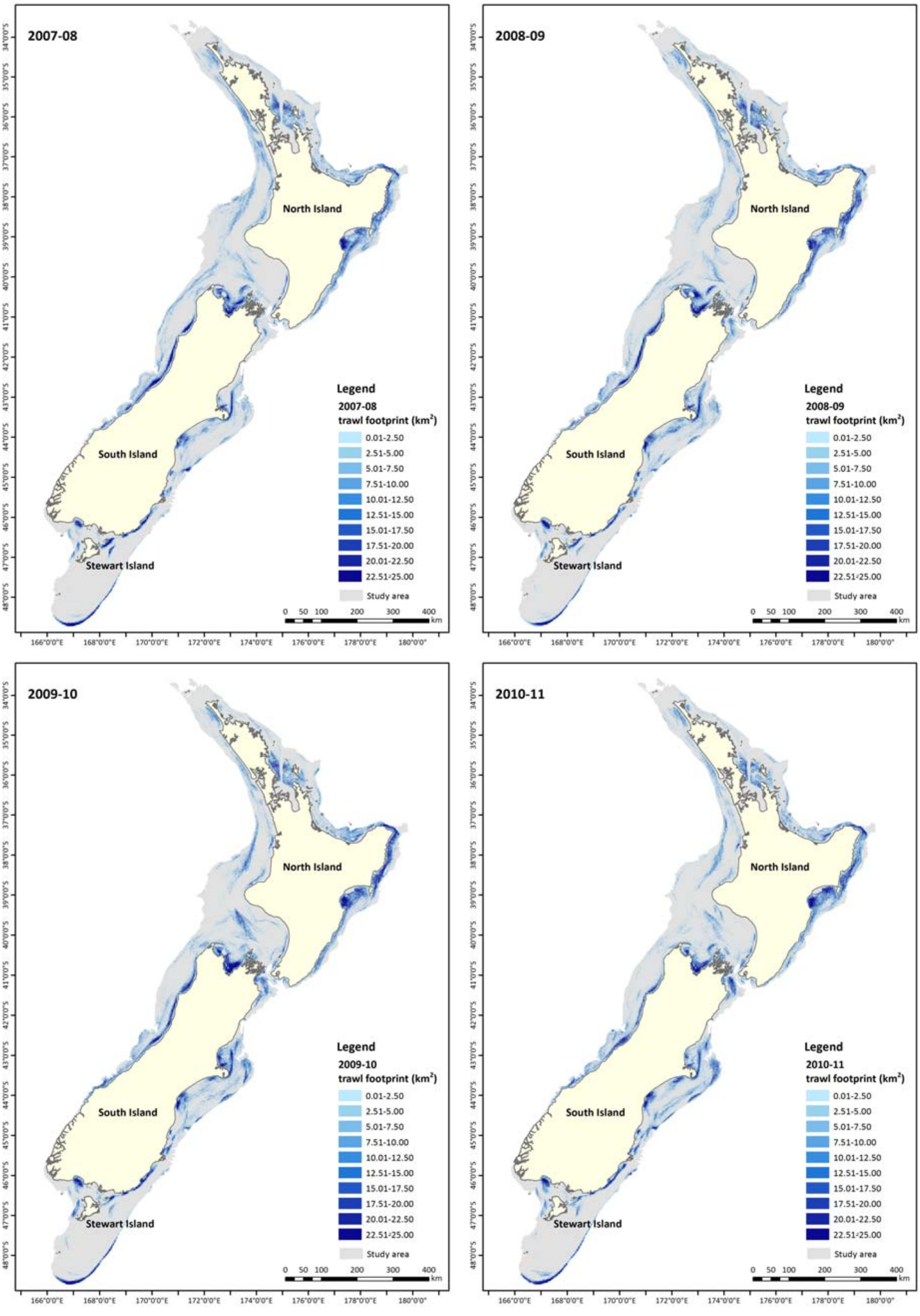


Figure 12: Annual cell trawl footprint for fishing years 2007–08 to 2011–12 and the number of years each cell was contacted by trawl gear.

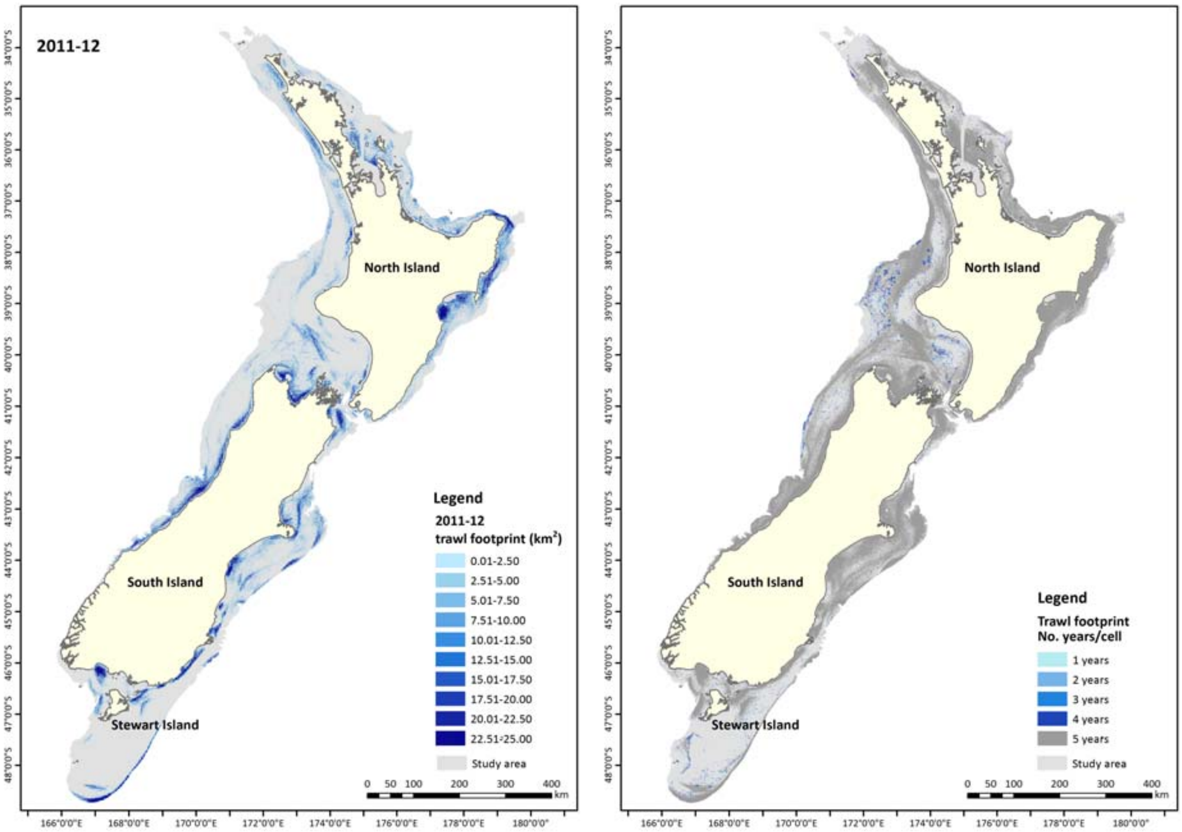
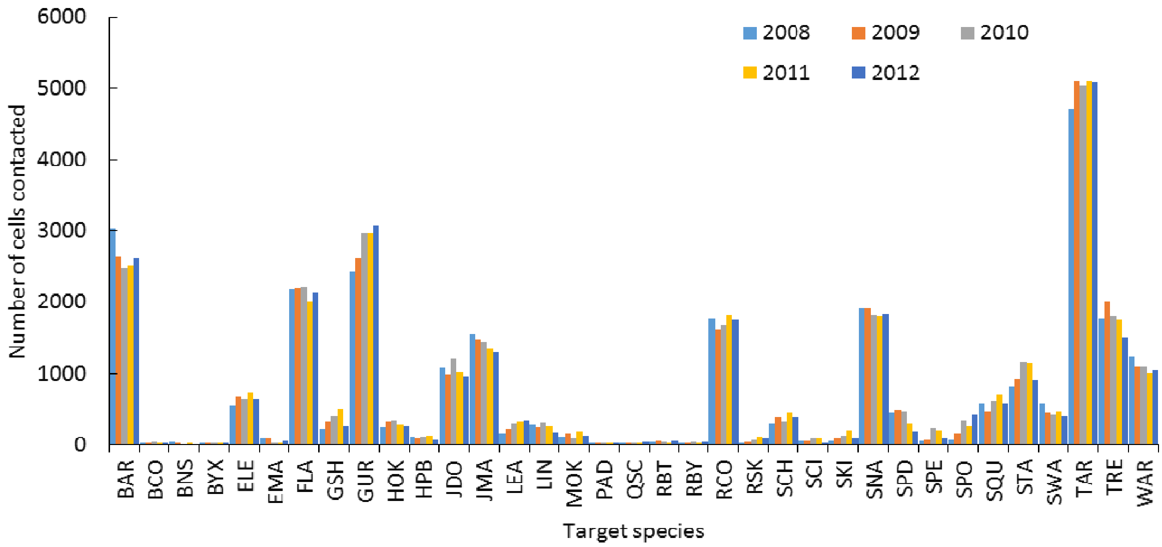


Figure 12 *continued*.

Target fisheries

Most of each annual footprint was from effort that targeted tarakihi, jack mackerel, flatfish species, red gurnard, barracouta, snapper, trevally, and red cod, as well as arrow squid, John dory, giant stargazer, blue warehou, and elephant fish (Table 6.1 in Appendix 6). The more concentrated effort for some inshore species is evident in the comparison of the numbers of cells contacted in a year with the extent of the footprint area for a year, for a given target species (Figure 13). This concentrated effort may be because these target species have shorter tows or a more limited range of fishing location. Distribution maps of the total footprint (2007–08 to 2011–12) are given in Figure 6.1 of Appendix 6 for the main target species. Figure 6.2 shows the annual distribution of the number of tows and footprint area for each of the main target species.



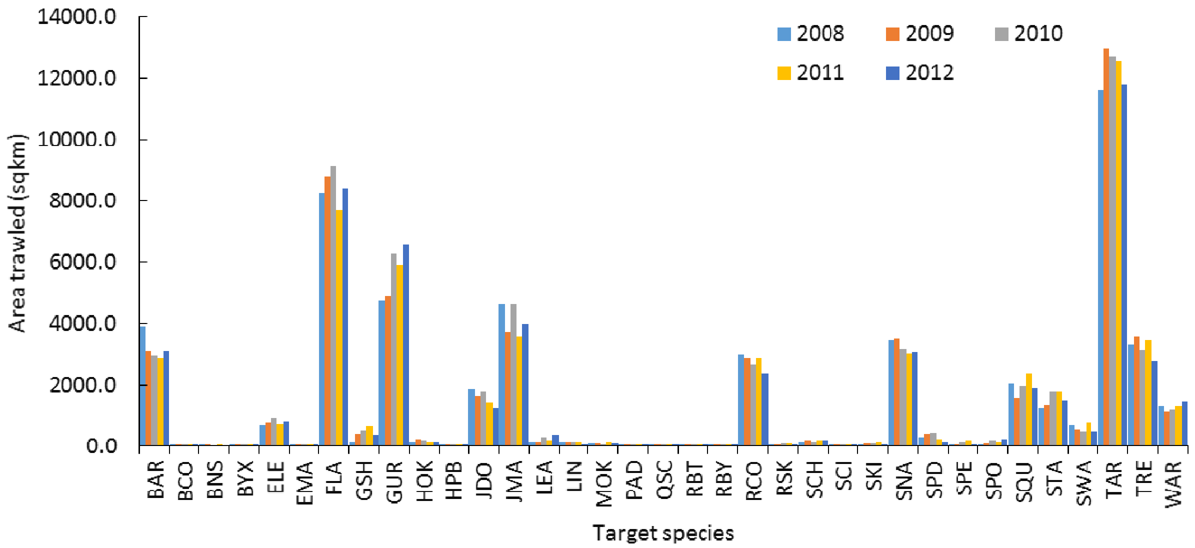


Figure 13: Number of 5 × 5 km cells (upper) and the footprint area (km^2) (lower) contacted by trawl gear, by the main target species (see Table 3 for the target species code definitions and Tables 5.15 and 6.1 for the annual data).

The maximum number of tows per cell for the total footprint was 2884 tows, but the interquartile range was between 14 and 184 tows per cell, with a median of 68 tows. The maximum footprint coverage within a cell is 25 km^2 (the actual area of the cell), and the interquartile range was between 2.2 and 19.4 km^2, with a median of 10.3 km^2. Figures 14 and 15 show the distribution of these total tow numbers and footprint data. Small changes were evident in the total footprint areas between years. There was a 0.4% increase between fishing years 2008 and 2009, 4.9% increase between 2009 and 2010, 4.2% decrease between 2010 and 2011, and a 2.1% decrease between 2011 and 2012 (Table 6.2 in Appendix 6). These changes are shown in Figure 16 for target species with total footprint areas of over 900 km^2. Most changes are less than 25% except for where those species where the effort (number of tows) is relatively small and the target fishing activity appears to be more sporadic.

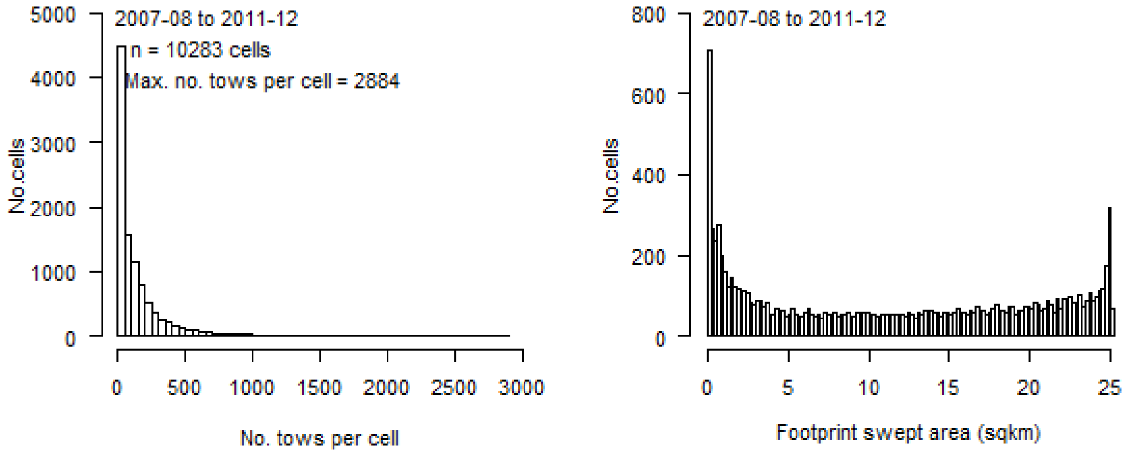


Figure 14: Distribution of the total number of tows per cell and the five year footprint per cell.

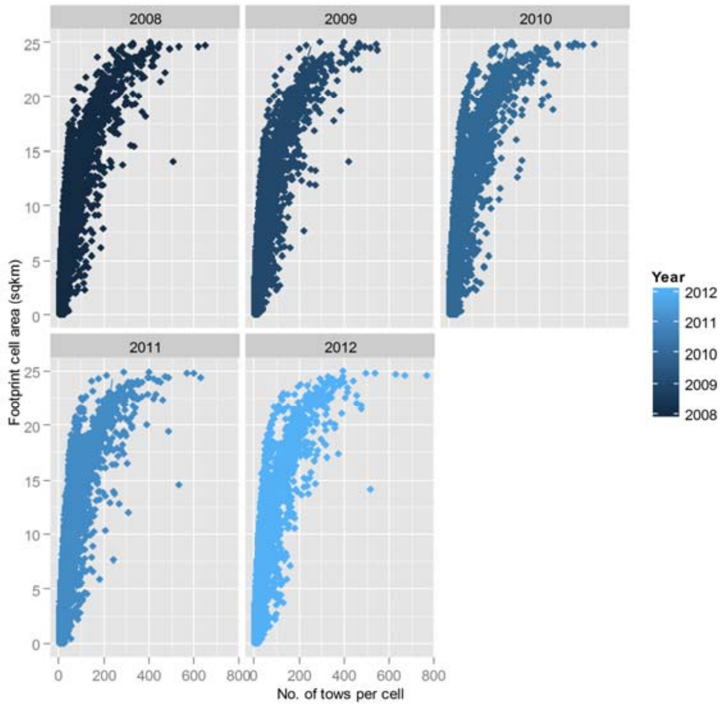


Figure 15: The relationship between the annual cell footprint areas and the number of tows for each cell, for all target species combined.

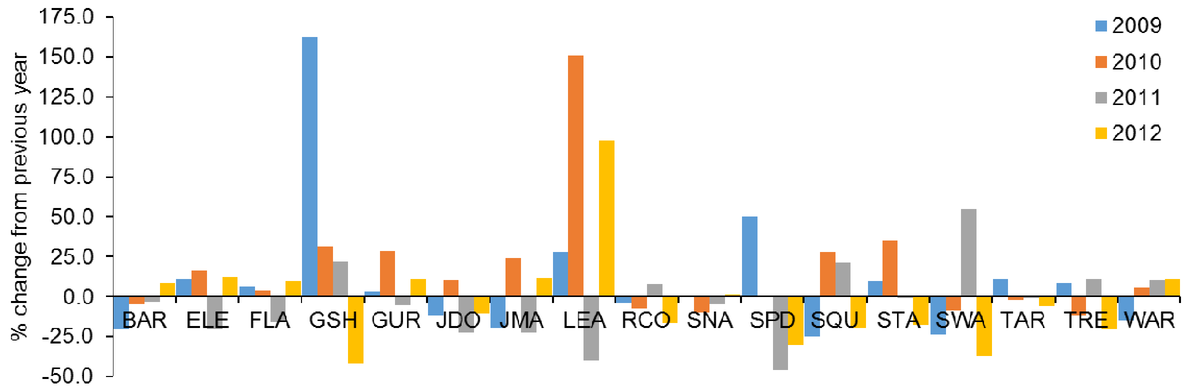


Figure 16: The percentage change between the fishing years in the area of the total footprint for the target species with at least 900 km^2 total footprint (all target data are given in Table 6.2 in Appendix 6). Target species codes are given in Table 3.

3.4 Overlap of five-year trawl footprint on habitats within 250 m

3.4.1 GIS overlay

The shapefile of the habitat classes was imported into the database and linked to the cell grid table containing the number of tows and footprint values for each of the 10 283 cells with trawl contact to create a new database table containing the intersection of the footprint and the habitat classes for each cell. The area (km^2) of each habitat class and footprint combination per cell, and the percentage of each habitat class in a cell that was contacted by the total cell footprint, were calculated and stored.

The study area (0–250 m contour) covered about 238 668 km^2. The habitat layer covered 232 235 km^2 (see Table 1) and includes areas where trawling is prohibited (see section 1). The habitat class layer coverage is less due to the finer resolution of the 1 × 1 km cell-based analysis that generated the BOMEC classes. Figure 17 shows an example of the edge effect created by the habitat class layer.

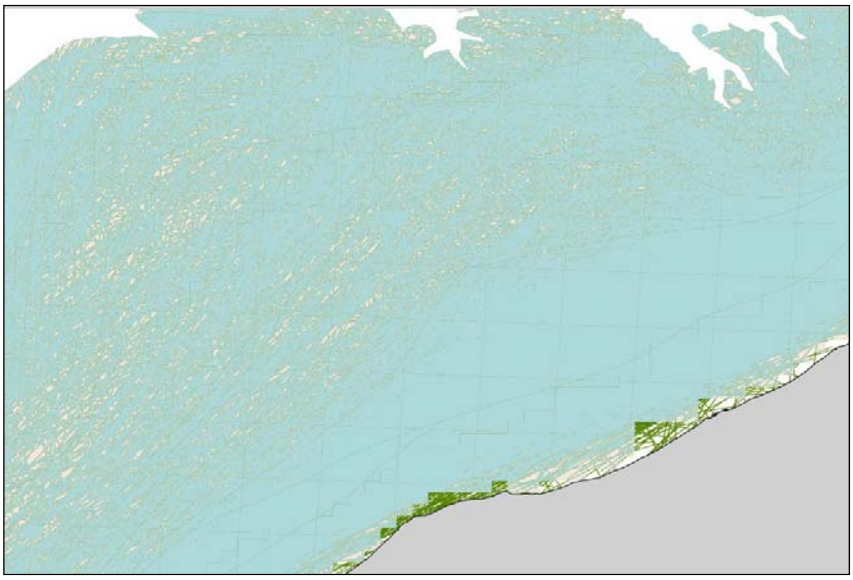


Figure 17: A snapshot of the edge effect created by the habitat class layer resolution of 1 km^2 cells. The cell footprint (green) overlaid by the cell footprint intersection with the habitat class layer (blue), the habitat class layer (fawn), alongside an area of the west coast South Island (grey).

3.4.2 Summary statistics from the overlay of the trawl footprint and habitats

The habitat class layer was overlaid with the trawl footprint (for all fishing years combined and for each fishing year) to provide a combined layer, and this overlay effectively excluded the areas closed to trawling. Based on the 11 BOMEC classes, the three depth zones, and the six sediment types, 108 habitat classes were identified within the study area. The distribution of the footprint by BOMEC class, depth zone, and sediment type is shown in Figure 18.

When the habitat class layer was overlaid by the 5 × 5 km cell-based footprint, it was reduced by 0.5% to 231 031 km^2. However, in this summary the habitat class area measures used are those given in Table 1. The largest BOMEC classes, by area, were C, E, and A, D, and H (Table 8). About 50% of the habitat class area is in 100–250 m and 45% is covered by sand.

After the overlay, the total footprint coverage was reduced by 1.2% to 112 422.5 km^2. At the scale of the BOMEC classification, the five year trawl footprint contacted at least 30%, and as much as 64.4%, of the area of the largest classes (see Table 8). The annual variation of the trawl footprint coverage of each habitat class is shown in Figure 19 (see Table 7.1 in Appendix 7 for the underlying data of the overlay of the annual trawl footprints on each habitat class).

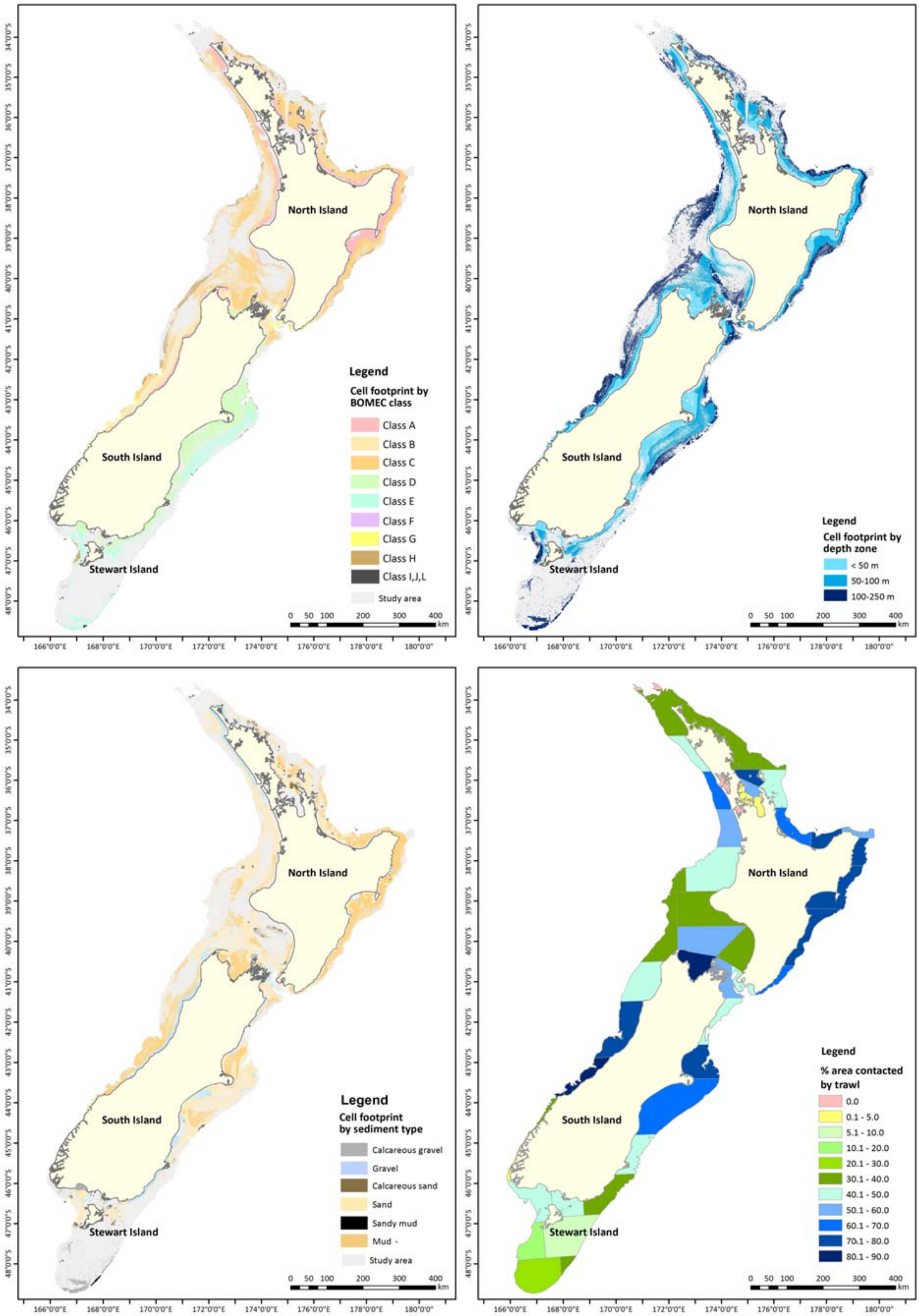


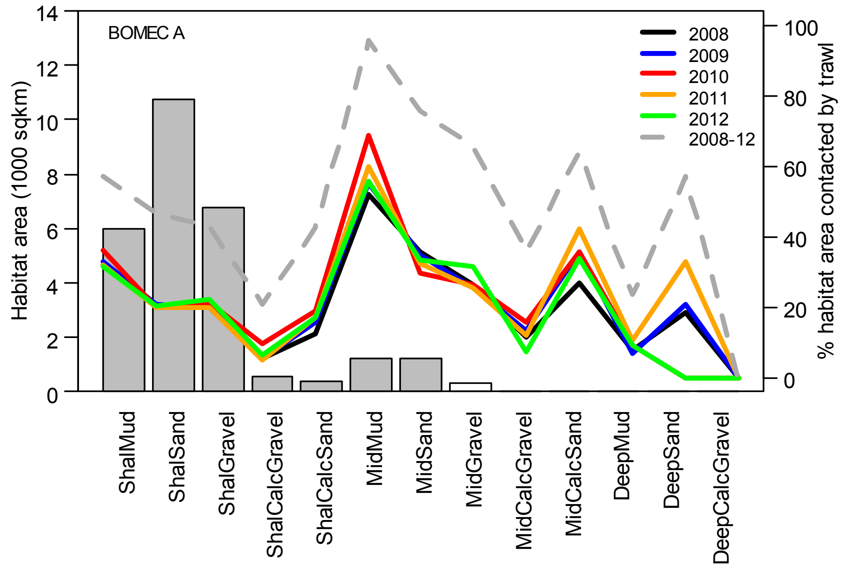
Figure 18: Distribution of the five year trawl footprint by BOMEC class (upper left), depth zone (upper right), and sediment type (lower left) and percentage of each Statistical Area (or part of, within the study area) contacted by trawl gear during 2007–08 to 2011–12.

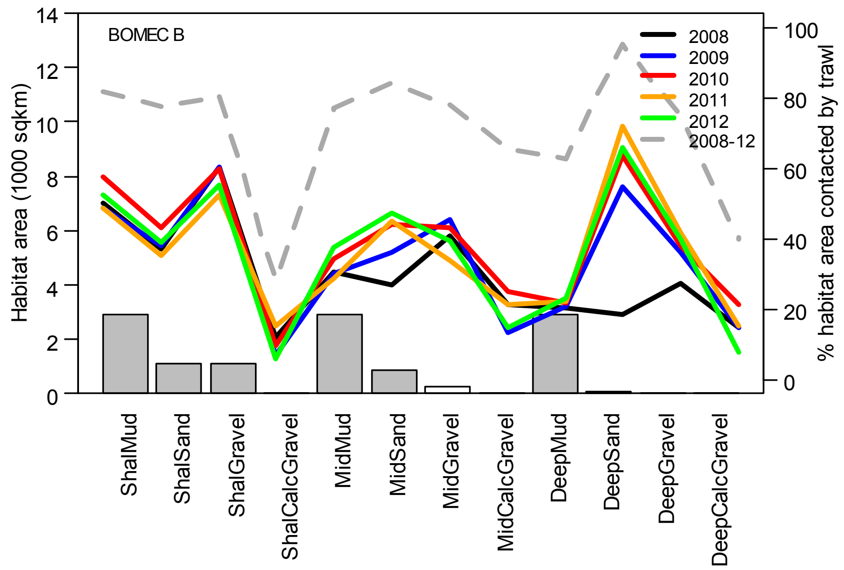
Where classes included in the study area are represented by a relatively small area – often as patches of seafloor – the trawl footprint may cover a higher proportion of the available area, such as with classes I and L, or a lesser proportion, as with classes F and J. All these classes are on the deeper edge of the study area.

Table 8: Areas* of the separate habitat classes and areas† of the five year trawl footprint in each habitat class, for the BOMEC classes, depth zones, and sediment types, and the percentage of the five year trawl footprint in each class.

Habitat class descriptors	Habitat class area (km^2)	Total footprint (km^2)	% area with trawl contact
BOMEC class			
A	27 375.2	14 047.1	52.1
B	12 318.8	9 322.3	75.7
C	89 560.4	47 120.0	52.6
D	25 513.1	16 344.7	64.4
E	47 186.8	13 890.6	29.6
F	381.7	73.2	21.1
G	3 898.4	1 902.9	50.8
H	25 204.4	9 228.1	36.8
I	473.2	340.8	72.0
J	133.9	31.3	30.0
L	188.9	121.5	67.6
Depth zone			
< 50 m	50 781.3	29 529.4	58.8
50–100 m	63 493.9	37 375.2	59.1
100–250 m	117 959.8	45 517.9	38.7
Sediment type			
Sand	104 830.2	54 851.9	52.4
Mud	72 518.1	41 001.8	57.0
Gravel	18 530.0	9 339.3	50.6
Sandy mud	203.4	203.4	99.98
Calcareous sand	6 763.7	2 080.7	31.3
Calcareous gravel	29 389.5	4 945.4	17.0
All	232 235.0	112 422.5	48.4

* The area measures for the habitat classes are from Table 1 (i.e., they include any seafloor closed to trawling).
† The area measures for the five year footprint are from the overlay and represent 98.8% of the total footprint.





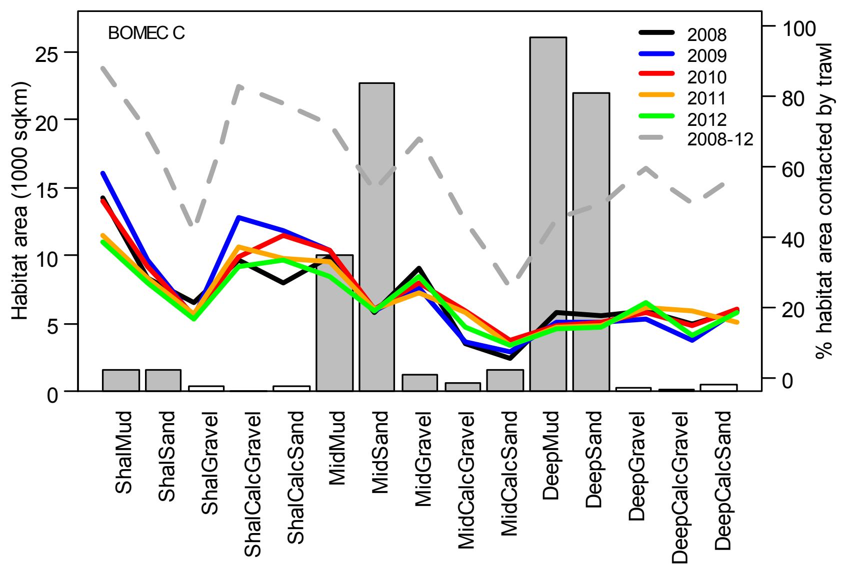


Figure 19: The habitat class (depth zone-sediment type) area of each BOMEC class (bars) and the percentage of each class contacted by the trawl footprint, by fishing year and for all years combined.

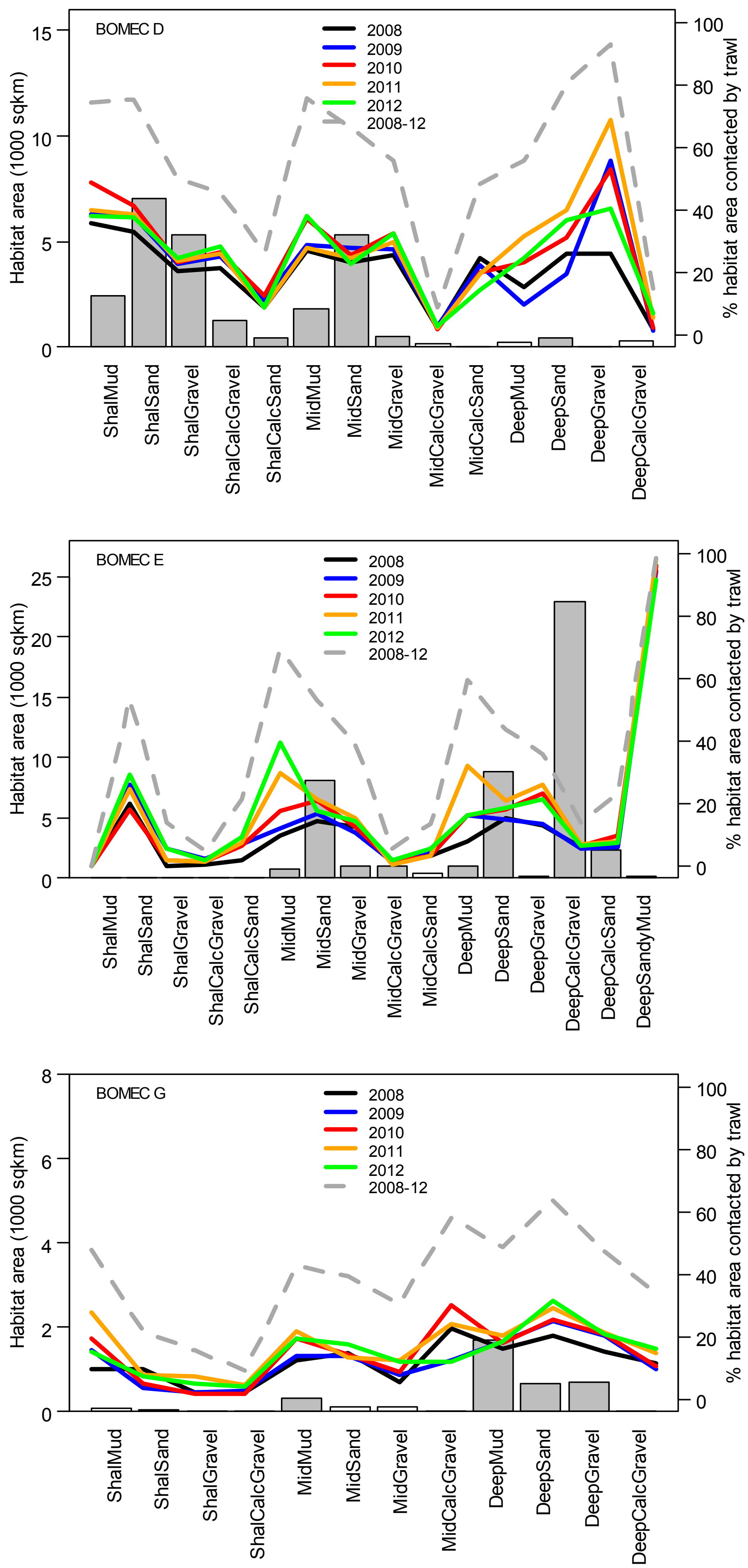


Figure 19 *continued.*

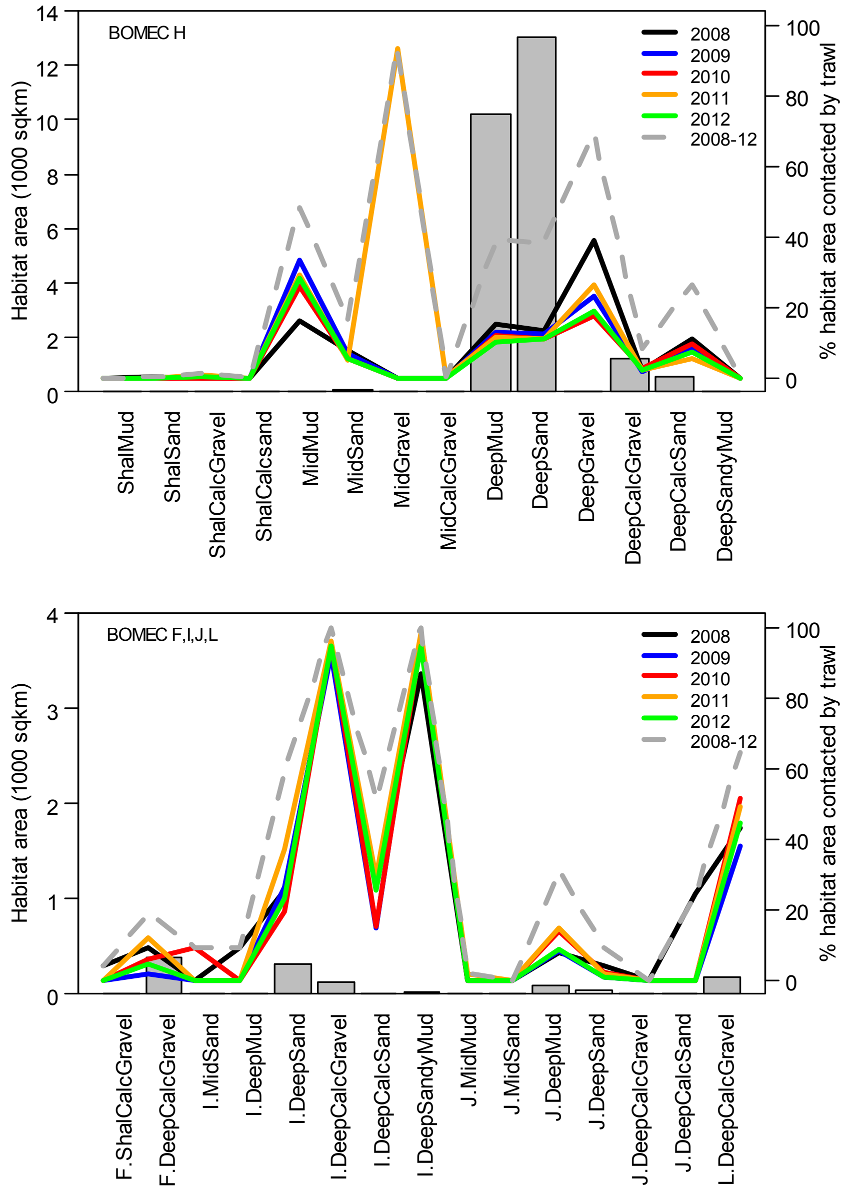


Figure 19 *continued.* Note that in the lower figure the BOMEC classes F, I, J, and L are displayed on the same figure.

3.5 GIS output from the overlay of the trawl footprint and habitat classes

This section describes the GIS outputs requested by MPI. These outputs are available on DVD. To request these outputs, please email: science.officer@mpi.govt.nz.

Disk contents

The files on this disk are provided as part of the output of the MPI project BEN2012-01 completed by NIWA. The files represent the GIS output from the bottom-contact trawl fishing effort for the 2007–08 and 2011–12 fishing years described in previous sections. These outputs are stored in three sub-directories.

1. **Figures** contains high resolution annotated maps using an equal area projection showing 5 × 5 km cells coloured by the number of fishing events in each cell. The colour bands are assigned equal numbers of cells per band, with the top 10 cells highlighted with a red circle.

The filename comprises the three letter species code (or "ALL" for all species combined), followed by an underscore, followed by the fishing year (or "ALL" for all years combined), followed by an underscore, followed by "fig.png". The maps are also annotated with the species code (see Table 3) and year. The 0–250m shelf region is plotted as a green layer, so any unfished cells will show as green. Green polygons representing various areas closed to trawling are included.

2. **Maps** contains similar images as contained in **Figures**, and a 'world file' for each image, which is used by mapping and GIS software to determine the geographic extent of the image and place it correctly on an interactive map. This process enables the maps to be displayed and used in GIS software, such as ArcGIS or QGIS, along with other data layers, such as fishery reporting areas, etc. The naming convention is as described above, but with "map" instead of "fig". To provide a tidier visual map layer, there is less annotation than the figures. The images are rendered in a Cartesian latitude/longitude grid, which will be correctly rendered on screen as a map by GIS software.

3. **Shapefiles** contains zipped shapefiles, with a similar naming scheme to that described above, ending in "_shp.zip". Each feature in the shapefile is a cell footprint, representing the estimated area swept within each cell, by fishing events for each target species and fishing year. These can be unzipped and opened in a mapping or GIS tool for display and use.

For users of these data who do not already have GIS software to display the GIS map images and shapefiles, a copy of the Open Source GIS application, QGIS is included. You will need administrator rights on your Windows PC to run the QGIS standalone installer. Version 2.2 is provided. For those users desiring a later version of the software, or who want to install a non-Windows version, see the QGIS web site at http://www.qgis.org.

4. SUMMARY OF NON-TRAWL BOTTOM-CONTACT FISHING METHODS IN THE STUDY AREA

Summaries of dredge oyster and scallop fisheries and Danish seine fisheries, within the study area, are given in Appendix 8 and Appendix 9, respectively. These summaries are preliminary and are based on limited grooming of the effort data, for the same time period as the trawl summary: 1 October 2007 to 30 September 2012. All these fisheries are subject to fishing area and gear restrictions which are not summarised in this report.

The dredge oyster data include both the Foveaux Strait fishery and the Challenger fishery. Scallop data are for the Challenger fishery, and the northern Coromandel and Northland fisheries (see Appendix 8).

The Danish seine data represent effort around the North and South islands, for target species such as snapper (36% of sets), red gurnard (21%), flatfish species (19%), tarakihi (8%), red cod (6%), John dory (6%), and rig (2%). About 5000–5500 sets were reported each year, and most effort was in eastern waters in Statistical Areas 003, 005, 006, 008, 009, 020, and 022, as well as 038 and 047 (areas are shown in Figure 2.3). Summaries are given in Appendix 9.

5. DISCUSSION

The 108 benthic habitat classes identified and described in this study were defined by three main data sources used as GIS layers: a subset of the BOMEC generated from modelling relevant distributions of environmental variables and groups of benthic organisms; a broad sediment type layer indicating areas of sand, mud, and gravels; and three depth zones to distinguish waters less than 50 m, 50–100 m, and 100–250 m deep. Presented on a 1 km^2 grid, these classes represented about 232 235 km^2 of seafloor in the study area defined by waters shallower than 250 m around North Island, South Island, and Stewart Island.

The overlap of bottom-contact trawl effort with these benthic habitat classes was assessed in terms of the number of tows and the area swept by the trawl gear, based on trawl data records from the 2007–08 to the 2011–12 fishing years. Trawl effort from two different data sources were used – one which had reported start and finish positions (Trawl Catch Effort Processing Returns) and one that had only tow start positions (Trawl Catch Effort Returns). For the former, the tow trackline was generated as a straight line between the start and finish. For the latter, tow endpoints were estimated using the bearing to the next tow and the distance measure calculated from the reported tow duration and the tow speed. Where there was no next tow (that is, the tow was the ony tow or the last tow of a trip), the bearing was estimated from other nearby tows with the same target species. Swept area estimates were generated from generic doorspread values and the tracklines and applied to a 5 × 5 km grid to provide summary statistics of the number of tows, the aggregated swept area, and the trawl contact area (footprint) by target species, year, and Statistical Area. This trawl effort targeted about 48 different species or species groups and similar amounts of effort were reported each year, with little overall difference in the estimated annual swept areas. The primary target species were flatfish, tarakihi, snapper, red gurnard, jack mackerel, barracouta, trevally, and John dory.

The trawl footprint for each year and for all five years combined was created for all target species and overlaid on the habitat classes to get a measure of the coverage of habitat classes by trawl gear. The total five year trawl footprint contacted about 113 800 km^2. Annual trawl footprints were in the range of 45 000–48 000 km^2, and the percentage change from year to year was generally between -4.2 and 4.9% due to a peak year in 2010 mainly as a result of an increase in effort for red gurnard.

This development of a trawl footprint for the inshore fishing effort provides a base on which to develop a footprint for the combined Territorial Sea and EEZ waters to encompass all bottom-contact trawl fishing effort. Currently, there is a 'deepwater' trawl footprint that includes TCEPR data only, with records from both the Territorial Sea and the EEZ, summarised by 400 m depth zones to a maximum of 1600 m (Black et al. 2013). The estimated annual 'deepwater' trawl footprints for three fishing years, 2007–08 to 2009–10 (that are also represented in this report), are between about 60 000 and 50 000 km^2 (from figure 34, Black et al. 2013). For the same fishing years, the 250 m study area annual trawl footprints (which is likely to include shallow TCEPR data of the 'deepwater' footprint) were about 46 000–48 000 km^2.

About 48% of the area covered by all the habitat classes was contacted by the five year trawl footprint. About 59% of the seafloor in depths of less than 50 m and 50–100 m were contacted by the five year trawl footprint compared with 39% of the 100–250 m depth zone. The percentage of the sediment types covered by the footprint varied, with about 50–58% of the three main sediment types (sand, mud, and gravel) contacted over the five years, 31% of calcareous sand, and about 19% of calcareous gravel. Five of the largest BOMEC classes (those with areas between 25 000 and 89 500 km^2 within the study area) had between 30 and 64% of their total area contacted by the five year trawl footprint.

The attempt to test how the benthic habitat classes might be affected by the physical contact from bottom trawling, through measures of sensitivity of benthic organisms, provided inconsistent results. Tests of the distributions of the benthic organisms from two independent sources showed little support for a difference in sensitivity to, or recovery from trawling of any of the habitat classifications trialled.

All the tests indicated a low degree of consistency in sensitivity or recoverability between the two data sources. Neither depth or sediment type created discrete sensitive habitat classes within the BOMEC classes, and subsets based on the depth zone or sediment type did not have lower variability in sensitivity levels. When the benthic habitat classes were combined with the Statistical Areas to provide a more geographic-based analysis, there was evidence of difference in sensitivity values of different BOMEC classes. Analyses of the recoverability data indicated different categorisation of habitat classes according to the source of the data.

Limitations and recommendations

The 'best available' data sources used in this attempt to provide some definition of the benthic habitat classes within the 250 m were ill-suited for the task. The development of the 15-class BOMEC, with respect to conditions favourable to benthic organisms and communities, relied heavily on use of biological data from research surveys beyond the 250 m contour, from deeper water areas of varying topography and substrates and under the influence of large oceanographic movements. The outer depth extent of the BOMEC (to 3000 m depths) and thus the influence of some of the environmental variables limited the value in describing the coastal waters at a meaningful scale for inshore habitats. The sediment layers were relatively coarse in their description and resolution.

The depth variable was the major influence in the development of 15-class BOMEC (Leathwick et al. 2012); however, the additional spatial separation by the three depth zones in this study provided some way in which to classify the BOMEC-sediment classes that was relevant to the depth ranges of many of the main target species represented in the fishing effort data. Attempting to define 'habitats' for this area of the continental shelf over a relatively large latitudinal gradient is also problematic, particularly with respect to identifying communities that may exist in different benthic habitat classes.

As new information is made available through current habitat and sediment studies, there may be opportunities to define benthic habitats, particularly those more sensitive to modification by fishing gears. In their recent review of biogenic habitats in New Zealand waters, Morrison et al. (2014a) suggest several areas of research to enable a better understanding of the links between marine species and seafloor habitats. These include improved habitat modelling and a better understanding of threats and stressors.

Certainly, a new environmental classification focussed on relevant (and more localised) variables, including a finer definition of the underlying geomorphology and biological data that are most relevant to the coastal continental shelf environments, could be the next step to better define the seafloor habitats affected by inshore commercial fisheries. However, consideration must also be given to the management objectives within a process designed to define a marine classification. For example, the use here of existing and available data to 'describe' benthic habitat classes resulted in a large number of 'habitat' classes within the study area. Whatever methodology and descriptors are used to define benthic habitat, there will always be a problem of scale for an area as large as this study area. Environmental data need to be modelled at a scale more relevant to that of the data collection of the biological data, and perhaps habitat classes need to be derived at more regional or local scales.

The extent to which sensitivity of organisms to fishing disturbance can be determined is dependent on the input data – on which organisms exist within which habitats, on what is known or understood about the organisms in terms of their life history and biological traits, and what is known or understood about the way in which, and how often, the fishing gear modifies the environment. Again, the scale of the input data will vary hugely for each data source.

The development of the trawl fishing footprint relies on certain assumptions (see Baird et al. 2011). The analysis presented here makes use of the TCER data for the first time in the development of an 'inshore' footprint. These TCER data represent the majority (78.6%) of the total trawl effort over the five year period, but the use of the form varies by area (Figure 20). The parameters that are used to determine the spatial placement of each tow in the TCER data are in part provided by the data and in part determined from assumed fishing behaviour. However, these estimated trawl tracks do show similarity in placement to that of the TCEPR data for any given target species effort. Although there may be more uncertainty in the spatial placement of the estimated swept areas for TCER tows, compared with that for the TCEPR tows (where a finish position is reported, there is room for greater uncertainty in all the estimates given the underlying assumptions used to develop a trackline (for example, assume a straight line and generic values for gear width) and the resolution of the start and finish position data.

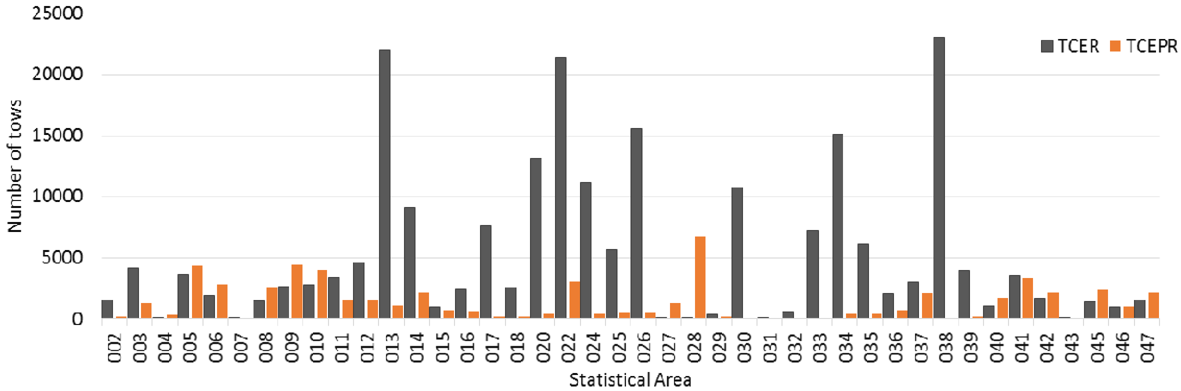


Figure 20: The number of TCER and TCEPR tows reported by Statistical Area, 2007–08 to 2011–12.

This measure of the area swept by trawl gear does not include other bottom-contact commercial fishing gears. The shellfish dredge and Danish seine effort is not available at the level of an individual event and has simply been summarised as the number of tows or sets within fishery-specific Statistical Areas. In some areas where shellfish dredging or Danish seining occurred, it is possible that the seafloor was contacted by trawl gear as well as dredge or seine gear. The trawl effort presented here represents about 52% of the total bottom-contact effort within the study area, in terms of the number of trawl tows, dredge tows, and Danish seine sets during 2007–08 to 2011–12 (about 545 195 tows and sets).

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APPENDIX 1: AREAS CLOSED TO FISHING WITHIN THE STUDY AREA

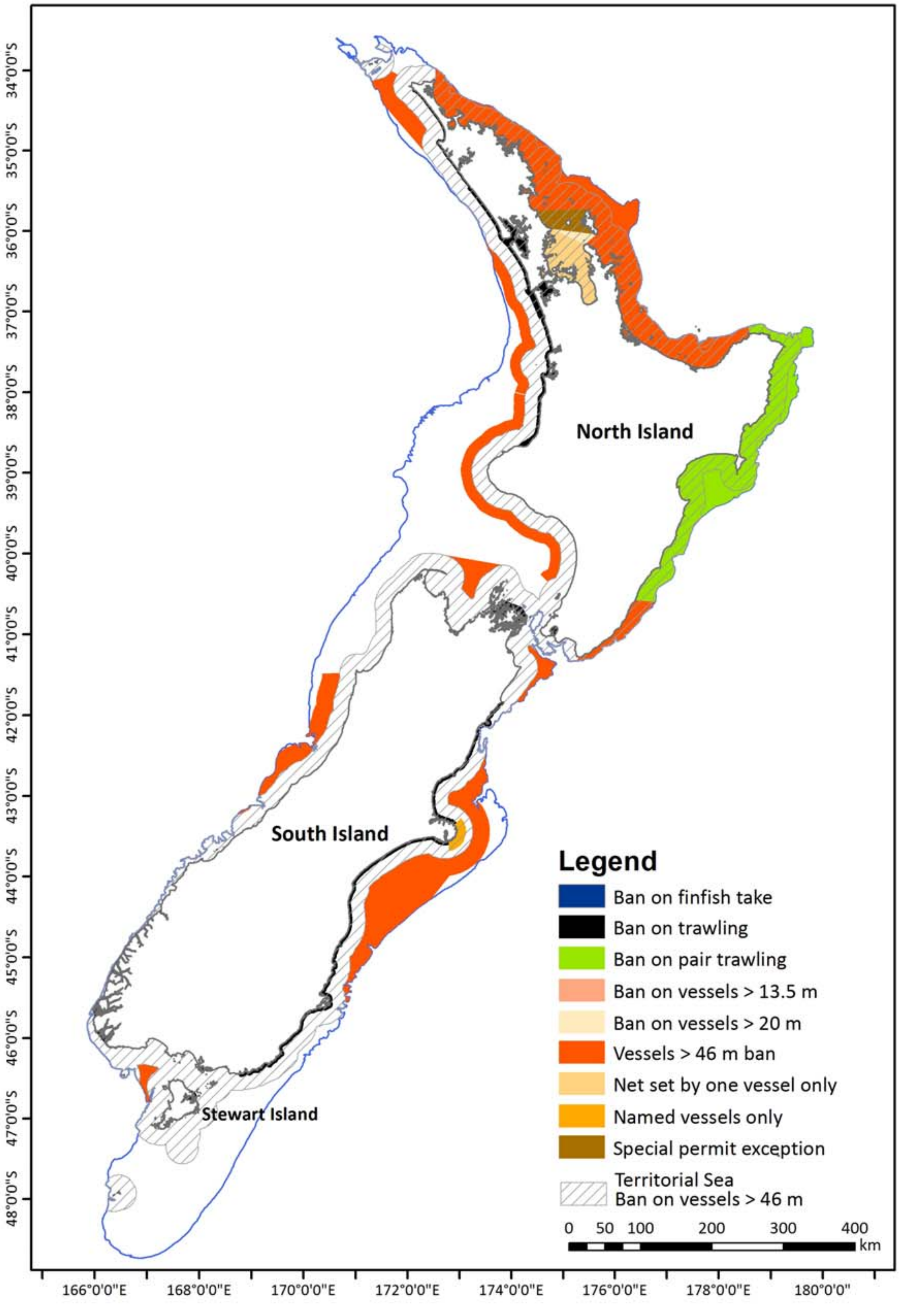

Figure 1.1: Areas showing where trawling is prohibited and other relevant restrictions apply. Note the area shown as "Ban on pair trawling" also is closed to vessels > 46 m.

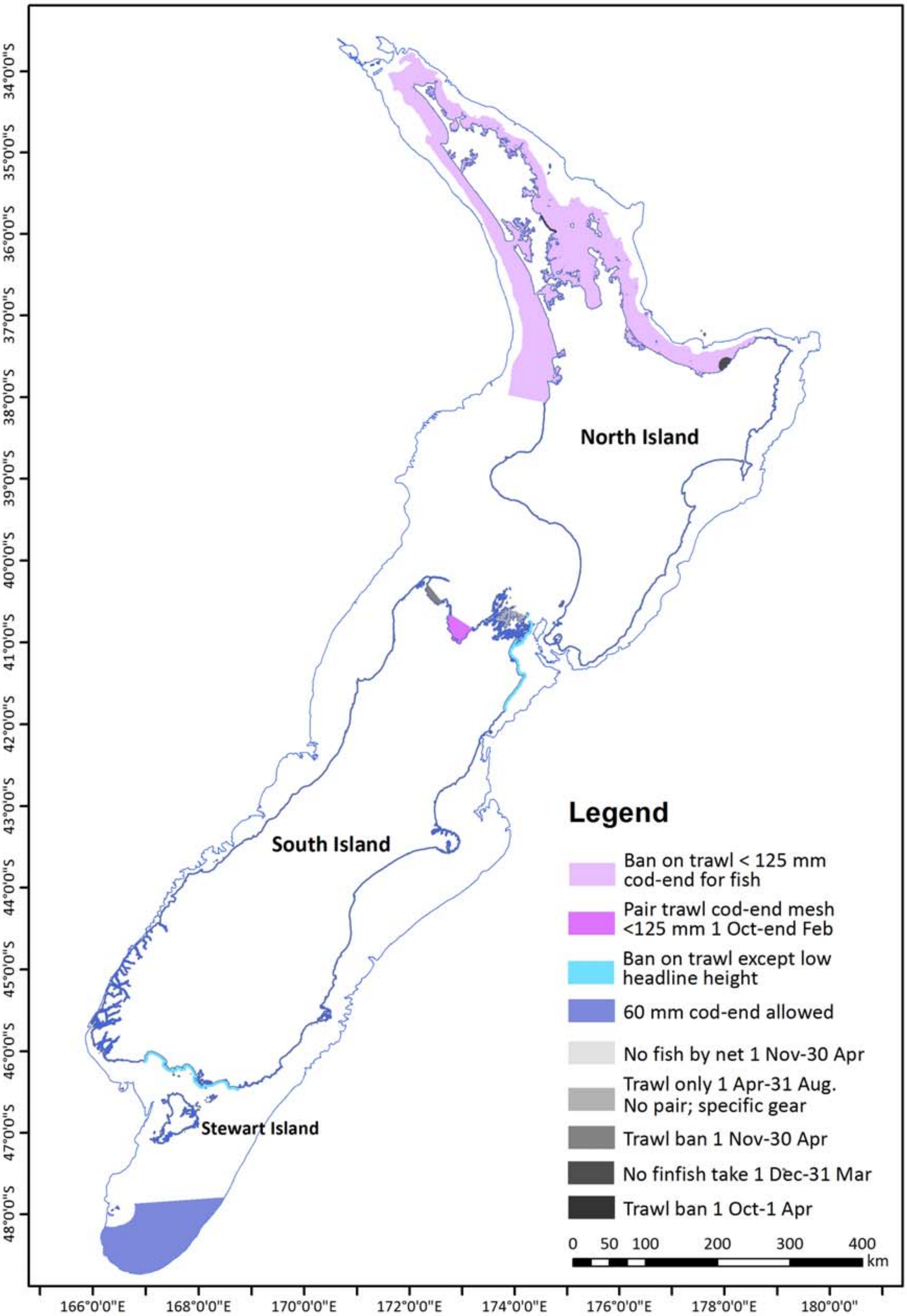

Figure 1.2: Areas where gear and seasonal restrictions apply to the use of trawl gear, within the study area.

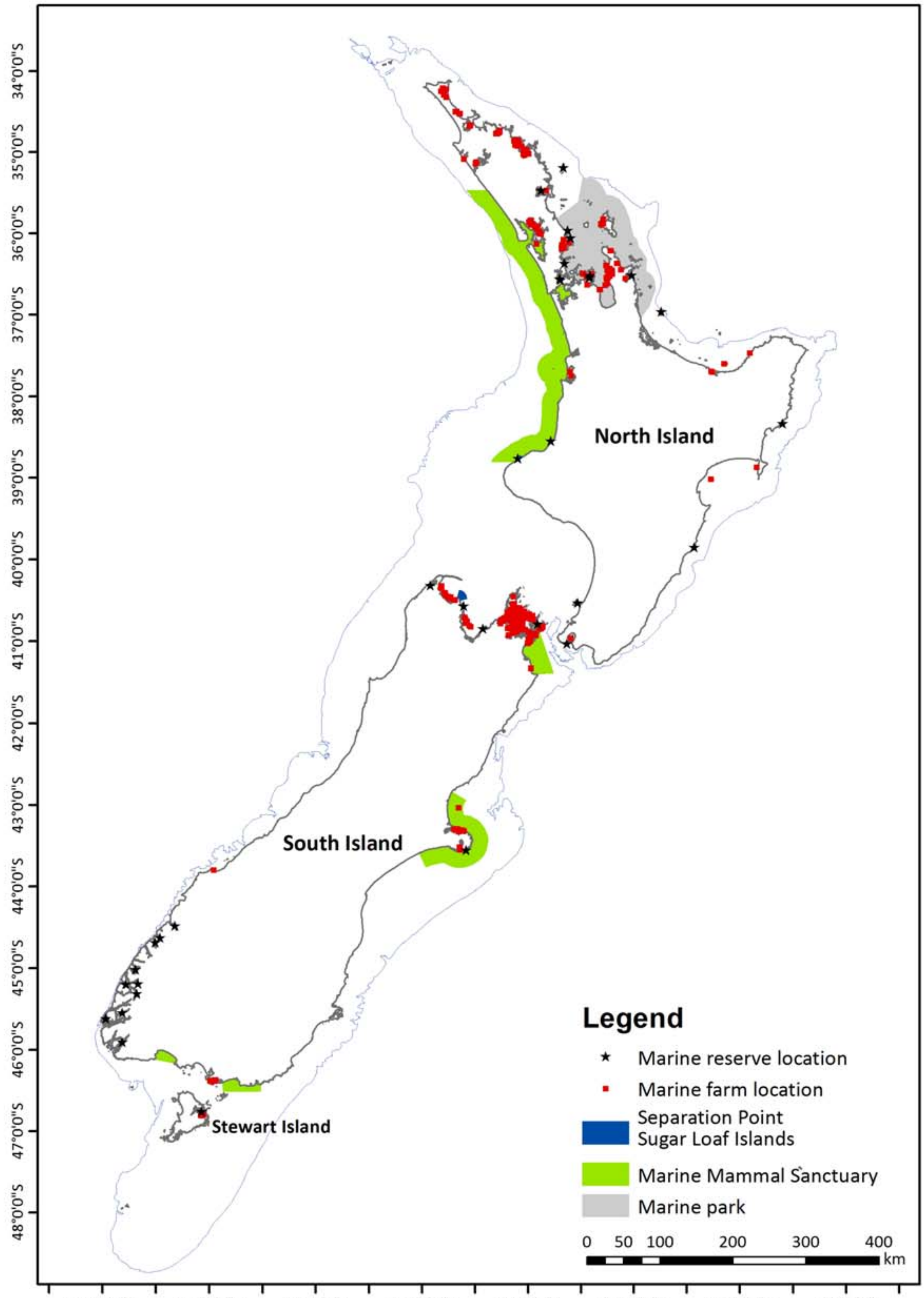

Figure 1.3: Points indicative of locations of marine reserves and marine farms, Separation Point and Sugar Loaf Islands closed areas, marine mammal sanctuaries, and marine parks, within the study area.

APPENDIX 2: MAPS SHOWING THE DISTRIBUTION OF THE DATA INPUTS FOR THE BENTHIC HABITAT DESCRIPTORS

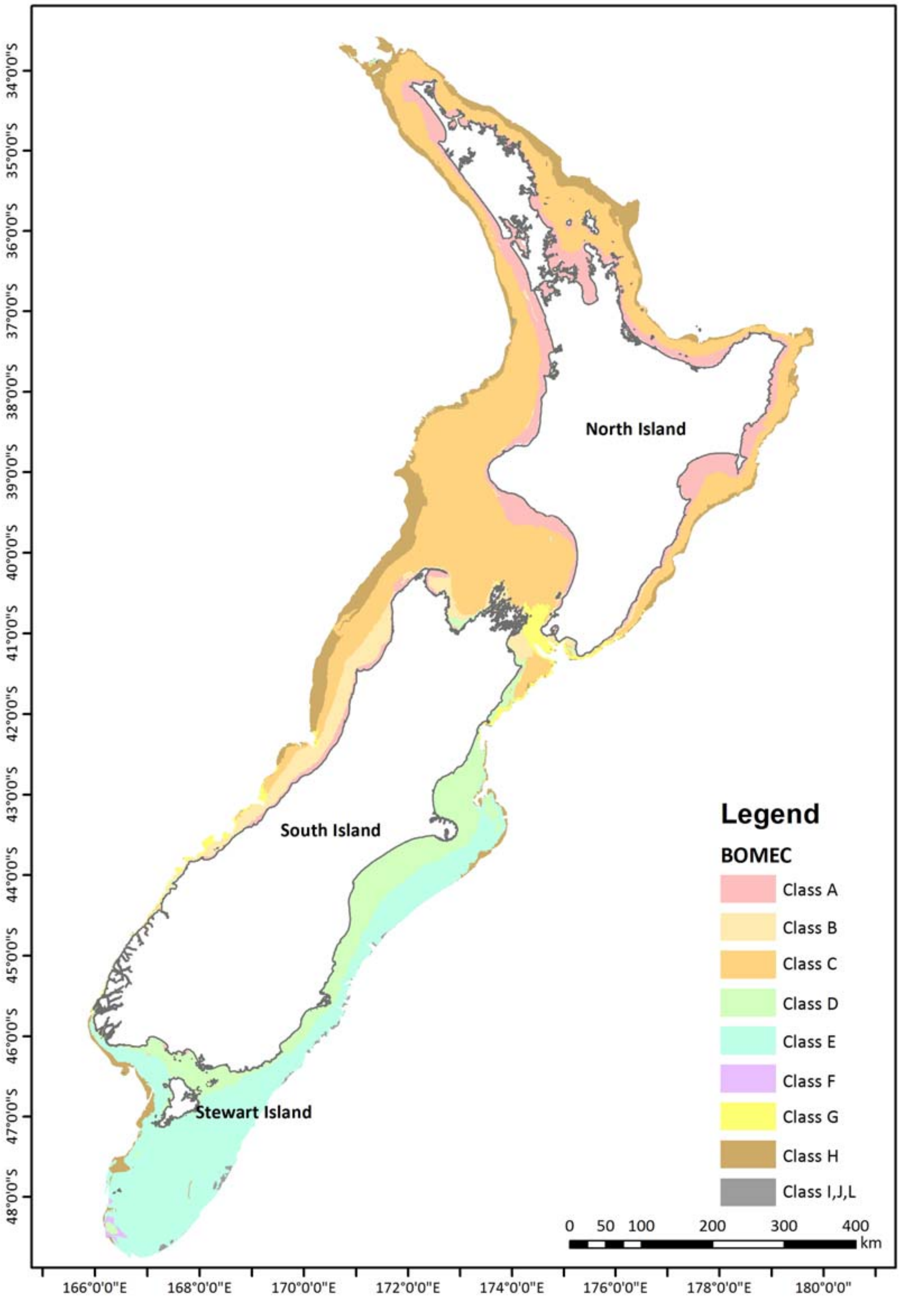

Figure 2.1: Distribution of BOMEC classes (see Leathwick et al. 2012) within the 250 m contour.

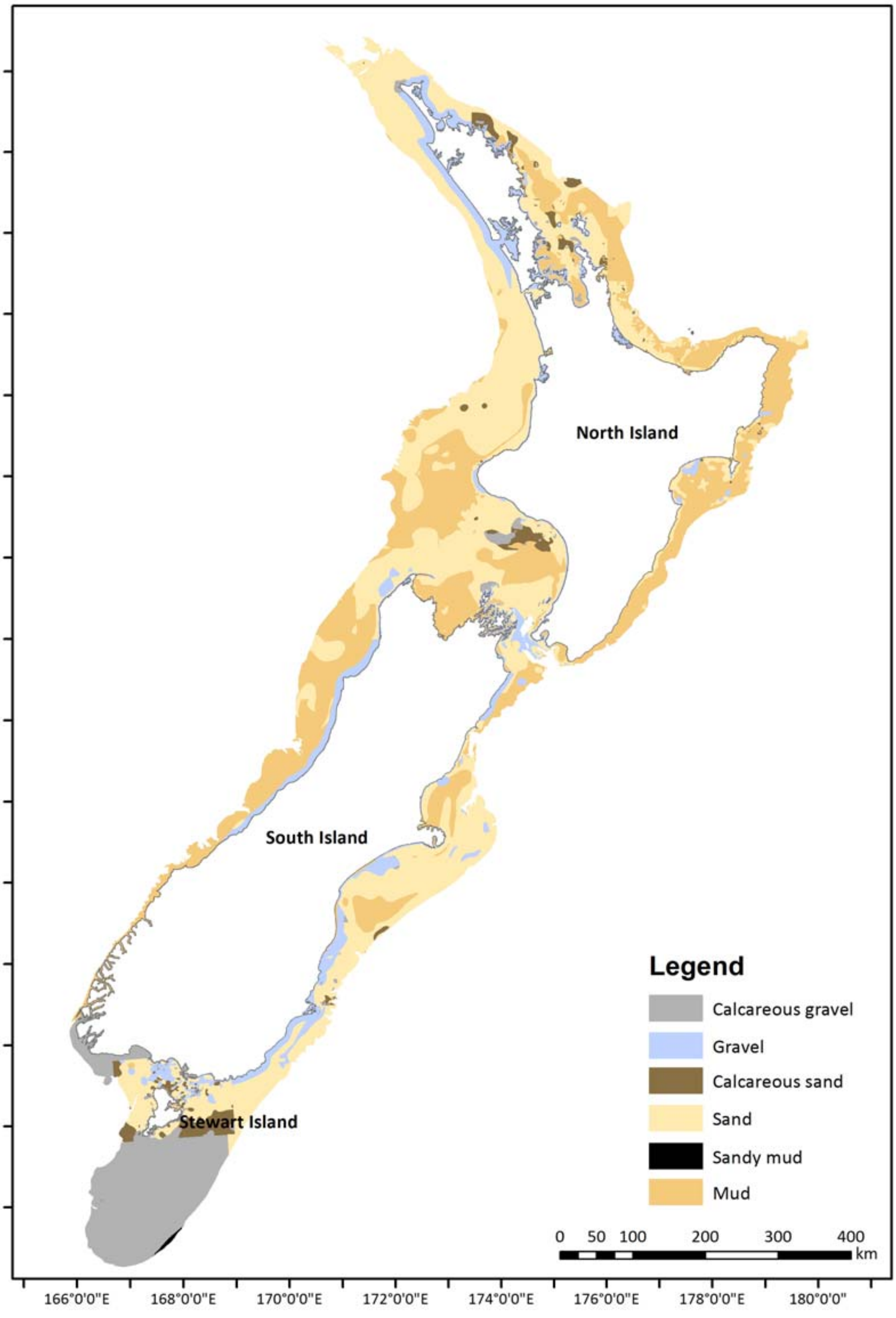

Figure 2.2: Distribution of broad sediment type (see appendix A in Leathwick et al. 2012) for derivation of this layer) within the 250 m contour.

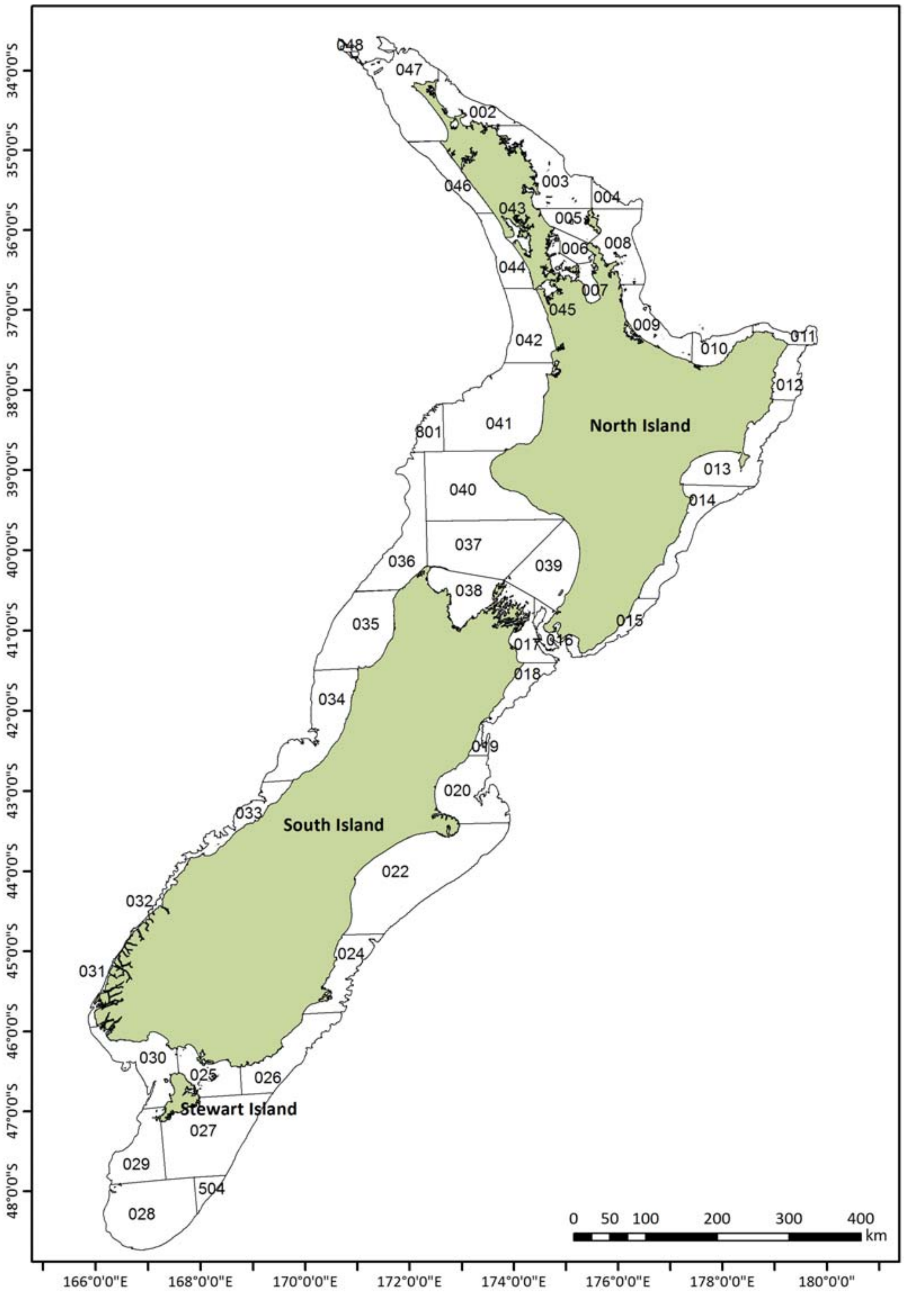

Figure 2.3: Statistical Areas within the 250 m contour.

Table 2.1: Coverage (km^2) of the seafloor for each BOMEC class by Statistical Area (Area code) and general region, where ecni is east coast North Island, ckst is Cook Strait, ecsi is east coast South Island, stew is Stewart-Snares shelf, wcsi is west coast South Island, tbgb is Tasman Bay-Golden Bay, and wcni is west coast North Island.

Region code	Area code	A	B	C	D	E	F	G	H	I	J	L	All
ecni	002	555	0	1 872	0	0	0	0	1 058	0	0	0	3 484
ecni	003	723	0	4 234	0	0	0	0	2 028	0	0	0	6 985
ecni	004	0	0	352	0	0	0	0	953	0	0	0	1 305
ecni	005	443	0	1 834	0	0	0	0	0	0	0	0	2 277
ecni	006	801	0	606	0	0	0	0	0	0	0	0	1 406
ecni	007	2 070	0	1	0	0	0	0	0	0	0	0	2 071
ecni	008	610	0	3 231	0	0	0	0	1 415	0	0	0	5 256
ecni	009	1 405	0	2 301	0	0	0	0	338	0	0	0	4 043
ecni	010	890	0	1 277	0	0	0	0	320	0	0	0	2 487
ecni	011	189	0	834	0	0	0	10	321	0	<0.1	0	1 354
ecni	012	719	0	1 471	0	0	0	0	410	0	<0.1	0	2 599
ecni	013	3 768	0	2 721	0	0	0	1	389	0	1	0	6 879
ecni	014	967	106	3 149	0	0	0	1	916	0	<0.1	0	5 139
ecni	015	201	204	574	25	0	0	324	213	0	1	0	1 542
ckst	016	54	296	173	120	0	0	987	41	0	3	0	1 674
ckst	017	66	1 563	989	210	0	0	674	5	0	0	0	3 506
ecsi	018	24	0	1 057	1 311	20	0	554	115	0	32	0	3 112
ecsi	019	0	0	0	0	0	0	0	0	0	<0.1	0	<0.1
ecsi	020	1	2	0	5 284	940	0	9	446	2	2	0	6 686
ecsi	022	0	0	0	8 689	8 182	0	2	464	24	0	0	17 361
ecsi	023	0	0	0	0	0	0	0	1	0	0	0	1
ecsi	024	6	0	0	2 426	1 934	0	0	0	101	0	0	4 466
stew	025	44	2	0	3 113	910	0	0	0	0	0	0	4 069
ecsi	026	17	0	0	1 386	4 384	0	0	0	200	0	0	5 986
stew	027	7	0	0	107	12 169	0	0	11	12	0	104	12 410
stew	028	0	0	0	195	9 556	380	0	123	106	0	20	10 379
stew	029	6	0	0	111	4 628	1	0	736	0	<0.1	3	5 485
stew	030	44	2	15	1 694	3 201	0	10	1 058	0	0	0	6 024
wcsi	031	6	4	8	185	112	0	148	68	0	5	0	535
wcsi	032	6	214	76	121	2	0	207	1	0	4	0	631
wcsi	033	362	1 855	186	16	0	0	720	8	0	5	0	3 152
wcsi	034	908	3 747	2 075	0	0	0	150	1 717	0	0	0	8 596
wcsi	035	442	2 371	4 006	1	0	0	0	2 053	0	0	0	8 873
wcsi	036	295	165	3 092	9	0	0	2	4 201	0	0	0	7 763
wcsi	037	463	58	11 004	17	0	0	3	0	0	0	0	11 545
tbgb	038	408	1 393	2 433	407	0	0	16	0	0	0	0	4 658
wcni	039	754	87	6 163	18	13	0	79	0	0	0	0	7 114
wcni	040	2 070	54	9 679	15	0	0	2	72	0	0	0	11 892
wcni	041	1 541	80	11 462	53	0	0	0	803	0	26	0	13 965
wcni	042	1 702	95	3 252	2	0	0	0	570	0	27	0	5 648
wcni	043	274	0	0	0	0	0	0	0	0	0	0	274
wcni	044	460	0	8	0	0	0	0	0	0	0	0	468
wcni	045	1 584	23	1 517	0	0	0	0	419	0	0	0	3 543
wcni	046	614	0	1 752	0	0	0	0	868	0	0	0	3 233
wcni	047	1 880	0	4 472	0	51	0	0	2 236	0	<0.1	0	8 639
wcni	048	0	0	0	0	0	0	0	432	0	25	0	457
wcni	204	0	0	0	0	0	0	0	19	0	0	0	19
wcni	504	0	0	0	0	1 085	0	0	0	29	0	62	1 176
wcni	801	0	0	1 687	0	0	0	0	380	0	1	0	2 068
All	All	27 375	12 319	89 560	25 513	47 187	382	3 898	25 204	473	134	189	232 235

APPENDIX 3: SENSITIVITY TO FISHING DISTURBANCE

Introduction

Definitions of vulnerability and sensitivity

The terms sensitivity, vulnerability and risk do not exist in a vacuum, instead they are threat and location-dependent. In risk assessment, the term threat (or "hazard") is used to describe an event that could cause an undesirable change in some response variable (e.g., value, service, organism, etc). The point at which the change occurs, or the magnitude of the change, is generally variable between organisms and the term *sensitivity* is often used to capture this variation. That is, organisms that exhibit greater response to a perturbation are more sensitive to it. A variety of definitions of vulnerability are used in the risk and natural hazards literature. In general terms, vulnerability is defined as the potential for harm or loss (Cutter et al. 2003) and is an interaction of the threat and the ability of the organism to respond.

The US EPA Framework for Cumulative Risk Assessment defines four properties of vulnerability, based on Kasperson et al. (1995). These are exposure, susceptibility, preparedness, and responsiveness. They define exposure as the threat and susceptibility (or sensitivity) as the differential likelihood of individuals, populations, or communities to respond adversely. Preparedness includes mechanisms or resources that can minimize harm at the time of exposure, and responsiveness is defined as the ability to recover from a response (equivalent to resilience (U.S. Environmental Protection Agency 2003)). Previous definitions of vulnerability include (Cutter 1996) the combination of (1) exposure, (2) response (sensitivity), and (3) location-specific components (these affect preparedness and responsiveness).

Within the framework of fisheries management, the topics of risk assessment and risk management are increasing in importance (Francis & Shotton 1997). Tuck et al. (2010) and Clark et al. (in revision) list a number of New Zealand and Australian studies (Fletcher 2005, Astles et al. 2006, Campbell & Gallagher 2007, Clark et al. 2011, Hobday et al. 2011, Richard & Abraham 2013), and similar approaches have also been developed elsewhere (e.g., Hiscock & Tyler-Walters 2006). These approaches generally focus on vulnerability (defined as "the susceptibility of a habitat, community or species to damage, or death (from an external factor)") and recoverability (defined as "the ability of a habitat, community or species to return to a state close to that which existed before the activity or event caused change" (Hiscock & Tyler-Walters 2006). An additional factor often considered in these assessments is representativeness and uniqueness: events affecting unique features or an area considered to represent a particular set of environments might be considered more serious than otherwise.

Due to difficutlies in gaining a consensus on the meaning of 'vulnerability' amongst stakeholders at an AEWG meeting (August 2013) and a further workshop, it was decided to focus this report on assessing sensitivity only, specifically in relation to bottom fishing by mobile gear. Sensitivity is defined as the susceptibility of an organism to damage, or death (from an external factor). Unlike Tuck et al. (2010), recoverability is not included in the definition for three reasons. Firstly, recoverability is highly location and threat extent dependent, driven by local hydrodynamics and the extent of the area under threat. Secondly, it is essentially a population level statistic rather than being associated with an organism. Thirdly, the biological traits that influence recoverability are generally not well known (reproductive cycle, dispersal mechanisms, and duration of larval viability). For this reason, it was decided to assess recoverability separately, by focussing on traits that would promote faster recovery.

Most mobile fishing activity occurs over sand and mud habitats (to avoid damage to fishing gear) and although, at first glance, these habitats may appear homogeneous, habitat-engineering activities of the organisms found there often make these systems highly heterogeneous and rich in species. Many of the habitat-forming species, as well as others that serve important functional roles in these seafloor ecosystems, are sensitive to physical disturbance because of biological traits associated with their morphology, life style, and ability to recolonise disturbed areas. Factors affecting sensitivity to disturbance include mobility (less mobile, more sensitive), body size (larger being more sensitive), and location (erect epifauna being more sensitive than infauna) (Thrush et al. 1998, Thrush & Dayton 2002, Tuck & Hewitt 2013). Biological trait analysis is increasingly used not only to assess sensitivity of an organism (e.g., de Juan et al 2009), but also to assess their importance to ecosystem functioning (Hewitt et al. 2008, Queirós et al. 2006, Villnäs et al. 2012). Within this report, sensitivity was defined by a set of biological traits reflecting best available knowledge of their response to disturbance following de Juan et al. (2009) and Hewitt et al. (2011) (see methods).

Methods

Habitat definitions

Initially it was hoped to be able to utilise information on the distribution of specific biogenic habitats and the recent coastal and marine classification developed by MPI and Department of Conservation (Ministry of Fisheries & Department of Conservation 2008). Highly structured, biogenic habitats are recognised as being very sensitive to disturbance by fishing gear, and some of these structuring taxa are also very slow to recover from disturbance. Sponges, corals, gorgonians, bryozoans, tube-worms, horse mussels, and sea grasses are all known to be sensitive to disturbance, but increasingly we are becoming aware of their importance as a focus for biodiversity and production, and as a nursery habitat for highly valued species of fish like snapper, tarakihi, and trevally (see Morrison et al. 2014a, 2014b). However these habitats, and the MPI/DOC classification, were considered at an AEWG meeting to be too subjective in definition to be used with confidence.

Species information and sensitivity assessment

Species data from two comprehensive sources were utilised: the MPI research trawl database *trawl* and NIWA's invertebrate collection database *specify*. For this study, each record represents the presence of a species; there is no measure of abundance. There are distinct differences in these records: differences in the methods of data collection, resolution of the location data, and taxonomic resolution.

Records from *trawl* represent catch during research trawl surveys primarily on RV *Kaharoa* and RV *Tangaroa* using several different types of bottom trawl gear (for example, see Bagley & Hurst 1996, Beentjes et al. 2013) that are used to target a group of fish species in defined depth zones at randomly stratified stations. Thus, such gear represent a non-specific method of catching benthic organisms over a trawl track of about 3 km length, over the seafloor where the ground gear and net can traverse without getting snagged or stuck on the seafloor. The location data of the *trawl* records are the start position co-ordinates for the vessel at the time when the net reaches the seafloor and starts fishing. Any invertebrate catch retained by the net is likely to only include part or whole organisms that are trapped in amongst the fish catch and thus retained in the cod-end, or caught up in netting. This catch is identified to the lowest taxonomic level possible by the survey science staff, weighed, and recorded. Some specimens are retained onboard and returned to NIWA for verification of identification or further taxonomic resolution by experts. The records for these specimens are updated in *trawl* to reflect the higher taxonomic resolution. During the years covered by this subset of the *trawl* database, there have been many improvements in the knowledge of science staff and this has resulted in better information being captured in more recent years.

Records from *specify* come from targeted sampling during biodiversity trips using gear such as shipek (bottom) grabs and small epibenthic sleds (for example, see Mitchell et al. 2009, Morrison et al. 2009a). The location data for each *specify* record represent the vessel location of where each sampling gear type is deployed. These gears may either take a grab from the sea floor or sample a small area of sea floor. The gear is designed to sample without too much damage to any organisms present. Once landed each specimen is identified to the highest taxonomic level and may be stored for the NIWA invertebrate collection or for further identification by experts.

Taxonomic resolution varies within and between each database, so from now the abbreviation OTU (operational taxonomic unit) will be used. There were 141 OTUs in the *trawl* database and 717 in *specify*, with 52 being in common.

Summary data for the two database sources are given in Table 3.1. [The full dataset is given at the end of this section in Appendix 3a.] The spatial distribution of the database records is shown in Figure 3.1. Records from both databases span the full extent of the shelf waters around the main islands, with *specify* records in higher numbers to north-east New Zealand and Hawke Bay, Cook Strait, and Foveaux Strait. *Trawl* records were generally towards the shelf edge where present near the North Island and across the shelf waters of the South Island with greater density of records off the west and east coasts and in Tasman Bay-Golden Bay.

OTU sensitivities were assessed in two ways. Firstly, New Zealand and international information on species/taxonomic groups was collated. International information came from the Marine Life Information Network MarLIN database (MarLIN 2005, Hiscock & Tyler-Walters 2006). MarLIN lists many potential effects of trawling and dredging, namely abrasion and physical disturbance, changes in nutrient levels, changes in oxygenation, smothering, displacement, selective extraction of non-target and target species, and substratum loss. To be conservative, we did not use information on sensitivity related to changes in nutrient levels, changes in oxygenation, smothering, or selective extraction of non-target and target species. Selective extraction of target species is of course highly location dependent and any taxa reported in the *trawl* database could be considered to be highly sensitive.

Table 3.1: Number of records used, number of different taxonomic levels represented, number of records per depth zone, earliest and most recent year sampled, and the geographic extent, for each data source.

Number	*Specify*	*trawl*
Records	2 720	3 921
Class	33	19
Order	92	48
Family	292	80
Genus	447	91
Species	423	80
< 50 m	944	621
50–100 m	820	639
100–250 m	956	2661
Min., max. year	1947–2010	1961–2013
Latitude extent	33.9°–48.9° S	34.3°–48.8° S
Longitude extent	166.3°–179.0° E	166.3°–178.8° E

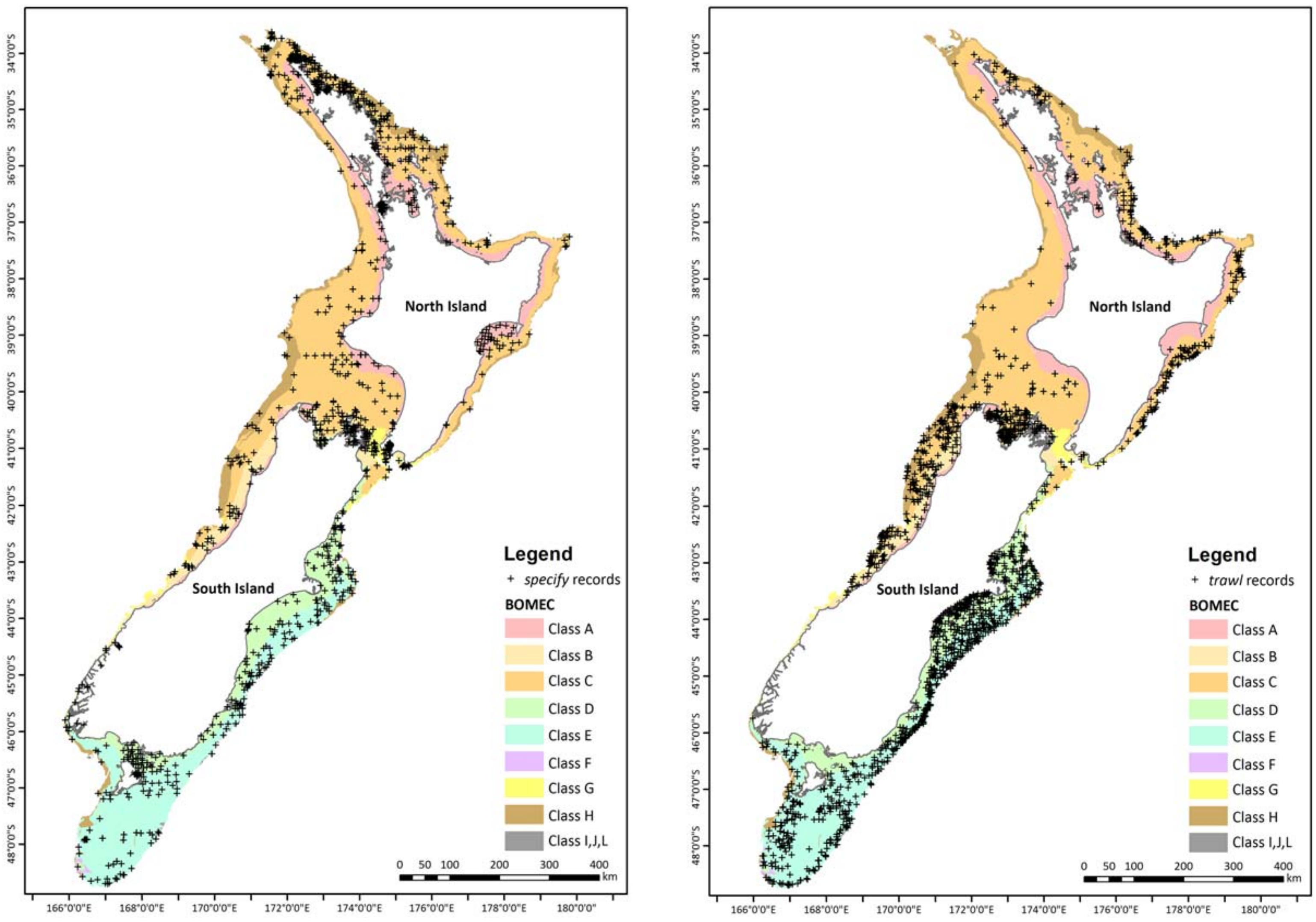

Figure 3.1: Locations of *specify* data records (left) and *trawl* data records (right) in relation to the 11 BOMEC classes within the 250 m contour.

Secondly, biological traits of species (and other levels of OTU) that drive sensitivity to mobile bottom fishing activities were determined. The set of traits used were determined from the literature of fishing impacts and are given in Table 3.2. After Hewitt et al. (2011), the traits used are an abbreviated list. Many functionally important attributes such as size, age, rarity, and density are not included, for a number of reasons: (a) information on these attributes was very limited; (b) the information would need to be spatially explicit and thus not fit into a general framework; or (c) they were more related to recoverability than sensitivity.

Table 3.2: Biological traits used to assess sensitivity to a bottom trawl or dredge. Note that potential problems with imprecision in definitions is dealt with by use of probabilities.

Category	Trait	Definition
Living position	Erect	Protrudes above the sediment surface > 4 cm
	Surface	On the sediment surface, but not protruding
	Top 2 cm	Lives in the sediment down to 2 cm deep
	> 2 cm deep	Lives > 2 cm deep in the sediment
Fragility	Very fragile	Breaks easily into many pieces
	Moderately	Harder to break, may be torn out
	Robust	Does not break or get torn up by passage of something rolling
Mobility	Sedentary	Does not move
	Limited Mobility	Crawls small distances across or through the sediment
	Highly mobile	Crawls large distances across the sediment surface or swims

The traits used by Hewitt et al. (2011) form a set that correspond to the likely sensitivity of species to bottom trawling. Because depth of disturbance is crucial to the sensitivity of many organisms, in this study we used three levels of sensitivity.

1. Level 1 is sensitive to trawling that does not scrape the surface of the seafloor and this level comprises erect species that are sedentary and very fragile.
2. Level 2 sensitivity will be moderately affected by trawling and comprises species living on the seafloor that are very or moderately fragile with limited or no mobility.
3. Level 3 sensitivity has low sensitivity to trawling, but will be affected by dredging. This level comprises species that live very close to the surface of the seafloor (though not on it), are not robust, and have limited mobility.

Dredging (for example, scallop dredging) will affect all three levels. This reasoning is supported by a meta-analysis of fishing impacts which found the most severe impacts occurring in biogenic habitats in response to scallop dredging (Kaiser et al. 2006).

To determine habitat class composition, a category of those that may respond positively is also included. For instance, if the scale of the fishing activity is less than the distance mobile predators and scavengers can readily move, these species can move into the disturbed area and take advantage of the short term increase in food resources provided by damaged organisms (Collie et al. 1997, de Grave & Whitaker 1999). All others not classified as sensitive or responding positively were considered neutral in response.

Some simplifying assumptions were made. The area disturbed at any one time was considered to be small enough to allow mobile predators to migrate into the area to utilise a new food resource and the rate of disturbance propagation across the surface of the seafloor was slow enough to allow highly mobile fauna to escape. We did not consider far-field effects associated with the production of sediment plumes that affect the feeding activity of organisms beyond the immediate area of impact because this will be highly location- and activity-dependent.

When information for the OTU was unknown, the OTU was assigned an equal probability of displaying all behaviour types. For example, if the mobility was unknown, the OTU was equally allotted to limited and high mobility categories (see Hewitt et al. 2008). If feeding mechanism or habit was unknown, the OTU was equally allotted to all possible traits. Some species also automatically fall into a number of categories. For example, tube worms may be erect, living on the sediment surface, or deeper in the sediment. For this situation, we also allot equal probabilities to all behaviour. Finally, marine species are also often plastic in their behaviour; that is, they can exhibit different behaviours depending on environmental conditions. For example, deposit feeders may also be suspension feeders or scavengers. For this situation, the probabilities allotted reflect the frequency with which they have been observed using the different behaviours. Imprecision in the trait definitions are also dealt with in this way. The likely effect of incorrect allocation of organisms to traits is not explicitly tested here, but it is generally low (Hewitt et al. 2008, Hewitt et al. 2011).

Habitat class sensitivity

Although manipulative experiments provide the most direct examination of sensitivity of areas to disturbances, such studies have only been conducted in a limited number of areas and are difficult to conduct in meaningful ways for large-scale or repetitive disturbances. Recently, ecologists have focussed on linking biological traits of species to characteristics of specific disturbances as a method of assessing sensitivity. Such methods are applicable across a wide range of habitats and regions where detailed species-specific knowledge or experimental data are not available (de Juan et al. 2009, Tyler-Walters et al. 2009).

The techniques considered to assess habitat sensitivity were based on the Chatham/Challenger Oceans Survey 2020 study, which used three methods to assess sensitivity (Hewitt et al. 2011).

1. Habitat sensitivity as defined by Tyler-Walters et al. 2009. The sensitivity of a site is defined as the sensitivity of the most sensitive taxa that characterise the habitat class that the site belongs to (called the "worst-case scenario"). Hewitt et al. (2011) observed this technique to lack the ability to discriminate between habitat classes on the Chatham Rise and Challenger Plateau.
2. Site sensitivity depending on the average sensitivity of individuals in a sample. Average sensitivity was calculated by multiplying the rank sensitivity value of a taxon by the abundance of each taxon at a given site and summing these values over all taxa at the site (e.g., Stark & Maxted 2007). Using this method, Hewitt et al. (2011) then calculated a weighted average for that site by dividing that sum by the number of taxa found at that site. This technique was not appropriate for the data used in this study because the data were not truly quantitative and only presence/absence information was available.
3. Number of taxa observed at a station within each of the five sensitivity levels. This was derived by summing the probability of each taxon exhibiting behaviour that placed it within each level. Habitat sensitivity thus becomes the average sensitivity of all the stations for which we had information within that habitat class.

For this study, because there was limited information on abundance, we used technique 3. For each site, we calculated the number of OTUs occurring in the three levels of sensitivity, the neutral, and the positive categories. For each site, each OTU was assigned to one of the five categories, in the following hierarchical way (Figure 3.2).

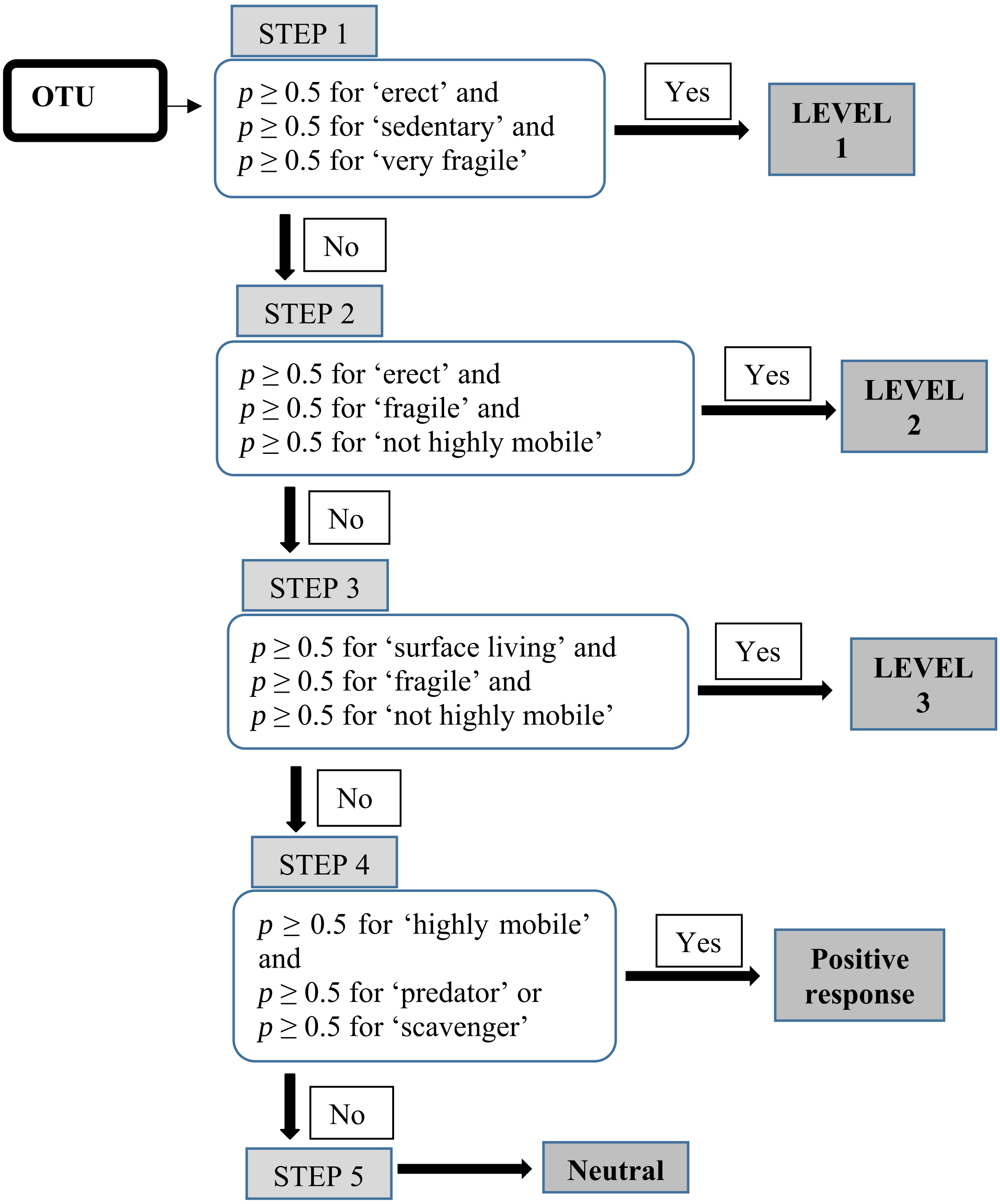

Figure 3.2: Illustration of the methods used assign sensitivity. Note that 'fragile' = 'very fragile' + 'moderately fragile'; 'not highly mobile' = 'limited' + 'no mobility'; and 'surface living' = 'not living deeper than 2 cm'.

Assessment of variability (or uncertainty) associated with the sensitivity value assigned to each habitat class is derived from two sources (i) the number of stations in each habitat class, with an increasing number of stations lowering the uncertainty, and (ii) the variability around the mean value for each habitat class. A further assessment could be based on the differences between ranks assigned by using *specify* data compared with *trawl* data to define sensitivity.

Recoverability assessment

Assessment of recoverability was based on biological traits associated with dispersal and reproductive frequency as representative of the potential for species to recolonize areas given appropriate hydrodynamics. Three traits of reproductive frequency were used: semelparous; iteroparous; and semi-continuous. Obviously a species that has semi-continuous reproduction has a greater chance of recolonising an area than one that only produces for a short time period most years (iteroparous) and one that only reproduces once in its life (semelparous). Development type is also important. Species that reproduce by fragmentation or by larvae that can feed in the water column (planktotrophic) are more likely to colonise an area than those that produce planktonic larvae that cannot feed (lecithotrophes) or those that are direct brooders. However, many species can also disperse as juveniles by swimming, rafting, or drifting. Finally, species that are highly mobile as adults are most likely to be able to recolonise a disturbed area. OTUs were allocated to six recovery categories as follows:

1. Recovery 5 (high): adults highly mobile;
2. Recovery 4: semi-continuous reproduction with planktotrophic larvae (note only one OTU fitted this category);
3. Recovery 3: semi-continuous reproduction with lecithotrophic larvae;
4. Recovery 2: iteroparous reproduction with planktotrophic or lecithotrophic larvae, or highly mobile juveniles;
5. Recovery 1: juveniles or adults able to crawl;
6. Recovery 0: not in any of the above categories; sessile adults and juveniles, with reproduction by brooding.

This information was gathered from a number of different sources, but in most cases species level information was not available, so an index of uncertainty was developed using information from other taxonomic levels. Information from another species in the same genus was considered to be "certain"; from within a family or order was considered "certain" if a number of species had all been described with the same characteristics; and information from within a class was always considered "uncertain". There were also a number of OTUs for which we could not find the relevant information.

For 44% of the OTUs we knew that adult mobility was high, for 13% we had "certain" knowledge of other characteristics, for 35% this knowledge was "uncertain", and for 7% there was no information (Table 3.3). Of the OTUs found in both databases, 31 were OTUs with highly mobile adults, 4 we were "certain" of the other characteristics, 13 we were "uncertain" of, and 4 we had no information about. Of the OTUs found in only the *specify* database, 285 were OTUs with highly mobile adults, 93 we were "certain" of the other characteristics, 247 we were "uncertain" of, and 41 we had no information about. Of the OTU found in only in the *trawl* database, 46 were OTUs with highly mobile adults, 7 we were "certain" of the other characteristics, 29 we were "uncertain" of, and 16 we had no information about.

Table 3.3: Summary of the state of knowledge for the OTUs in the two databases giving the number and proportion of OTUs in each information category.

	All OTUs		OTU in both databases		*specify* only		*trawl* only	
	No.	Prop.	No.	Prop.	No.	Prop.	No.	Prop.
Certain	359	0.44	31	0.60	285	0.43	46	0.47
Knowledge of other species characteristics	106	0.13	4	0.08	93	0.14	7	0.07
Uncertain	286	0.35	13	0.25	247	0.37	29	0.30
No information	57	0.07	4	0.08	41	0.06	16	0.16

Statistical analyses

Database differences

The first step in the analysis was to establish whether the sensitivity determined for the habitat classes differed between the two record types (*specify* and *trawl*) because the two database sources contained data collected by very different methods, particularly in terms of spatial scale. For this, the number of taxa in each sensitivity level across all stations was analysed using multivariate ordination. A two-way

Permanova (Anderson 2001) in Primer E (Clarke & Gorley 2006) based on Bray-Curtis similarities was run, using a fixed factor ("habitat" as represented by BOMEC class) with "database" nested within "habitat".

Species-based characterisation of habitats

The Primer E software SIMPER (Clarke & Gorley 2006) was then used to determine the species that characterised different habitat classes, again based on Bray-Curtis similarities. A separate SIMPER was run for *specify* records and for *trawl* records.

Sensitivity-based characterisation of habitats

SIMPER was also used to determine the sensitivity levels that characterised different habitat classes\s, again based on Bray-Curtis similarities. A separate SIMPER was run for *specify* records and for *trawl* records.

Differences in sensitivity between habitats

The significance of differences between habitats in sensitivity level was determined using Generalised Linear Modelling, based on a Poisson distribution and a log-link function. Where over or under dispersion occurred, a quasi-likelihood function was used. For each response variable (high, medium, and low sensitivity) the following models were run:

1. One-way fixed factor (BOMEC class) for all stations in the two database types separately.
2. One-way fixed factor (depth band) for each of three BOMEC classes which had more than 10 stations in two or more depth bands in the two database types separately.
3. One-way fixed factor (sediment type) for each of three BOMEC classes which had more than 10 stations in four or more sediment types in the two database types separately.
4. One-way fixed factor (BOMEC class) for each of four statistical reporting areas which had more than 10 stations in two or more BOMEC classes in the two database types separately.

The second and third analyses were run to investigate whether there was any consistency in sensitivity within BOMEC class related to depth or sediment type. The final analysis investigated whether there were likely to be differences associated with habitats, defined as BOMEC classes, within statistical reporting areas. For all these analyses, when significant results (probability of achieving a result as extreme by chance was less than 0.05) were detected, the magnitude of the difference was calculated as the difference between averages.

5. Finally, there were 108 different BOMEC class, depth band, sediment type combinations. Of these, 23 combinations had more than 10 sites sampled from both the *specify* and *trawl* databases (Table 3.4). For these combinations we tested whether there were differences in the proportion of OTUs: sensitive to a disturbance that comes occasionally in contact with the seafloor (Level 1 sensitivity); sensitive to a disturbance that drags across the seafloor (Levels 1 and 2); and a dredge type disturbance (Levels 1, 2, and 3).

Differences in recovery between habitats

Because of the limited certainty related to the estimates of recovery, only the equivalent of the analysis detailed in 5 above was run. Differences in the proportions of high recovery (recovery 5), moderate recovery (recovery 2 and 3), and low to no recovery (recovery 0 and 1) from the different BOMEC class/depth zone/sediment type combinations were analysed using a one-way fixed factor Generalised Linear Model.

Table 3.4: Combinations of BOMEC class/ depth zone/ sediment type with more than 10 sample sites in both *specify* and *trawl* databases. Number of sample sites is given. CGravel is calcareous gravel and CSand is calcareous sand.

			No. sampling stations per database	
BOMEC class	Depth zone	Sediment type	*specify*	*trawl*
A	shallow	Gravel	99	13
	shallow	Mud	33	13
	shallow	Sand	72	21
B	deep	Mud	13	22
	shallow	Gravel	20	22
	shallow	Mud	33	60
	shallow	Sand	12	15
C	deep	Mud	45	151
	deep	Sand	62	50
	mid	Mud	36	34
	mid	Sand	104	33
D	mid	Mud	10	18
	mid	Sand	19	61
	shallow	Gravel	56	65
	shallow	Mud	199	39
	shallow	Sand	32	105
E	deep	CGravel	36	176
	deep	CSand	10	19
	deep	Sand	49	205
	mid	Sand	37	82
G	deep	Mud	23	17
H	deep	Mud	42	122
	deep	Sand	66	68

Results

Distribution of data within BOMEC classes

Although 11 BOMEC classes occur within the 250 m depth contour, only 7 contained more than 10 *specify* stations, and 8 contained more than 10 *trawl* stations (Table 3.5). BOMEC classes F, J, and L were not well sampled by either the *trawl* or the *specify* data.

Information on the distribution of depth bands and sediment classes within the BOMEC classes is given in Table 1. BOMEC classes A, C, and E were selected for detailed analysis with respect to depth zone and sediment type differences based on the number of stations sampled within them and the area they covered.

Table 3.5: Number of *specify* and *trawl* stations in each BOMEC class.

BOMEC class	*specify*	*trawl*
A	234	54
B	91	156
C	353	323
D	348	311
E	158	537
F	1	1
G	50	23
H	119	196
I	9	19
J	1	0
L	1	6

Four Statistical Areas, with varying degrees of fishing intensity (see Section 4 and Table 4.5 in Appendix 4), that covered more than two BOMEC classes were selected for detailed analysis: 047 (n = 2209 tows), 020 (n = 480 tows), 024 (n = 401 tows), and 022 (n = 3112 tows) (see Figure 2.3 in Appendix 2 for location of Statistical Areas). Note that the numbers of tows given for these Statistical Areas are for only the parts of those areas that lie within the study area, for the fishing years 2007–08 to 2011–12.

Database differences

The *specify* records comprised 665 OTUs that were not in the *trawl* records, and 90 OTUs were found only in the *trawl* records. Another 52 OTUs were found in both record database sources. The lower number of taxa found in the *trawl* data may be due to the lower taxonomic resolution used for some records in the *trawl* database (e.g., porifera, crab), particularly from earlier years when identification guides were still being developed, as well as the different collection methods.

The percentage of records from each of the two databases assigned to the sensitivity levels is given in Table 3.6. For the *specify* data, there was little consistency across stations in which OTUs represented the three sensitivity levels, with no OTU present in more than 10% of stations (Table 3.7). This was most obvious for the Level 1 sensitivity with the OTU most frequently present being *Callyspongia* at 1.5% and least for Level 2 being *Neothyris lenticularis* at 5.1%.

There was somewhat more consistency for the *trawl* data. For levels 1 and 2, a single taxon did occur in more than 10% of stations ("sponge" at 20.9% for Level 1 and *Stichopus mollis* at 16.6% for Level 2, Table 3.8). Although Level 3 did not have any OTUs occurring at more than 10% of the stations, it did have a number that occurred at more than 1%. An overall difference in the sensitivity composition of the different databases within the BOMEC classes was detected (p = 0.001). For this reason all the following analyses were conducted on each database separately.

Table 3.6: Percentage of *specify* and *trawl* records that were assigned to each sensitivity level.

Sensitivity	*specify* (%)	*trawl* (%)
Level 1	14.8	24.1
Level 2	32.4	26.1
Level 3	24.1	31.1
Neutral	21.9	22.9
Positive response	42.0	57.8

Table 3.7: Operational taxonomic units (OTU) important in defining the 3 levels of sensitivity that occurred at more than 1% of *specify* stations.

Level 1		Level 2		Level 3	
OTU	%	OTU	%	OTU	%
Callyspongia	1.5	*Neothyris lenticularis*	5.1	*Astropecten polyacanthus*	2.5
Crella incrustans	1.0	C. Hydrozoa	2.4	P. Polychaeta	2.3
		Calloria inconspicua	2.3	F. Calanidae	2.1
		C. Ascidiacea	1.8	C. Bivalvia	2.1
		Notosaria nigricans	1.4	*Peronella hinemoae*	1.5
		Heterothyone alba	1.1	*Psilaster acuminatus*	1.1
		O. Hydroida	1.0	*Astromesites primigenius*	1.0
		Lytocarpia chiltoni	1.0		
		Amphisbetia	1.0		

Table 3.8: Operational taxonomic units (OTU) that occurred at more than 1% of *trawl* stations important in defining the three levels of sensitivity.

Level 1		Level 2		Level 3	
OTU	%	OTU	%	OTU	%
Sponge (P. Porifera)	20.9	*Stichopus mollis*	16.6	*Sclerasterias mollis*	9.4
Callyspongia	1.6	C. Anthozoa	8.0	C. Asteroidea	7.6
Coral	1.3	Ascidiacea	6.8	*Zygochlamys delicatula*	7.0
		P. Bryozoa	2.5	*Pseudechinus huttoni*	4.4
		C. Hydrozoa	1.6	F. Hormathiidae	4.2
		Celleporina grandis	1.3	F. Actinostolidae	3.8
		O. Pennatulacea	1.1	*Aglaophenia acanthocarpa*	3.4
				Mesopeplum convexum	2.8
				Pecten novaezelandiae	2.5
				Bunodactis chrysobathys	2.3
				Ostrea chilensis	2.3
				Perna canaliculus	2.1
				Odontaster	1.7
				Pteraster bathamae	1.6
				C. Echinoidea	1.4
				Psilaster acuminatus	1.2
				Atrina zelandica	1.2
				Polychaeta	1.1
				Echinoderms	1.1

OTU-based characterisation of habitat classes

OTUs characterising the BOMEC classes were never similar in *specify* and *trawl* data (Tables 3.9 and 3.10). For example, using the *specify* data, class A was characterised by *Astropecten polyacanthus*, Order Decapoda, *Echinocardium cordatum*, and *Pontophilus australis*. Using *trawl* data, class A was characterised by Class Anthozoa, *Jasus edwardsii*, *Ovalipes catharus*, and Phylum Porifera.

A few OTUs were important in characterising more than one class. For example, using *specify* data, *Echinocardium cordatum* characterised classes A, B, and D, and using *trawl* data, *Stichopus mollis* characterised classes D, E, and I.

The only species that was found in the MarLIN database was *Echinocardium cordatum*, which was classified as having moderate sensitivity to abrasion and physical disturbance and substratum loss, with a high to moderate degree of certainty.

Table 3.9: Habitat composition based on each Operational Taxonomic Unit (OTU) for the *specify* data, with the contribution to group similarity from SIMPER.

BOMEC class	OTU	Average number of OTU	Contribution (%)
A	*Astropecten polyacanthus*	0.10	33.89
	Pontophilus australis	0.06	14.10
	O. Decapoda	0.07	13.52
	Echinocardium cordatum	0.06	11.65
B	*Echinocardium cordatum*	0.24	82.51
C	O. Decapoda	0.14	35.60
	Peronella hinemoae	0.05	5.85
D	*Echinocardium cordatum*	0.42	93.47
E	*Neothyris parva*	0.08	8.41
	Callyspongia	0.06	6.59
	Neothyris lenticularis	0.20	58.72
	Leptomithrax longipes	0.09	11.04
G	*Thacanophrys filholi*	0.10	9.34
	Liothyrella neozelanica	0.08	8.98
	Cryptolaria prima	0.06	5.67
	Notosaria nigricans	0.10	23.65
	Nemertesia elongata	0.08	13.51
	Calloria inconspicua	0.08	12.55
	F. Calanidae	0.06	10.86
H	O. Decapoda	0.13	29.82
	Leptomithrax longipes	0.04	6.14
	Caryophyllia profunda	0.04	5.13
	F. Calanidae	0.04	9.45
	Psilaster acuminatus	0.05	6.99

Table 3.10: Habitat composition based on each Operational Taxonomic Unit (OTU) for the *trawl* data.

BOMEC class	OTU	Average number of OTU	Contribution (%)
A	P. Porifera	0.67	65.63
	C. Anthozoa	0.50	23.06
	Ovalipes catharus	0.35	72.51
	Jasus edwardsii	0.15	11.87
B	C. Ophiuroidea	0.16	33.83
	Pecten novaezelandiae	0.13	10.88
	Perna canaliculus	0.12	10.24
	Jasus edwardsii	0.08	8.34
	Ovalipes catharus	0.08	7.03
	Ostrea chilensis	0.11	6.74
C	*Ibacus alticrenatus*	0.37	79.09
	P. Porifera	0.17	10.02
D	*Ovalipes catharus*	0.31	66.48
	Crab [O.Decapoda]	0.16	12.06
	Stichopus mollis	0.16	7.91
E	P. Porifera	0.42	35.35
	Crab [O.Decapoda]	0.36	26.81
	Stichopus mollis	0.33	14.37
G	*Ibacus alticrenatus*	0.35	75.68
	Metanephrops challengeri	0.17	16.22
H	*Ibacus alticrenatus*	0.70	91.66
I	P. Porifera	0.74	21.93
	Crab [O.Decapoda]	0.63	15.87
	C. Asteroidea	0.53	7.52
	Zygochlamys delicatula	0.53	6.46
	Pseudechinus huttoni	0.53	6.46
	Sclerasterias mollis	0.53	6.46
	Stichopus mollis	0.53	6.46
	C. Ascidiacea	0.53	6.46

Sensitivity-based characterisation of habitat classes

BOMEC classes based on *specify* data did not form distinct clusters in the multivariate space (Figure 3.3); instead they demonstrated high variability in composition based on sensitivity levels. The category most important in classifying the classes was the positive response level, contributing 25–58% of the similarity in all 7 classes (Table 3.11). Sensitivity level 2 was the next most important, contributing 14–58% of the similarity in 5 classes, and sensitivity level 3 was next, contributing 8–26% of the similarity in 5 classes.

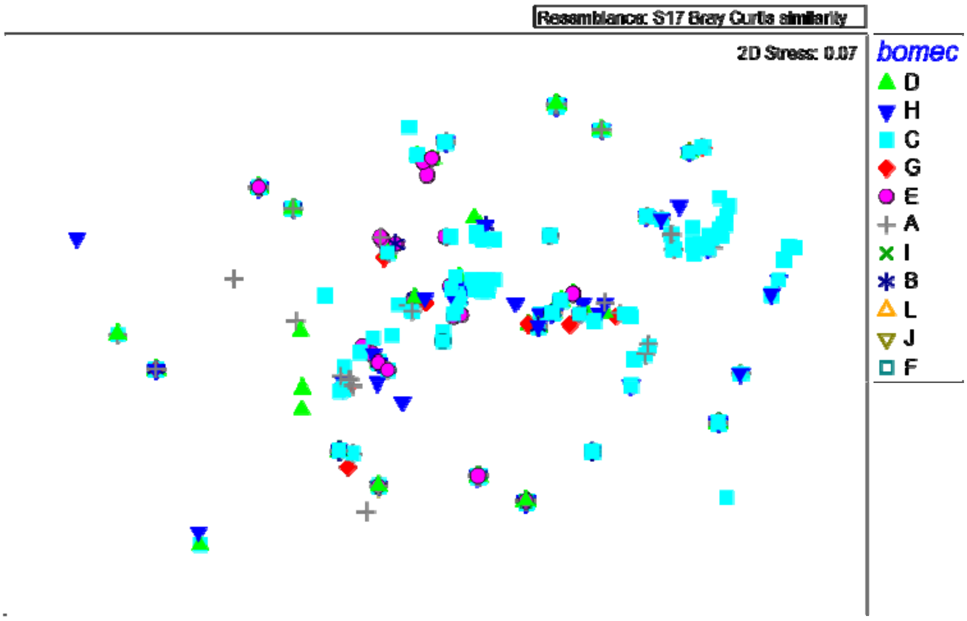

Figure 3.3: Nonmetric multidimensional scaling ordination of sensitivity observed in the *specify* data. Points closest together are most similar and stress values < 0.1 mean that the 2-dimensional plot is a good representation of the similarities.

Table 3.11: Composition based on sensitivity levels for the *specify* data. The average OTU count is the average sum (across OTUs at a site) of the probabilities of OTUs being at that sensitivity.

BOMEC classes	Sensitivity	Average OTU count	Contribution (%)
A	Positive	0.62	58.15
	Level 3	0.33	25.59
	Neutral	0.21	8.02
B	Positive	0.42	39.48
	Neutral	0.35	37.51
	Level 2	0.29	14.45
C	Positive	0.64	34.67
	Level 2	0.68	32.92
	Level 3	0.48	15.56
	Level 1	0.87	15.41
D	Neutral	0.52	64.43
	Positive	0.4	25.81
E	Positive	0.58	42.94
	Level 2	0.57	37.86
	Level 3	0.35	15.31
G	Level 2	0.72	58.22
	Positive	0.66	29.39
	Level 3	0.2	7.58
H	Positive	0.74	44.77
	Level 2	0.59	26.85
	Level 3	0.4	20.29

BOMEC classes based on *trawl* data also did not form distinct clusters in the multivariate space (Figure 3.4); instead they demonstrated high variability in composition based on sensitivity levels. The category most important in classifying the classes was again the positive response level, contributing 20–99% of the similarity in all 8 classes (Table 3.12). Sensitivity level 3 was the next most important, contributing 11–51% of the similarity in 5 classes, and sensitivity level 2 was next, contributing 6–20% of the similarity in 3 classes.

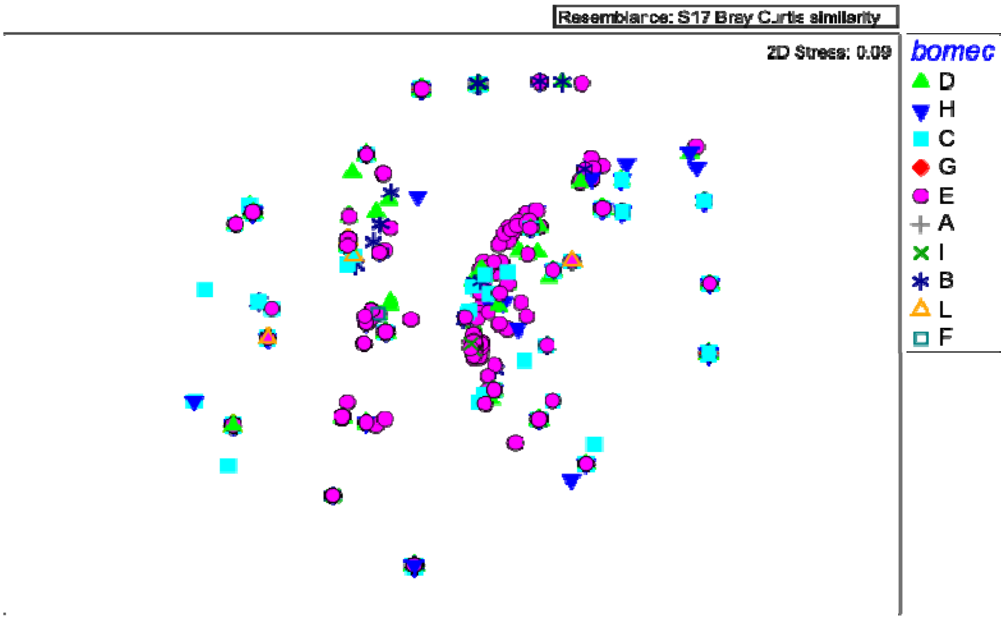

Figure 3.4: Nonmetric multidimensional scaling ordination of sensitivity observed in the *trawl* data. Points closest together are most similar and stress values < 0.1 mean that the 2-dimensional plot is a good representation of the similarities.

Table 3.12: Composition based on sensitivity levels for the *trawl* data. The average OTU count is the average sum (across OTUs at a site) of the probabilities of OTUs being at that sensitivity.

BOMEC classes	Sensitivity	Average number of OTU	Contribution %
A	Positive	0.56	74.40
	Level 3	0.41	24.31
B	Level 3	0.69	50.91
	Positive	0.49	43.06
C	Positive	0.79	86.64
D	Positive	0.70	74.53
	Level 3	0.37	11.73
	Level 2	0.28	6.02
E	Level 1	0.45	22.13
	Positive	0.90	21.67
	Level 2	0.78	19.97
	Level 3	1.27	18.37
	Neutral	0.41	17.85
G	Positive	0.87	99.48
H	Positive	1.24	95.69
I	Level 3	3.21	30.57
	Positive	1.68	20.24
	Level 2	1.79	17.93
	Level 1	0.74	16.56
	Neutral	0.95	14.69

Differences in sensitivity between habitat classes, based on *specify* data

Site values within BOMEC classes for sensitivity levels 1–3 ranged from 0 to a maximum of 12, 6, and 5 respectively. BOMEC class C followed by class H had significantly higher values of sensitivity level 1 taxa than the other classes, with class D having the lowest values. The sensitivity level 1 value for class C was more than double that for class H (Figure 3.5), which was over double that of the next highest class (class A). Classes C and H also belonged to the cluster of classes with high values of sensitivity level 2, along with class E and G. Classes C, H, and E belonged to the cluster of classes with highest values of sensitivity level 3. Classes D and B had low values for all three sensitivity levels.

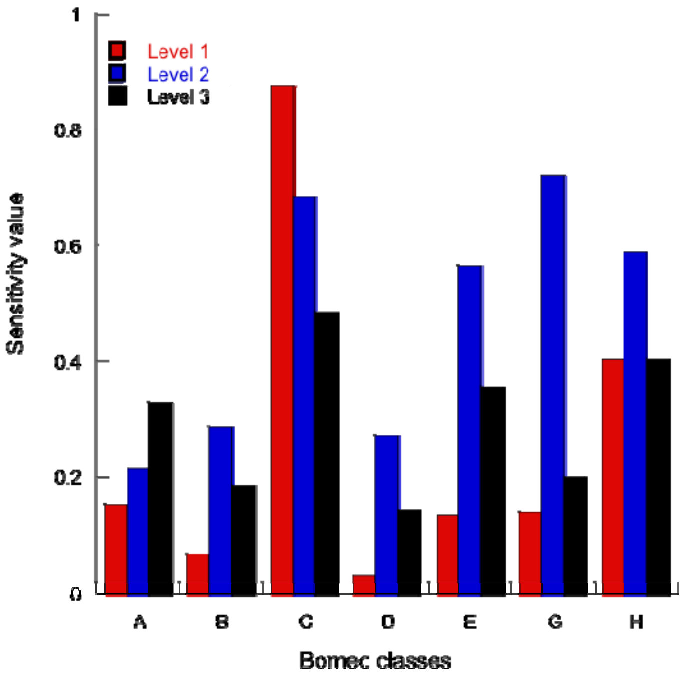

Figure 3.5: Mean values for Sensitivity Levels 1 to 3 for BOMEC classes with more than 10 *specify* stations.

Within BOMEC class A, only two depth bands occurred, shallow (less than 50 m) and mid (50–100 m). There were no significant differences ($p < 0.05$) in values for sensitivity level 2; but for sensitivity level 1, mid-depth areas had significantly higher values than shallow depths (Figure 3.6). A similar relationship with depth was found for class C where mid-depth areas had significantly higher values than shallow and deep areas, for sensitivity level 1 only. For class E, deep areas had the lowest sensitivity level 1 values, but the highest sensitivity level 3 values.

Significantly higher sensitivity level 1 values were found for gravel substrates in BOMEC class A and for gravel and sand within BOMEC class C, but there was no significant effect of substrate type for BOMEC class E. A cluster of classes with high values of sensitivity level 2 were found for mud substrates in class C and mud and sand substrates in class E (Figure 3.7). Significant differences for sensitivity level 3 were only found for class C, where calcareous gravel, mud, and sand substrates had lowest values and calcareous sand had the highest value.

Within Statistical Area 047, there were three BOMEC classes with more than 10 *specify* stations, classes A, C, and H. No significant differences between these classes were detected for sensitivity level 3. For level 2, there was a gradient between class C (highest) and class A (lowest values) (Figure 3.8). For level 1, classes H and A had significantly lower values than class C.

Within Statistical Areas 020, 022, and 024 there were only two BOMEC classes with more than 10 *specify* stations, classes D and E. No significant differences between these classes were detected for sensitivity level 3 or 2 for any of the Statistical Areas. For level 1, class D had significantly higher values than class E (Figure 3.8) in Statistical Area 020, and the reverse occurred in Statistical Areas 022 and 024.

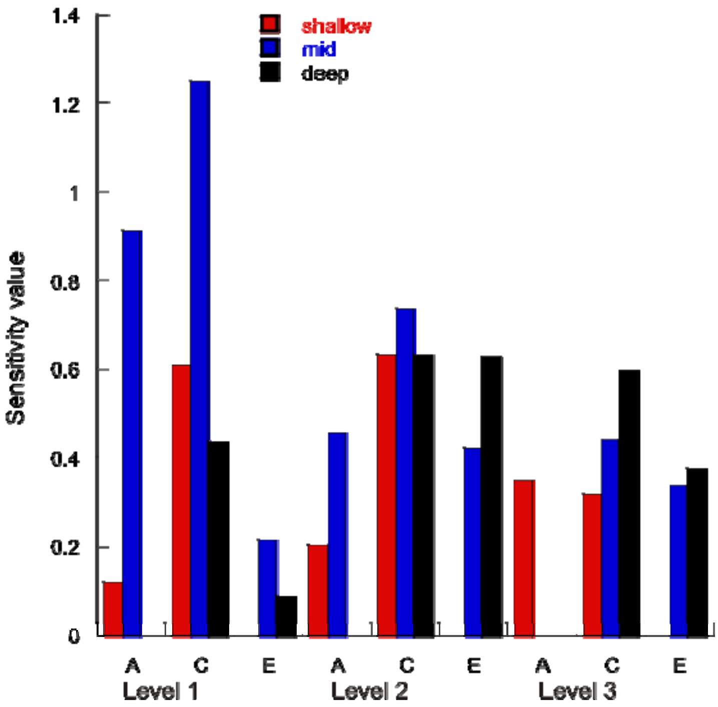

Figure 3.6: Mean values for Sensitivity Levels 1 to 3 from *specify* data for depth bands within BOMEC classes A, C, and E.

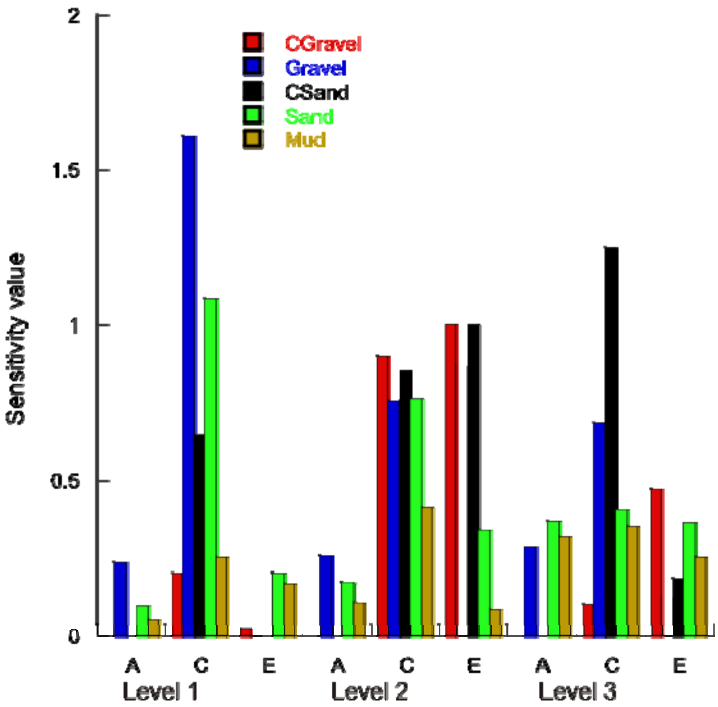

Figure 3.7: Mean values for Sensitivity Levels 1 to 3 from *specify* data for sedimentary habitat classes within BOMEC classes A, C, and E.

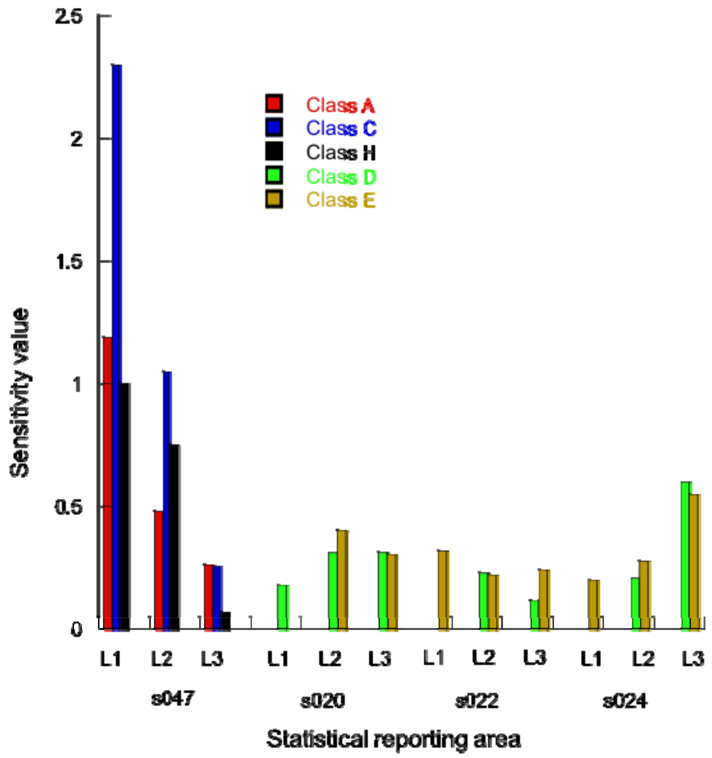

Figure 3.8: Mean values for Sensitivity Levels 1 to 3 from *specify* data for BOMEC classes A, C, D, E, and H within Statistical Areas 047, 020, 022, and 024.

Differences in sensitivity between habitat classes, based on *trawl* data

Station values for sensitivity levels 1–3 ranged from 0 to a maximum of 3, 6, and 11 respectively. BOMEC class I (not included in the *specify* analysis due to too few stations) had the highest values of all three sensitivity levels, followed by class E. For sensitivity levels 2 and 3, class I had significantly higher values than class E, being more than double (Figure 3.9), though for sensitivity level 1 they were not significantly different. The class with the next highest value was variable: class C for sensitivity level 1, class D for sensitivity level 2, and class B for sensitivity level 3. The clusters of classes with the lowest values were G, A, H, D, and B for sensitivity level 1; G, A, and H for sensitivity level 2; and G, C, and H for sensitivity level 3.

Within BOMEC class A, only shallow depths had been sampled. However, for class C, although no significant difference was detected for sensitivity level 2, for sensitivity levels 1 and 3, shallow depths had significantly higher values (Figure 3.10). Deeper areas (100–250 m) were always lowest, although only significantly different from mid-depths for sensitivity level 1. A different pattern was observed for class E which only had mid and deep areas; the deep areas displayed significantly higher values than mid-depths for all three sensitivity levels.

The effect of sediment type was again generally variable. For sensitivity level 3, there were significant differences within class A values in mud, higher than sand and gravel. However, for class C, no significant differences were detected and for class E, significantly higher values were found in sand than other types (Figure 3.11). For sensitivity level 2, no significant differences were detected for class A or class C, but for class E sand was the highest. No more consistency was observed across classes for sensitivity level 1. No significant difference was detected for class A or C, but for class E, gravels had the significantly higher values.

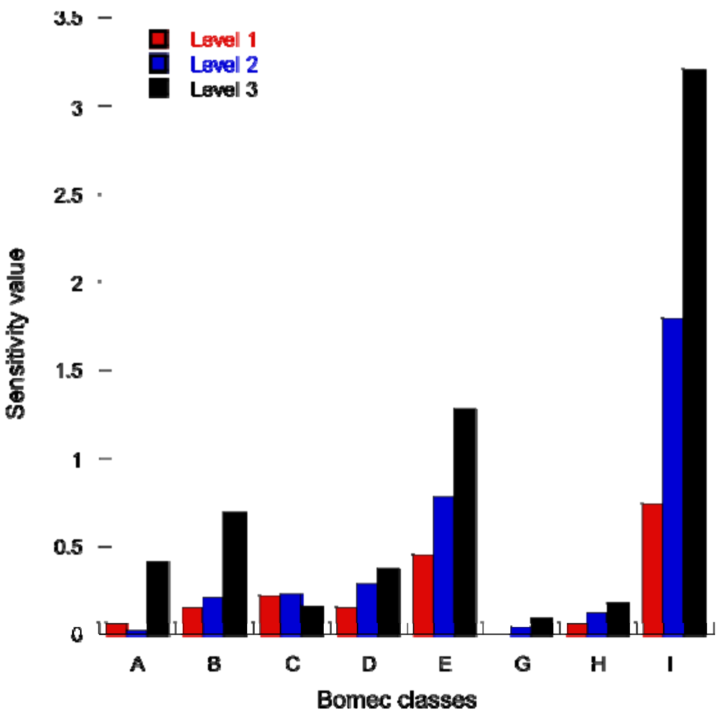

Figure 3.9: Mean values for Sensitivity Levels 1 to 3 for BOMEC classes with more than 10 *trawl* sampling stations.

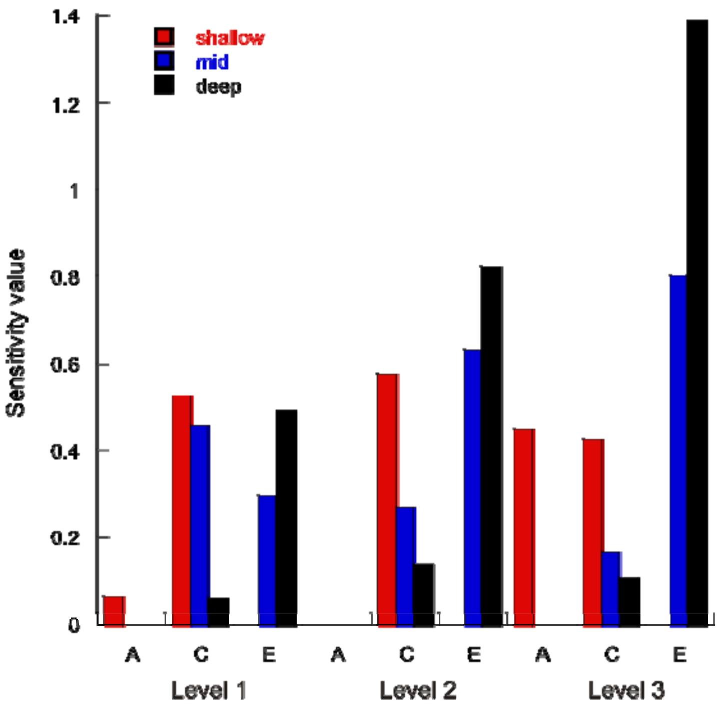

Figure 3.10: Mean values for Sensitivity Levels 1 to 3 from *trawl* data for depth bands within BOMEC classes A, C, and E.

Within Statistical Area 047, there were no BOMEC classes with more than 10 *trawl* stations. Within Statistical Areas 020, 022, and 024 there were only two BOMEC classes with more than 10 *specify* stations, classes D and E. No significant differences between these classes were detected for sensitivity level 1 for any of the Statistical Areas (Figure 3.12). For levels 2 and 3, class E had significantly higher values than class 4 in all three Statistical Areas.

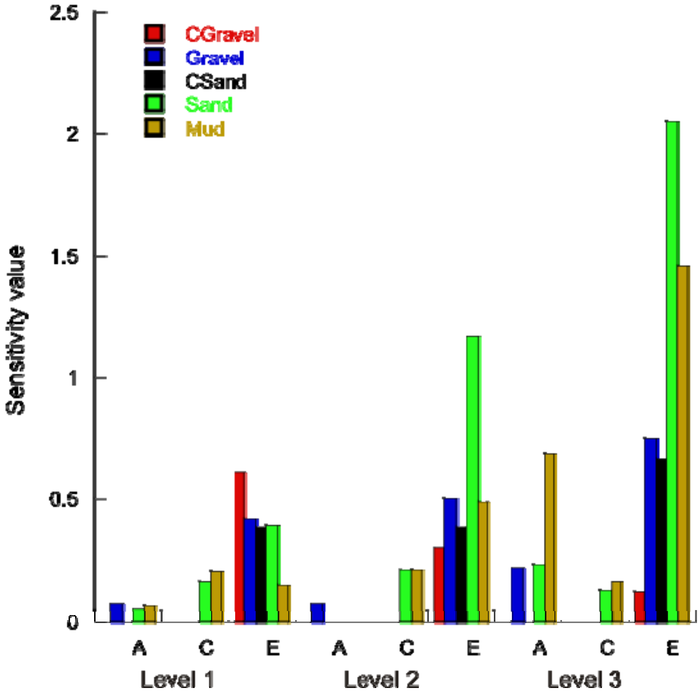

Figure 3.11: Mean values for Sensitivity Levels 1 to 3 from *trawl* data for sedimentary habitat classes within BOMEC classes A, C, and E.

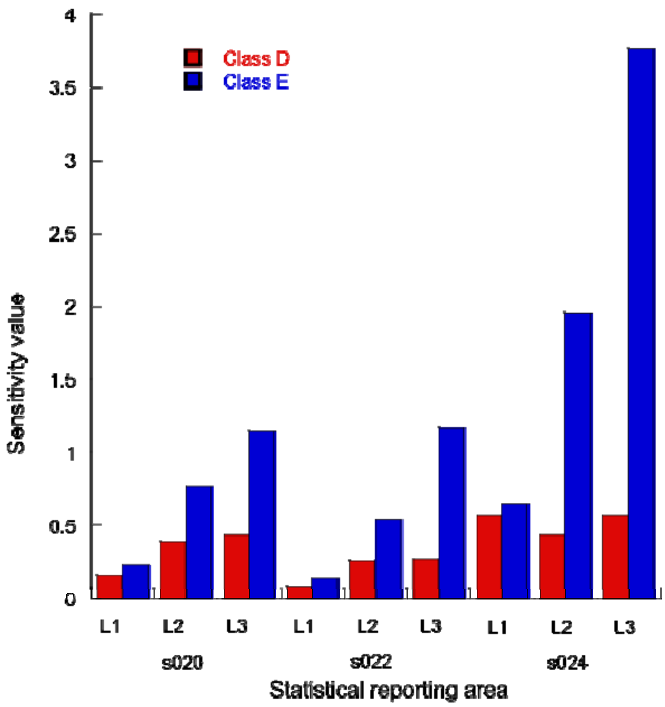

Figure 3.12: Mean values for Sensitivity Levels 1 to 3 from *trawl* data for BOMEC classes D and E within Statistical Areas 020, 022, and 024.

Uncertainty in habitat class estimates

There was considerable variation in the number of stations representing the BOMEC classes and also in the standard deviation of the values for the three sensitivity levels within each class (Table 3.13). For BOMEC classes, level 1 displayed more variability when calculated using the *specify* data (see Table 3.13, higher minimum, average and maximum standard deviations). This did not seem to be related to the number of stations. In the *trawl* data, higher variability was observed in the level 3 values.

Splitting the BOMEC classes into subsets based on depth or sediment type did not decrease the variability seen (Table 3.14), with the possible exception of Level 2 depth bands.

Table 3.13: Number of stations and standard deviation of the three sensitivity levels in the BOMEC classes with more than 10 stations per class, for each data source.

BOMEC				*specify*				*trawl*
Class	No. stations	Level 1	Level 2	Level 3	No. stations	Level 1	Level 2	Level 3
A	234	0.68	0.47	0.52	54	0.23	0.14	0.60
J	1	–	–	–	0	–	–	–
L	1	–	–	–	6	–	–	–
B	91	0.29	0.52	0.42	156	0.37	0.60	0.83
C	351	2.02	0.98	0.91	322	0.47	0.65	0.42
D	348	0.19	0.64	0.46	311	0.38	0.56	0.63
E	158	0.36	0.77	0.61	537	0.52	1.15	2.16
F	1	–	–	–	1	–	–	–
G	50	0.40	0.90	0.45	23	0.00	0.21	0.29
H	119	0.94	0.83	0.63	196	0.26	0.32	0.51
I	9	–	–	–	19	0.45	1.65	3.07
Maximum		2.02	0.98	0.91		0.52	1.65	3.07
Average		0.70	0.73	0.57		0.34	0.66	1.06
Minimum		0.19	0.52	0.42		0.00	0.21	0.29

Table 3.14: Number of stations and standard deviation of the three sensitivity levels in the BOMEC classes A, C, and E, by depth zones and sediment types, for each data source.

					specify				*trawl*
BOMEC class	Depth zone	No. stations	Level 1	Level 2	Level 3	No. stations	Level 1	Level 2	Level 3
A	mid	11	1.81	0.69	0	5	–	–	–
	shallow	223	0.56	0.45	0.53	49	0.24	0.00	0.61
C	deep	131	0.89	0.83	0.94	203	0.26	0.40	0.31
	mid	182	2.57	1.08	0.91	79	0.59	0.70	0.44
	shallow	38	1.48	0.97	0.77	40	0.68	1.24	0.71
E	deep	104	0.28	0.81	0.63	432	0.52	1.23	2.33
	mid	51	0.46	0.65	0.59	105	0.50	0.70	1.12
	shallow	3	–	–	–	0	–	–	–
	Sediment	No. stations	Level 1	Level 2	Level 3	No. stations	Level 1	Level 2	Level 3
A	Cgravel	7	–	–	–	1	–	–	–
	CSand	7	–	–	–	1	–	–	–
	Gravel	106	0.79	0.5	0.45	14	0.27	0.27	0.43
	Mud	38	0.32	0.39	0.7	16	0.25	0.00	0.70
	Sand	76	0.7	0.41	0.51	22	0.21	0.00	0.43
C	CGravel	10				1			
	CSand	28	0.99	1.04	1.29	9			
	Gravel	41	2.91	1.2	1.21	7			
	Mud	88	0.68	0.69	0.7	216	0.44	0.67	0.40
	Sand	184	2.28	1.02	0.82	89	0.42	0.60	0.39
E	CGravel	40	0.16	1.04	0.68	177	0.52	0.50	0.32
	CSand	11	0	0.45	0.4	21	0.50	0.92	1.83
	Gravel	8				12	0.51	0.52	0.97
	Mud	12	0.39	0.29	0.45	35	0.36	0.61	1.52
	Sand	86	0.43	0.57	0.63	287	0.52	1.37	2.57
	Sdymud	1				5			

Differences between combined habitat classes in proportion of sensitivity and recoverability

Specify data

Significant differences between the 23 BOMEC class, depth band, sediment type combinations in the proportion of OTU that were sensitive to a disturbance that comes occasionally in contact with the seafloor (defined as "high" = Level 1 sensitivity) were observed (χ^2 value = 1.081E12, p-value <0.0001). Significant differences were also observed for the proportion of OTU that were sensitive to a disturbance that drags across the seafloor (defined as "moderate" = Levels 1 + 2; χ^2 value = 126.6, p-value <0.0001), and a dredge type disturbance (defined as "low" = Levels 1 + 2 + 3; χ^2 value = 4.6533E10, p-value <0.0001).

The following descriptions of the significant differences observed all use the same pattern. The habitat class with the greatest proportion is given and the habitat classes to which it is significantly different to, in decreasing order of their proportion of OTUs sensitive to trawl type disturbances. Then the habitat class with the lowest proportion is given and the habitat classes to which it is significantly different to, in decreasing order of their proportions. The exception to this is when the number of habitat classes significantly different to the greatest (or lowest) is much larger than the number of habitat classes that it is equal to, in which case these are listed instead.

- The greatest "high" sensitivity was observed in BOMEC class C/mid/Sand, which was significantly different to everything but C/deep/Mud, H/deep/Mud, E/mid/Sand, E/deep/Sand, D/mid/Mud and H/deep/Sand (Figure 3.13). BOMEC class A/shallow/Sand had the smallest "high" sensitivity and was only significantly different to C/mid/Sand.
- The greatest "moderate" sensitivity was also observed in BOMEC class E/deep/CSand, which was significantly different to everything other than C/mid/Sand and E/deep/CGravel (Figure 3.14). BOMEC class D/shallow/Mud had the smallest "moderate" sensitivity, followed by A/shallow/Mud and was significantly different to E/deep/CSand, C/mid/Sand and E/deep/CGravel.
- The greatest "low" sensitivity was observed in BOMEC class E/deep/CSand, which was significantly different to everything but E/deep/CGravel, C/mid/Sand, D/mid/Mud, E/deep/Sand and C/deep/Sand (Figure 3.15). BOMEC class D/shallow/Mud had the smallest "low" sensitivity and was significantly different to E/deep/CSand, E/deep/CGravel, C/mid/Sand, D/mid/Mud, E/deep/Sand, C/deep/Sand, H/deep/Mud, H/deep/Sand, C/deep/Mud, D/shallow/Sand, E/mid/Sand, C/mid/Mud and A/shallow/Gravel.

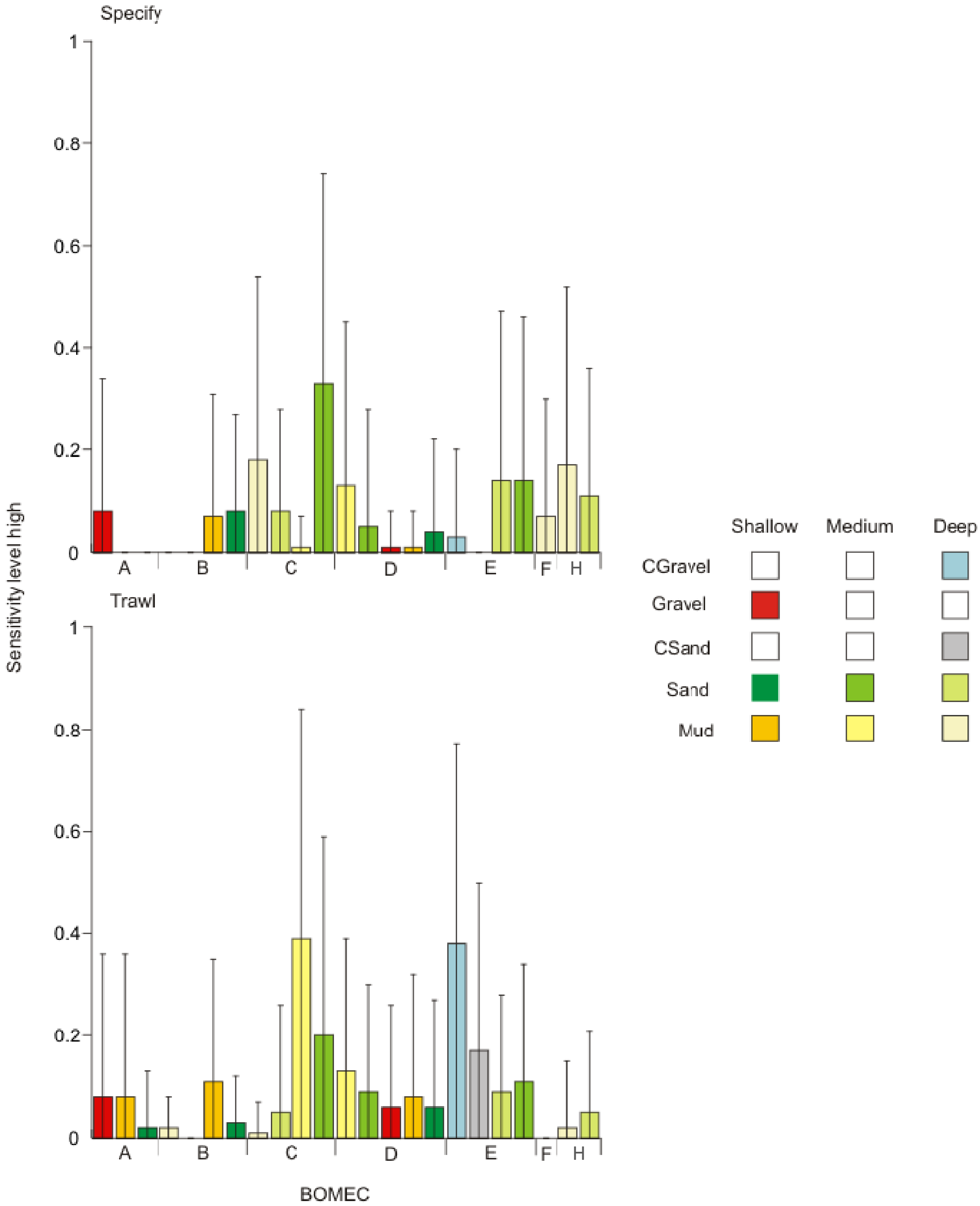

Figure 3.13: Mean proportion of OTUs (with standard deviation) from the sampling stations in the *specify* and *trawl* databases that were sensitive to a disturbance that comes occasionally in contact with the seafloor (defined as "high" = Level 1 sensitivity) for the combined habitat classes.

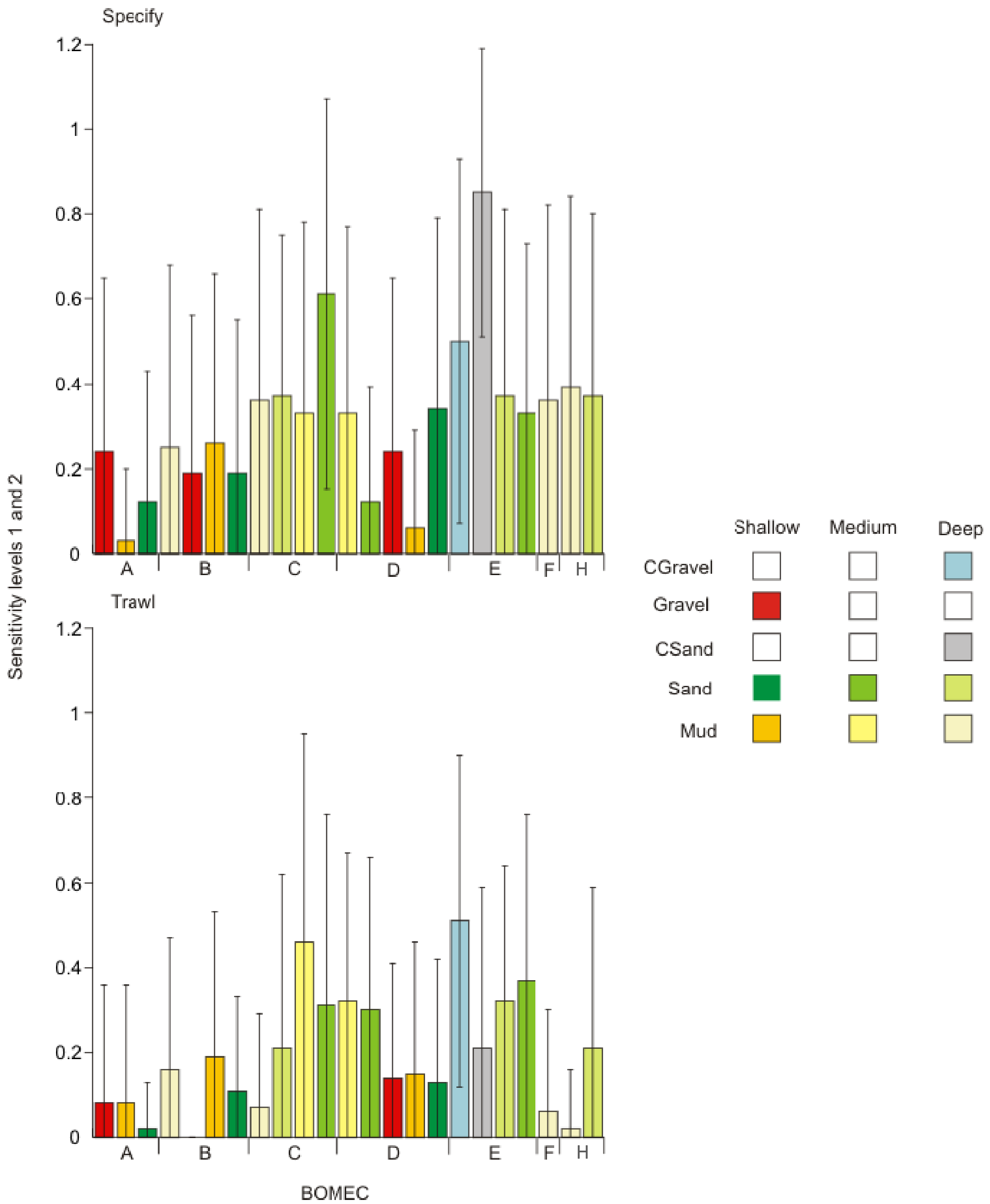

Figure 3.14: Mean proportion of OTUs (with standard deviation) from the sampling stations in the *specify* and *trawl* databases that were sensitive to a disturbance that comes occasionally in contact with the seafloor (defined as "moderate" = Levels 1 and 2 sensitivities) for the combined habitat classes.

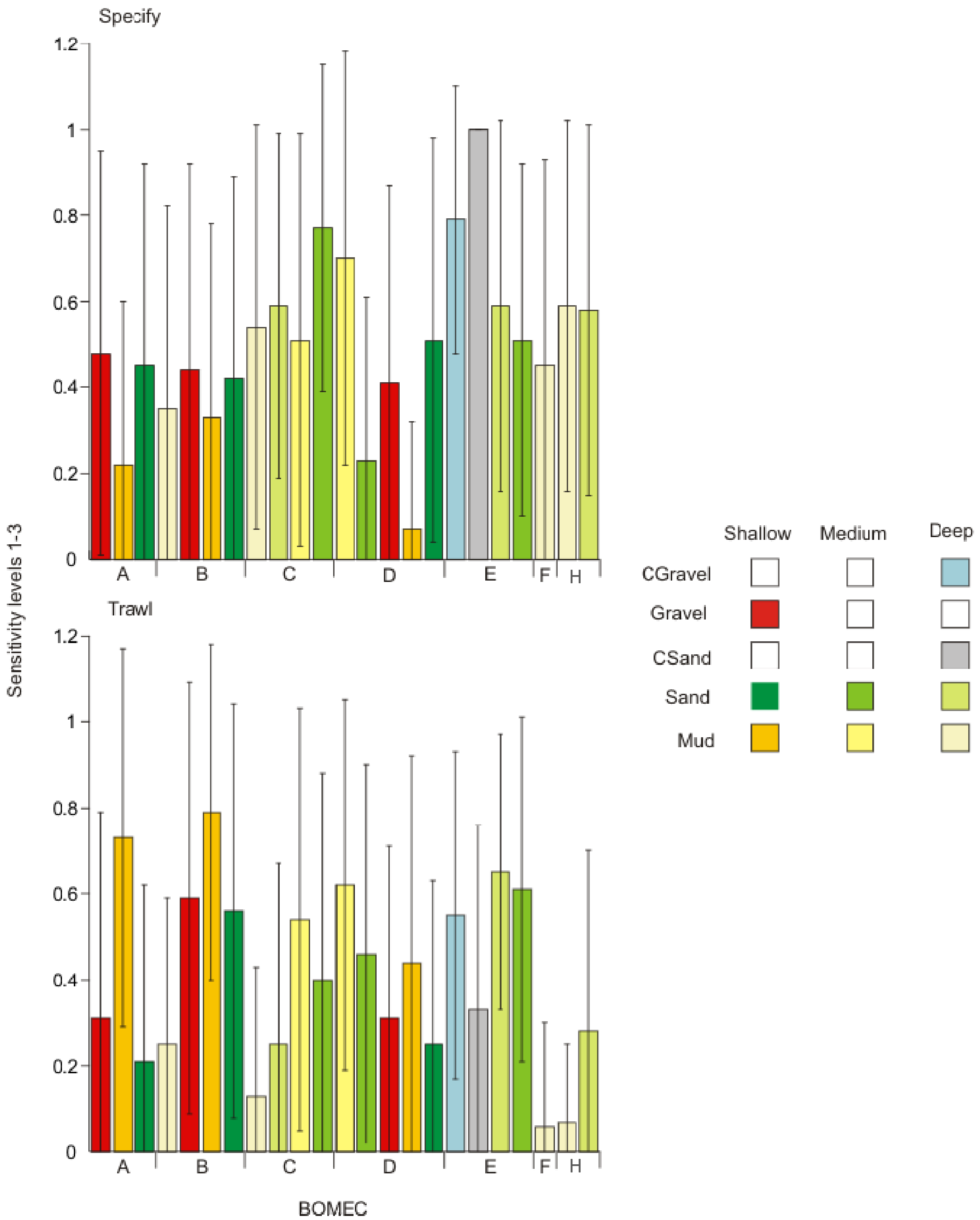

Figure 3.15: Mean proportion of OTUs (with standard deviation) from the sampling stations in the *specify* and *trawl* databases that were sensitive to a disturbance that comes occasionally in contact with the seafloor (defined as "low" = Levels 1, 2, and 3 sensitivities) for the combined habitat classes.

Significant differences were also observed for proportions of OTUs with high ability to recover (recovery level 5; χ^2 value = 4.75028E10, p-value <0.0001), moderate ability to recover (recovery levels 2, 3, and 4; χ^2 value = 105.6, p-value <0.0001), but not for low ability to recover (recovery levels 0 and 1; χ^2 value = 31.7, p-value = 0.0865; see Figure 3.16).

- The greatest high recoverability was observed in BOMEC class D/shallow/Mud, which was significantly different to class C/deep/Mud, E/mid/Sand, H/deep/Mud, C/deep/Sand, E/deep/Sand, H/deep/Sand, E/deep/CGravel, D/mid/Mud, C/mid/Sand and E/deep/CSand (Figure 3.17). BOMEC class E/deep/CSand had the smallest high recoverability and was significantly different to everything but E/deep/CGravel, D/mid/Mud and C/mid/Sand.

- The greatest moderate recoverability was observed in BOMEC class E/deep/CSand, which was significantly different to everything else (Figure 3.18). BOMEC class A/shallow/Mud had the smallest moderate recoverability, followed by D/shallow/Mud, and these were significantly different to E/deep/CSand, C/mid/Sand, E/deep/CGravel and D/mid/Mud.

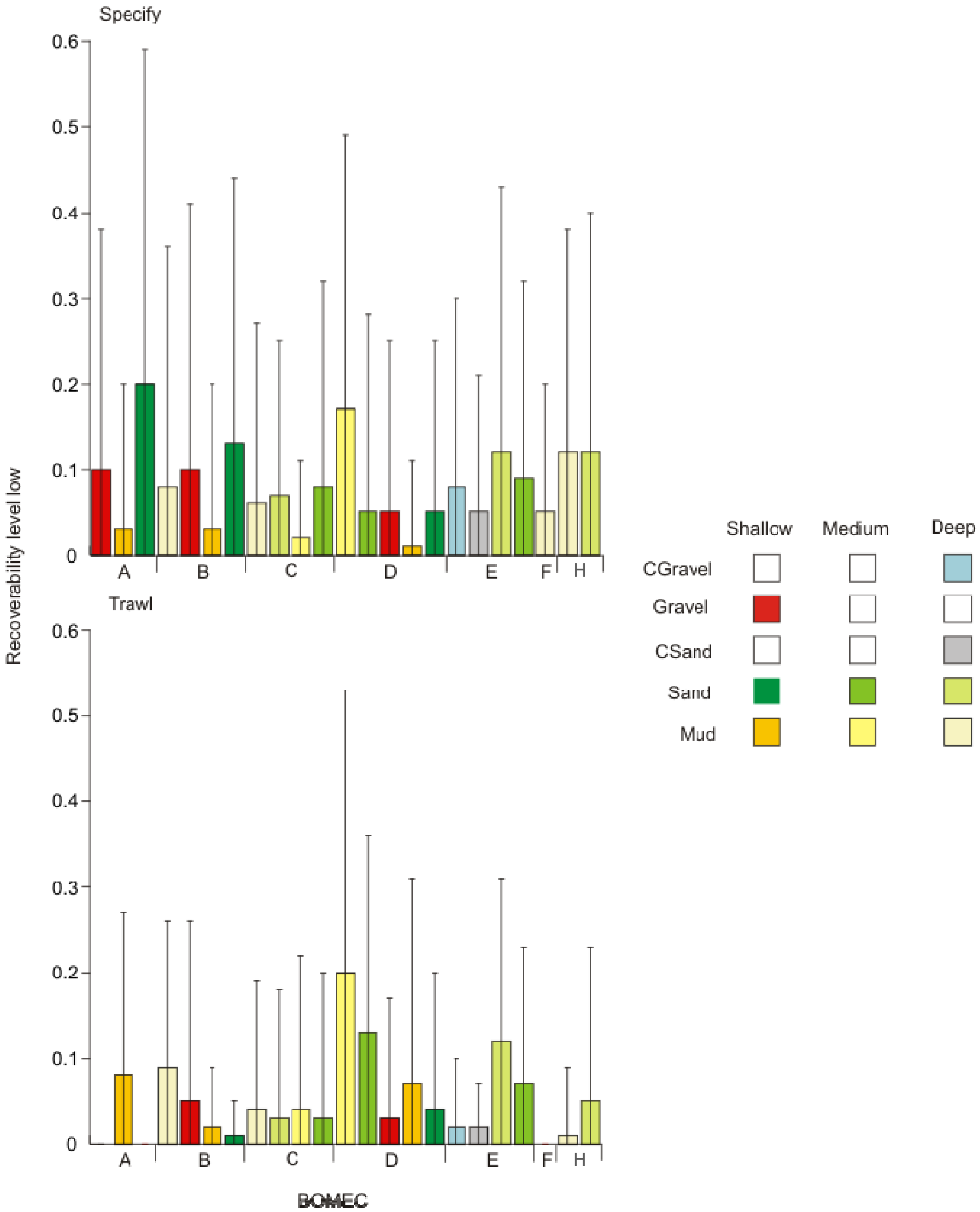

Figure 3.16: Mean proportion of OTUs (with standard deviation) from the sampling stations in the *specify* and *trawl* databases with low recoverability (recovery levels 0 + 1) for the combined habitat classes. Note that these proportions do not sum to 1 because most sites had some OTUs that were without recovery trait information.

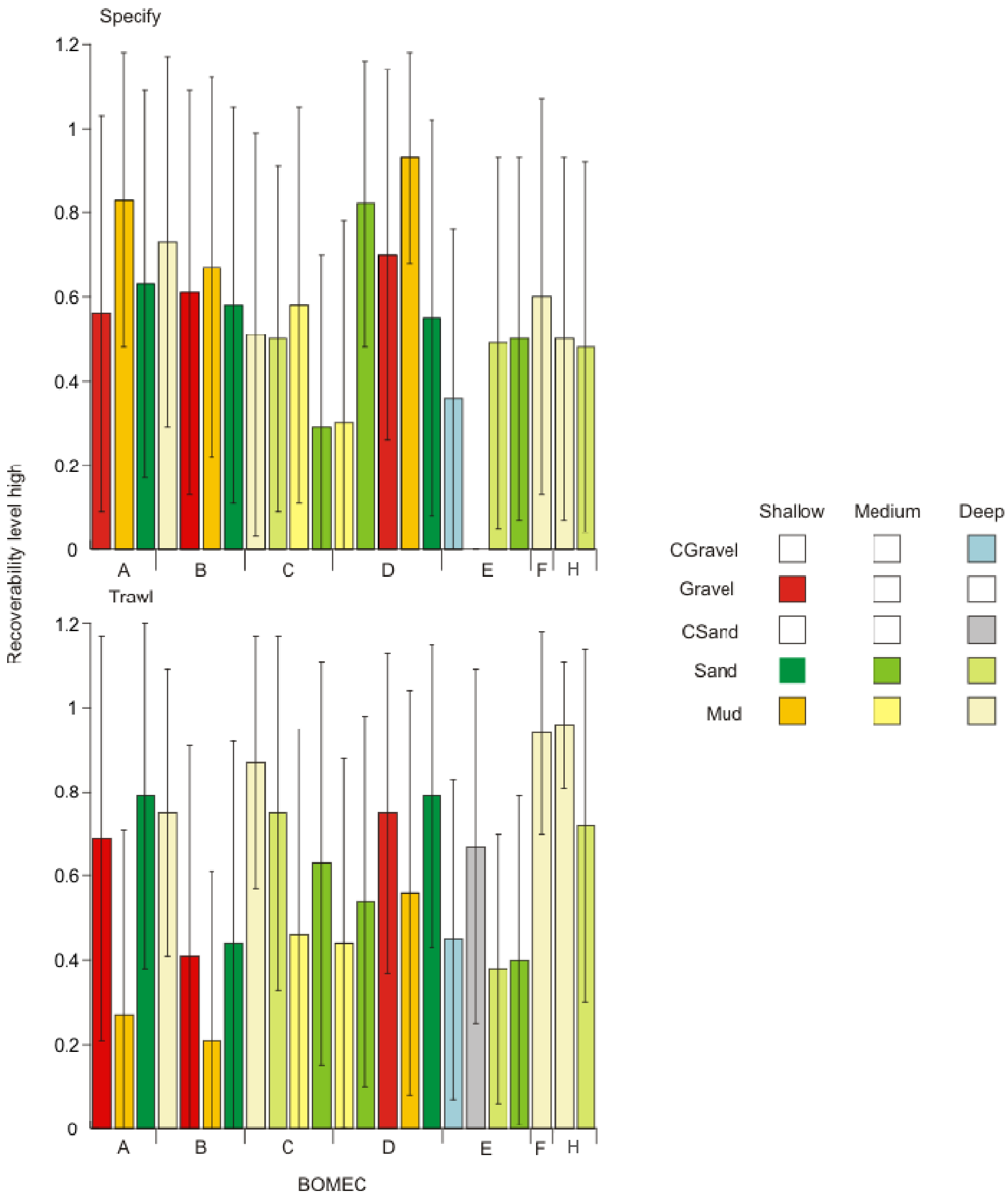

Figure 3.17: Mean proportion of OTUs (with standard deviation) from the sampling stations in the *specify* and *trawl* databases with high recoverability (recovery level 5) for the combined habitat classes. Note that these proportions do not sum to 1 because most sites had some OTUs that were without recovery trait information.

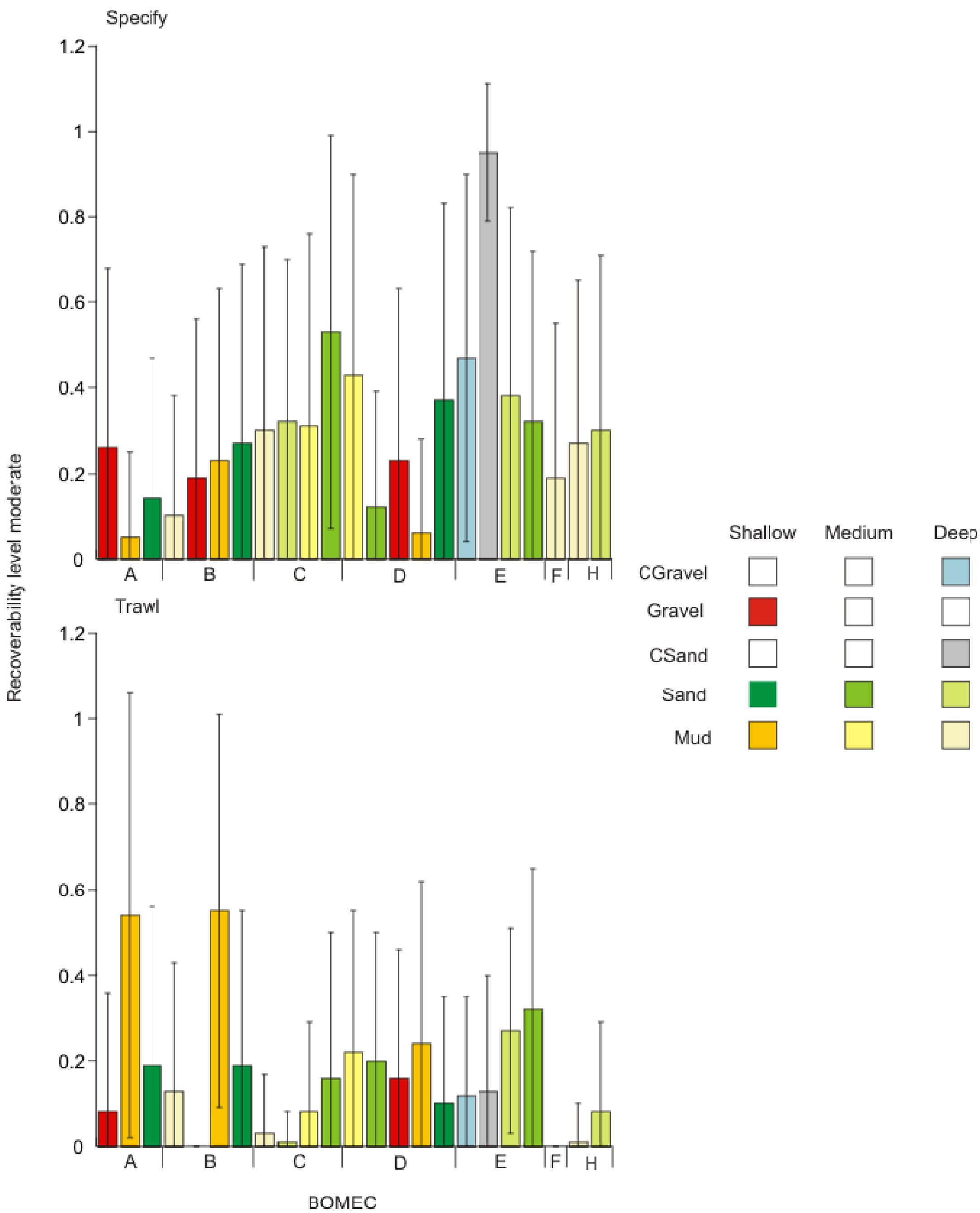

Figure 3.18: Mean proportion of OTUs (with standard deviation) from the sampling stations in the *specify* and *trawl* databases with moderate recoverability (recovery levels 2, 3, and 4) for the combined habitat classes. Note that these proportions do not sum to 1 because most sites had some OTUs that were without recovery trait information.

Trawl data

Significant differences were detected for proportions of all sensitivity and recoverability levels in the trawl data (all χ^2 value > 200, all p-values <0.0001).

- The greatest "high" sensitivities were observed in BOMEC class C/mid/Mud and E/deep/CGravel, which were significantly different to everything else (see Figure 3.13). BOMEC classes H/deep/Mud, B/shallow/Gravel, C/deep/Mud, B/deep/Mud had the smallest "high" sensitivities and were significantly different to C/mid/Mud, E/deep/CGravel and C/mid/Sand.
- The greatest "moderate" sensitivity was observed in BOMEC class E/deep/CGravel, which was significantly different to everything other than C/mid/Mud, E/mid/Sand (see Figure 3.14).

BOMEC class B/shallow/Gravel had the smallest "moderate" sensitivity and was significantly different to E/deep/CGravel, C/mid/Mud, E/mid/Sand, E/deep/Sand, D/mid/Mud, C/mid/Sand, D/mid/Sand, H/deep/Sand, E/deep/CSand and C/deep/Sand.

- The greatest "low" sensitivity was observed in BOMEC class B/shallow/Mud followed by A/shallow/Mud, and these were significantly different from everything but class E/deep/Sand, D/mid/Mud, E/mid/Sand and B/shallow/Gravel (see Figure 3.15). BOMEC class H/deep/Mud had the smallest "low" sensitivity value and was not was significantly different from anything but C/mid/Sand, which was significantly different from everything but class D/shallow/Sand, B/deep/Mud, C/deep/Sand, A/shallow/Sand, C/deep/Mud, and H/deep/Mud.
- The greatest "high" recoverability was observed in BOMEC class H/deep/Mud, which was significantly different to everything but class F/deep/Mud, C/deep/Mud, D/shallow/Sand and A/shallow/Sand (see Figure 3.17). BOMEC class B/shallow/Mud had the smallest "high" recoverability and was significantly different to everything but B/shallow/Gravel, E/mid/Sand, E/deep/Sand, and A/shallow/Mud.
- The greatest "moderate" recoverability values were observed in BOMEC class B/shallow/Mud, A/shallow/Mud, which were significantly different to everything else (see Figure 3.18). BOMEC class H/deep/Mud, followed by B/shallow/Gravel, had the smallest "moderate" recoverability and these were significantly different to B/shallow/Mud, A/shallow/Mud, E/mid/Sand, E/deep/Sand, D/shallow/Mud, D/mid/Mud, D/mid/Sand, A/shallow/Sand, B/shallow/Sand, C/mid/Sand, and D/shallow/Gravel.
- The greatest "low" recoverability was observed in BOMEC class D/mid/Mud, which was significantly different to everything but class D/mid/Sand and E/deep/Sand (see Figure 3.16). BOMEC class A/shallow/Gravel, H/deep/Mud and A/shallow/Sand all had "low" recoverability values of 0, but were only significantly different to D/mid/Mud, D/mid/Sand and E/deep/Sand.

Discussion

There was a low degree of consistency between the two databases in which BOMEC class was allotted high or low sensitivity values. Although BOMEC classes B and D had the lowest values for all three levels based on the *specify* data, these classes only had the lowest values for Level 1 based on the *trawl* data. Instead, for Level 2 calculated from the *trawl* data, class H had the lowest value, despite having the second highest value when this level was calculated from the *specify* data. Similarly, for Level 3 calculated from the *trawl* data, classes H and C had the lowest values, despite having the second and first highest values when this level was calculated from the *specify* data. The BOMEC class with the highest value for all three sensitivity levels calculated from the trawl data was class I, which did not have enough *specify* stations for it to be included in that set of calculations.

There was little evidence that depth or sediment type created individualised sensitive habitat classes within the BOMEC classes. While mid-depths had higher values of Level 1 sensitivity for all three BOMEC classes tested, this was the only consistency observed. Moreover, subsets based on depth or sediment type did not have lower variability in sensitivity values compared with the BOMEC classes.

There was evidence of differences in sensitivity values of different BOMEC classes within the Statistical Areas, for both *trawl* and *specify* databases. This suggests that the BOMEC classification could be used to apportion areas of differing sensitivity at the scale of reporting areas; however, data should be specifically collected to test this.

There are two possible reasons why strong, consistent results from this analysis were not apparent.

- Firstly, it may be that BOMEC classes are not at a suitable scale for using in assessment of sensitivity. Initially we investigated using actual habitat class definitions to derive sensitivity but this was when we envisaged that descriptions based on sediment type and biotic factors would be available. As these were not available we had to rely on the BOMEC and its associations with available biological species information. The BOMEC, although optimised to benthic organisms, has two specific problems which may confound this analysis. (1) Included among the eight groups of benthic organisms used for the optimisation was demersal fish. This was the most extensively sampled group and is likely to have had a strong influence on the classification. (2) BOMEC is based on the entire Territorial Sea and the EEZ out to 3000 m depths; as a result the shallower areas are not well differentiated at the scale at which benthic animals generally respond to the environment.

- Secondly, only two data sources for biological information were available and neither of these were well suited to the task in hand. While the *specify* database held information on a large number of species at a good taxonomic resolution, the data collection methods vary and are usually collecting organisms over a smaller scale than the methods used for the *trawl* database. Such methods do not always sample larger long-lived benthic animals very well, particularly if they have a patchy distribution, although these animals are often those that are most sensitive to bottom fishing. Conversely the *trawl* database generally samples larger animals that protrude from the seafloor well, but has a lower taxonomic resolution and does not sample smaller organisms or those that protrude only small distances from the seafloor or live within the sediment. Finally, data could only be used as presence/absence and changes in abundance are generally the first response to stress. Thus, inherent in analyses of vulnerability (and thus sensitivity) is the need for abundance data.

With the data at hand it is not possible to determine which of these are the most likely to be the confounding factors and in reality it is likely to be a combination of all of the above. The scientific and management communities have acknowledged the limitations of BOMEC generally, and particularly in the shallow waters around New Zealand, funding a number of benthic habitat mapping studies. For example, the Oceans Survey 2020 voyages around the Chatham Rise, Challenger Plateau and Bay of Islands, funded by LINZ, MPI, NIWA and DOC; and the MBIE funded CCM project in the shallow waters around New Zealand. There are also a number of smaller MPI and DOC funded projects. These projects not only solve the problem of the scale of the BOMEC classes but, generally, also provide more adequate species information on which to assess sensitivity.

Analyses of recoverability again provided different categorisation of habitat classes by the two different databases. But there are greater problems than this for assessing recoverability. Firstly, recoverability is very location-specific, depending on hydrodynamics and a source for organisms. It is also very driven by the spatial extent of the disturbance- how mobile does an organism have to be to be able to recolonize from round the edges? Secondly, the biological trait information needed to create even a non-location specific general assessment is much less available, and thus certain, than the information needed for sensitivity assessments. Thus for 35% of the OTUs in the databases, this knowledge was “uncertain” and for 7% there was no information.

APPENDIX 3a: OPERATIONAL TAXONOMIC UNIT (OTU) *SPECIFY* DATABASE

PHYLUM ANNELIDA

OTU	Order	Super order	Infraclass	Sub class	Class
Stibarobdella	Rhynchobdellida		Euhirudinea	Hirudinea	Clitellata
Hyalinoecia	Eunicida			Aciculata	Polychaeta
Hyalinoecia longibranchiata	Eunicida			Aciculata	Polychaeta
Kinbergonuphis proalopus	Eunicida			Aciculata	Polychaeta
Oenonidae	Eunicida			Aciculata	Polychaeta
Scoletoma brevicirra	Eunicida			Aciculata	Polychaeta
Aglaophamus macroura	Phyllodocida			Aciculata	Polychaeta
Aphrodita	Phyllodocida			Aciculata	Polychaeta
Euphione squamosa	Phyllodocida			Aciculata	Polychaeta
Hemipodus simplex	Phyllodocida			Aciculata	Polychaeta
Platynereis australis	Phyllodocida			Aciculata	Polychaeta
Pontogenia latifolia	Phyllodocida			Aciculata	Polychaeta
Sigalionidae	Phyllodocida			Aciculata	Polychaeta
Protula bispiralis	Sabellida			Canalipalpata	Polychaeta
Pseudopotamilla laciniosa	Sabellida			Canalipalpata	Polychaeta
Pseudopotamilla pseudopotamilla-B	Sabellida			Canalipalpata	Polychaeta
Polydora haswelli	Spionida			Canalipalpata	Polychaeta
Polydora websteri	Spionida			Canalipalpata	Polychaeta
Scolecolepides scolecolepides-A	Spionida			Canalipalpata	Polychaeta
Spio aequalis	Spionida			Canalipalpata	Polychaeta
Spiophanes japonicum	Spionida			Canalipalpata	Polychaeta
Pseudopista rostrata	Terebellida			Canalipalpata	Polychaeta
Abarenicola devia				Scolecida	Polychaeta
Armandia maculata				Scolecida	Polychaeta
Clymenura snaiko				Scolecida	Polychaeta
Polychaeta					Polychaeta

PHYLUM ARTHROPODA, SUBPHYLUM CHELICERATA

OTU	Order	Super order	Infraclass	Sub class	Class
Achelia assimilis	Pantopoda				Pycnogonida
Ammothea australiensis	Pantopoda				Pycnogonida
Ammothea magniceps	Pantopoda				Pycnogonida
Austropallene cornigera	Pantopoda				Pycnogonida
Pallenopsis obliqua	Pantopoda				Pycnogonida
Pallenopsis pilosa	Pantopoda				Pycnogonida
Pantopoda	Pantopoda				Pycnogonida
Pycnogonida					Pycnogonida

PHYLUM ARTHROPODA, SUBPHYLUM CRUSTACEA

OTU	Order	Super order	Infraclass	Sub class	Class
Aegaeon lacazei	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Alope spinifrons	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Alpheopsis garricki	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Alpheus socialis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Areopaguristes pilosus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Areopaguristes setosus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Aristaeomorpha foliacea	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Bathypaguropsis cruentus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Cancellus sphraerogonus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Chlorotocus novaezealandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Ctenocheles maorianus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Cyclohombronia depressa	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Cyrtomaia hispida	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Decapoda	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Diacanthurus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Diacanthurus rubricatus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Diacanthurus spinulimanus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Dittosa cheesmani	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Dromia wilsoni	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Ebalia	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Eplumula australiensis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Eurynome bituberculata	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Galatheidae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Halicarcinus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Halicarcinus tongi	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Haliporoides sibogae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Hymenosomatidae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Ibacus alticrenatus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Jacquinotia edwardsii	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Jasus verreauxi	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax australis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax garricki	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax longipes	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax tuberculatus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Liocarcinus corrugatus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lophopagurus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lophopagurus cookii	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lophopagurus eltaninae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lophopagurus foresti	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lophopagurus laurentae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lophopagurus nodulosus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lophopagurus stewarti	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lophopagurus thompsoni	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lyreidus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lyreidus tridentatus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Metacarcinus novaezelandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Metadynomene tanensis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Metanephrops challengeri	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Munida gracilis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Munida gregaria	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Munidopsis tasmaniae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Nauticaris marionis	Decapoda	Eucarida		Eumalacostraca	Malacostraca

OTU	Order	Super order	Infraclass	Sub class	Class
Nectocarcinus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Nectocarcinus antarcticus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Nectocarcinus bennetti	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Nectocarcinus stephensoni	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Neommatocarcinus huttoni	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Notomithrax	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Notomithrax minor	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Notomithrax peronii	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Ogyrides delli	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Oplophorus novaezeelandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Ovalipes catharus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Paguridae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Paguristes	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Paguristes barbatus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Paguristes subpilosus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Pagurus albidianthus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Palaemon affinis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Periclimenes yaldwyni	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Petrolisthes novazelandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Phylladiorhynchus pusillus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Pilumnopeus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Pinnotheres	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Pontophilus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Pontophilus australis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Pontophilus pilosoides	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Porcellanopagurus edwardsii	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Porcellanopagurus filholi	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Prismatopus filholi	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Propagurus deprofundis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Rhynchocinetes balssi	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Solenocera novaezealandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Teratomaia richardsoni	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Thacanophrys filholi	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Tozeuma novaezealandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Trichopeltarion fantasticum	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Uroptychus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Uroptychus tomentosus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Ampelisca	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Ampelisca bouvieri	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Ampelisca chiltoni	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Ampeliscidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Amphipoda	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Ampithoe lessoniae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Bathymedon neozelanicus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Caprellina longicollis	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Ceradocus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Cerapus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Corophiidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Elasmopus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Eurystheus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Eurystheus dentatus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Eurystheus thomsoni	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Harpinia pectinata	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Haustoriidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Ischyrocerus longimanus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca

OTU	Order	Super order	Infraclass	Sub class	Class
Liljeborgia barhami	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Lysianassidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Melitidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Oedicerotidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Paraphoxus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Parathemisto	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Parathemisto gaudichaudii	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Parawaldeckia thomsoni	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Photis	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Photis brevicaudata	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Phoxocephalidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Platyscelus serratulus	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Proharpinia	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Proharpinia stephenseni	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Protophoxus australis	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Pseudambasia rossii	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Scypholanceola	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Socarnes	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Tmetonyx suteri	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Torridoharpinia hurleyi	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Urohaustoriidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Urothoidae	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Ventojassa frequens	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Waitangi brevirostris	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Campylaspis	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Colurostylis castlepointensis	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Cumacea	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Cyclaspis	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Cyclaspis argus	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Cyclaspis elegans	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Cyclaspis levis	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Cyclaspis triplicata	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Diastylis	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Diastylis neozealanica	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Diastylopsis crassior	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Diastylopsis elongata	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Eudorella	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Hemilamprops pellucidus	Cumacea	Peracarida		Eumalacostraca	Malacostraca
Aegiochus coroo	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Aegiochus laevis	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Amphoroidea	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Amphoroidea media	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Cassidina typa	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Cilicaea angustispinata	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Cilicaea dolorosa	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Cirolana kokoru	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Cirolanidae	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Crinoniscus cephalatus	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Cymodoce	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Cymodoce iocosa	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Dynamenoides decima	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Exosphaeroma falcatum	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Exosphaeroma planulum	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Isocladus armatus	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Isopoda	Isopoda	Peracarida		Eumalacostraca	Malacostraca

OTU	Order	Super order	Infraclass	Sub class	Class
Janiridae	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Joeropsis	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Leptanthura	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Maoridotea naylori	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Mexicope sushara	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Natatolana	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Natatolana aotearoa	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Natatolana hirtipes	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Natatolana pellucida	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Neastacilla	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Nerocila orbignyi	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Notopais	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Paranthura	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Paridotea ungulata	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Phreatoicidae	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Pseudaega	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Pseudaega secunda	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Pseudidotea	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Rocinela garricki	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Sphaeroma quoyanum	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Sphaeromatidae	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Tenagomysis longisquama	Mysida	Peracarida		Eumalacostraca	Malacostraca
Tenagomysis macropsis	Mysida	Peracarida		Eumalacostraca	Malacostraca
Tenagomysis producta	Mysida	Peracarida		Eumalacostraca	Malacostraca
Apseudes	Tanaidacea	Peracarida		Eumalacostraca	Malacostraca
Leptognathia	Tanaidacea	Peracarida		Eumalacostraca	Malacostraca
Pancoloides	Tanaidacea	Peracarida		Eumalacostraca	Malacostraca
Paratanais oculatus	Tanaidacea	Peracarida		Eumalacostraca	Malacostraca
Tanaidacea	Tanaidacea	Peracarida		Eumalacostraca	Malacostraca
Zeuxo phytalensis	Tanaidacea	Peracarida		Eumalacostraca	Malacostraca
Zeuxoides aka	Tanaidacea	Peracarida		Eumalacostraca	Malacostraca
Zeuxoides ohlini	Tanaidacea	Peracarida		Eumalacostraca	Malacostraca
Anchisquilloides mcneilli	Stomatopoda			Hoplocarida	Malacostraca
Heterosquilla tricarinata	Stomatopoda			Hoplocarida	Malacostraca
Heterosquilla trifida	Stomatopoda			Hoplocarida	Malacostraca
Pariliacantha georgeorum	Stomatopoda			Hoplocarida	Malacostraca
Pterygosquilla schizodontia	Stomatopoda			Hoplocarida	Malacostraca
Stomatopoda	Stomatopoda			Hoplocarida	Malacostraca
Aetideidae	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Aetideopsis tumorosa	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Augaptilus	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Calanidae	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Candacia bipinnata	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Candacia cheirura	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Chirundina streetsii	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Clausocalanus ingens	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Clausocalanus jobei	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Clausocalanus laticeps	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Ctenocalanus vanus	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Euaugaptilus nodifrons	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Eucalanidae	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Euchaetidae	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda

OTU	Order	Super order	Infraclass	Sub class	Class
Gaetanus kruppi	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Gaetanus minor	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Gaetanus pileatus	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Gaetanus pungens	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Gaetanus tenuispinus	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Haloptilus oxycephalus	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Heterorhabdus	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Heterorhabdus abyssalis	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Heterorhabdus austrinus	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Heterorhabdus pustulifer	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Heterorhabdus spinifrons	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Heterorhabdus spinosus	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Lucicutia	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Mecynocera clausi	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Neocalanus gracilis	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Paraeuchaeta biloba	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Paraeuchaeta pseudotonsa	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Undeuchaeta incisa	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Undeuchaeta plumosa	Calanoida	Gymnoplea	Neocopepoda	Copepoda	Maxillopoda
Chitinolepas spiritsensis	Ibliformes	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Arcoscalpellum affibricatum	Scalpelliformes	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Calantica spinilatera	Scalpelliformes	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Calantica spinosa	Scalpelliformes	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Calantica studeri	Scalpelliformes	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Graviscalpellum pedunculatum	Scalpelliformes	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Austrominius modestus	Sessilia	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Balanus	Sessilia	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Notobalanus vestitus	Sessilia	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Notomegabalanus decorus	Sessilia	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Pachylasma auranticacum	Sessilia	Thoracica	Cirripedia	Thecostraca	Maxillopoda
Maxillopoda					Maxillopoda

PHYLUM BRACHIOPODA

OTU	Order	Super order	Infraclass	Sub class	Class
*Novocrania huttoni**	Craniida				Craniata
Notosaria nigricans	Rhynchonellida				Rhynchonellata
Notosaria reinga	Rhynchonellida				Rhynchonellata
Aerothyris macquariensis	Terebratulida				Rhynchonellata
Calloria inconspicua	Terebratulida				Rhynchonellata
Calloria variegata	Terebratulida				Rhynchonellata
Gyrothyris mawsoni	Terebratulida				Rhynchonellata
Liothyrella	Terebratulida				Rhynchonellata
Liothyrella neozelanica	Terebratulida				Rhynchonellata
Neothyris compressa	Terebratulida				Rhynchonellata
Neothyris lenticularis	Terebratulida				Rhynchonellata
Neothyris parva	Terebratulida				Rhynchonellata
Terebratella haurakiensis	Terebratulida				Rhynchonellata
Terebratella sanguinea	Terebratulida				Rhynchonellata

* Sub-Phylum Craniiformea. The remaining OTUs are from Sub-Phylum Rhynchonelliformea.

PHYLUM BRYOZOA

OTU	Order	Super order	Infraclass	Sub class	Class
Adeonellopsis	Cheilostomatida				Gymnolaemata
Biflustra grandicella	Cheilostomatida				Gymnolaemata
Celleporaria agglutinans	Cheilostomatida				Gymnolaemata
Eurystomella aupouria	Cheilostomatida				Gymnolaemata
Eurystomella biperforata	Cheilostomatida				Gymnolaemata
Integripelta sextaria	Cheilostomatida				Gymnolaemata
Amathia wilsoni	Ctenostomatida				Gymnolaemata
Calvetia osheai	Cyclostomatida				Stenolaemata
Doliocoitis cyanea	Cyclostomatida				Stenolaemata
Hornera	Cyclostomatida				Stenolaemata
Liripora pseudosarniensis	Cyclostomatida				Stenolaemata
Spiritopora perplexa	Cyclostomatida				Stenolaemata

PHYLUM CHORDATA

OTU	Order	Super order	Infraclass	Sub class	Class
*Branchiostoma lanceolatum**					Leptocardii
*Epigonichthys hectori**					Leptocardii
Aplousobranchia†	Aplousobranchia				Ascidiacea
Cnemidocarpa†	Stolidobranchia				Ascidiacea
Cnemidocarpa nisiotis†	Stolidobranchia				Ascidiacea
Pyura pachydermatina†	Stolidobranchia				Ascidiacea
Pyura picta†	Stolidobranchia				Ascidiacea
Ascidiacea [Tunicates]†					Ascidiacea
Thaliacea [Salps]†					Thaliacea
Scorpaenidae‡	Scorpaeniformes				Actinopterygii

* Sub-Phylum Cephalochordata.
† Sub-Phylum Tunicata.
‡ Sub-Phylum Vertebrata, Super Class Ganthostomata.

PHYLUM CNIDARIA

OTU	Order	Super order	Infraclass	Sub class	Class
Actiniaria	Actiniaria			Hexacorallia	Anthozoa
Bunodactis	Actiniaria			Hexacorallia	Anthozoa
Bunodactis chrysobathys	Actiniaria			Hexacorallia	Anthozoa
Phellia aucklandica	Actiniaria			Hexacorallia	Anthozoa
Antipatharia	Antipatharia			Hexacorallia	Anthozoa
Antipathella	Antipatharia			Hexacorallia	Anthozoa
Antipathella fiordensis	Antipatharia			Hexacorallia	Anthozoa
Antipathes gracilis	Antipatharia			Hexacorallia	Anthozoa
Antipathes pauroclema	Antipatharia			Hexacorallia	Anthozoa
Myriopathidae	Antipatharia			Hexacorallia	Anthozoa
Stichopathes variabilis	Antipatharia			Hexacorallia	Anthozoa
Stylopathes tenuispina	Antipatharia			Hexacorallia	Anthozoa
Corynactis	Corallimorpharia			Hexacorallia	Anthozoa
Caryophyllia	Scleractinia			Hexacorallia	Anthozoa
Caryophyllia profunda	Scleractinia			Hexacorallia	Anthozoa
Caryophyllia quadragenaria	Scleractinia			Hexacorallia	Anthozoa
Desmophyllum	Scleractinia			Hexacorallia	Anthozoa
Desmophyllum cristagalli	Scleractinia			Hexacorallia	Anthozoa
Desmophyllum dianthus	Scleractinia			Hexacorallia	Anthozoa
Kionotrochus suteri	Scleractinia			Hexacorallia	Anthozoa

OTU	Order	Super order	Infraclass	Sub class	Class
Oculina virgosa	Scleractinia			Hexacorallia	Anthozoa
Scleractinia	Scleractinia			Hexacorallia	Anthozoa
Solenosmilia variabilis	Scleractinia			Hexacorallia	Anthozoa
Sphenotrochus squiresi	Scleractinia			Hexacorallia	Anthozoa
Tethocyathus cylindraceus	Scleractinia			Hexacorallia	Anthozoa
Epizoanthus	Zoantharia			Hexacorallia	Anthozoa
Epizoanthus paguriphilus	Zoantharia			Hexacorallia	Anthozoa
Parazoanthus	Zoantharia			Hexacorallia	Anthozoa
Savalia	Zoantharia			Hexacorallia	Anthozoa
Zoantharia	Zoantharia			Hexacorallia	Anthozoa
Zoanthidae	Zoantharia			Hexacorallia	Anthozoa
Alcyonacea	Alcyonacea			Octocorallia	Anthozoa
Alcyoniidae	Alcyonacea			Octocorallia	Anthozoa
Rhodelinda gardineri	Alcyonacea			Octocorallia	Anthozoa
Taiaroa tauhou	Alcyonacea			Octocorallia	Anthozoa
Telesto	Alcyonacea			Octocorallia	Anthozoa
Acanthogorgia	Gorgonacea			Octocorallia	Anthozoa
Acanthogorgiidae	Gorgonacea			Octocorallia	Anthozoa
Callogorgia	Gorgonacea			Octocorallia	Anthozoa
Callogorgia ventilabrum	Gorgonacea			Octocorallia	Anthozoa
Chrysogorgia	Gorgonacea			Octocorallia	Anthozoa
Echinisis	Gorgonacea			Octocorallia	Anthozoa
Fanellia	Gorgonacea			Octocorallia	Anthozoa
Gorgonacea	Gorgonacea			Octocorallia	Anthozoa
Keratoisis	*Gorgonacea*			Octocorallia	Anthozoa
Perissogorgia	*Gorgonacea*			Octocorallia	Anthozoa
Plexauridae	Gorgonacea			Octocorallia	Anthozoa
Primnoella	*Gorgonacea*			Octocorallia	Anthozoa
Primnoidae	Gorgonacea			Octocorallia	Anthozoa
Scleracis	*Gorgonacea*			Octocorallia	Anthozoa
Thouarella	*Gorgonacea*			Octocorallia	Anthozoa
Anthoptilum grandiflorum	*Pennatulacea*			Octocorallia	Anthozoa
Funiculina	*Pennatulacea*			Octocorallia	Anthozoa
Pennatulacea	Pennatulacea			Octocorallia	Anthozoa
Amphinema dinema	Anthoathecata			Hydroidolina	Hydrozoa
Barnettia caprai	Anthoathecata			Hydroidolina	Hydrozoa
Chitina ericopsis	Anthoathecata			Hydroidolina	Hydrozoa
Coryne pusilla	Anthoathecata			Hydroidolina	Hydrozoa
Ectopleura crocea	Anthoathecata			Hydroidolina	Hydrozoa
Eudendrium	Anthoathecata			Hydroidolina	Hydrozoa
Hydractinia novaezelandiae	Anthoathecata			Hydroidolina	Hydrozoa
Leuckartiara octona	Anthoathecata			Hydroidolina	Hydrozoa
Myriothela	Anthoathecata			Hydroidolina	Hydrozoa
Podocoryna minuta	Anthoathecata			Hydroidolina	Hydrozoa
Solanderia	Anthoathecata			Hydroidolina	Hydrozoa
Solanderia secunda	Anthoathecata			Hydroidolina	Hydrozoa
Stylaster eguchii	Anthoathecata			Hydroidolina	Hydrozoa
Stylasteridae	Anthoathecata			Hydroidolina	Hydrozoa
Turritopsis nutricula	Anthoathecata			Hydroidolina	Hydrozoa
Aglaophenia acanthocarpa	Leptothecata			Hydroidolina	Hydrozoa
Aglaophenia ctenata	Leptothecata			Hydroidolina	Hydrozoa
Aglaophenia laxa	Leptothecata			Hydroidolina	Hydrozoa
Amphisbetia	Leptothecata			Hydroidolina	Hydrozoa
Amphisbetia bispinosa	Leptothecata			Hydroidolina	Hydrozoa
Amphisbetia fasciculata	Leptothecata			Hydroidolina	Hydrozoa
Amphisbetia minima	Leptothecata			Hydroidolina	Hydrozoa

OTU	Order	Super order	Infraclass	Sub class	Class
Amphisbetia operculata	Leptothecata			Hydroidolina	Hydrozoa
Antennella kiwiana	Leptothecata			Hydroidolina	Hydrozoa
Antennella secundaria	Leptothecata			Hydroidolina	Hydrozoa
Clytia johnstoni	Leptothecata			Hydroidolina	Hydrozoa
Corhiza scotiae	Leptothecata			Hydroidolina	Hydrozoa
Crateritheca	Leptothecata			Hydroidolina	Hydrozoa
Crateritheca insignis	Leptothecata			Hydroidolina	Hydrozoa
Crateritheca novaezelandiae	Leptothecata			Hydroidolina	Hydrozoa
Crateritheca zelandica	Leptothecata			Hydroidolina	Hydrozoa
Cryptolaria	Leptothecata			Hydroidolina	Hydrozoa
Cryptolaria pectinata	Leptothecata			Hydroidolina	Hydrozoa
Cryptolaria prima	Leptothecata			Hydroidolina	Hydrozoa
Dictyocladium monilifer	Leptothecata			Hydroidolina	Hydrozoa
Filellum serpens	Leptothecata			Hydroidolina	Hydrozoa
Gonaxia	Leptothecata			Hydroidolina	Hydrozoa
Gonaxia immersa	Leptothecata			Hydroidolina	Hydrozoa
Gymnangium longirostre	Leptothecata			Hydroidolina	Hydrozoa
Gymnangium stolifer	Leptothecata			Hydroidolina	Hydrozoa
Halecium delicatulum	Leptothecata			Hydroidolina	Hydrozoa
Halopteris campanula	Leptothecata			Hydroidolina	Hydrozoa
Halopteris heterogona	Leptothecata			Hydroidolina	Hydrozoa
Hydrodendron	Leptothecata			Hydroidolina	Hydrozoa
Hydrodendron mirabile	Leptothecata			Hydroidolina	Hydrozoa
Lytocarpia chiltoni	Leptothecata			Hydroidolina	Hydrozoa
Lytocarpia incisa	Leptothecata			Hydroidolina	Hydrozoa
Lytocarpia spiralis	Leptothecata			Hydroidolina	Hydrozoa
Monotheca hyalina	Leptothecata			Hydroidolina	Hydrozoa
Nemertesia	Leptothecata			Hydroidolina	Hydrozoa
Nemertesia ciliata	Leptothecata			Hydroidolina	Hydrozoa
Nemertesia elongata	Leptothecata			Hydroidolina	Hydrozoa
Nemertesia pinnatifida	Leptothecata			Hydroidolina	Hydrozoa
Obelia bidentata	Leptothecata			Hydroidolina	Hydrozoa
Plumularia	Leptothecata			Hydroidolina	Hydrozoa
Plumularia diploptera	Leptothecata			Hydroidolina	Hydrozoa
Plumularia setacea	Leptothecata			Hydroidolina	Hydrozoa
Plumularia tenuissima	Leptothecata			Hydroidolina	Hydrozoa
Pycnotheca mirabilis	Leptothecata			Hydroidolina	Hydrozoa
Salacia bicalycula	Leptothecata			Hydroidolina	Hydrozoa
Salacia buski	Leptothecata			Hydroidolina	Hydrozoa
Sertularella geodiae	Leptothecata			Hydroidolina	Hydrozoa
Sertularella intricata	Leptothecata			Hydroidolina	Hydrozoa
Sertularella richardsoni	Leptothecata			Hydroidolina	Hydrozoa
Sertularia unguiculata	Leptothecata			Hydroidolina	Hydrozoa
Staurotheca megalotheca	Leptothecata			Hydroidolina	Hydrozoa
Stereotheca elongata	Leptothecata			Hydroidolina	Hydrozoa
Symplectoscyphus columnarius	Leptothecata			Hydroidolina	Hydrozoa
Symplectoscyphus johnstoni	Leptothecata			Hydroidolina	Hydrozoa
Symplectoscyphus subarticulatus	Leptothecata			Hydroidolina	Hydrozoa
Synthecium campylocarpum	Leptothecata			Hydroidolina	Hydrozoa
Synthecium elegans	Leptothecata			Hydroidolina	Hydrozoa
Synthecium longithecum	Leptothecata			Hydroidolina	Hydrozoa
Synthecium subventricosum	Leptothecata			Hydroidolina	Hydrozoa
Zygophylax	Leptothecata			Hydroidolina	Hydrozoa
Zygophylax antipathes	Leptothecata			Hydroidolina	Hydrozoa
Zygophylax polycarpa	Leptothecata			Hydroidolina	Hydrozoa
Zygophylax tizardensis	Leptothecata			Hydroidolina	Hydrozoa

OTU	Order	Super order	Infraclass	Sub class	Class
Zygophylax unilateralis	Leptothecata			Hydroidolina	Hydrozoa
Hydroida				Hydroidolina	Hydrozoa
Hydrozoa					Hydrozoa
Desmonema gaudichaudi	Semaeostomeae			Discomedusae	Scyphozoa

PHYLUM ECHINODERMATA, SUB-PHYLUM ASTEROZOA

OTU	Order	Super order	Infraclass	Sub class	Class
Brisinga chathamica	Brisingida				Asteroidea
Allostichaster insignis	Forcipulatida				Asteroidea
Allostichaster polyplax	Forcipulatida				Asteroidea
Sclerasterias mollis	Forcipulatida				Asteroidea
Stichaster australis	Forcipulatida				Asteroidea
Astromesites primigenius	Paxillosida				Asteroidea
Astropecten	Paxillosida				Asteroidea
Astropecten dubiosus	Paxillosida				Asteroidea
Astropecten polyacanthus	Paxillosida				Asteroidea
Luidia	Paxillosida				Asteroidea
Luidia maculata	Paxillosida				Asteroidea
Luidia neozelanica	Paxillosida				Asteroidea
Proserpinaster neozelanicus	Paxillosida				Asteroidea
Psilaster acuminatus	Paxillosida				Asteroidea
Henricia ralphae	Spinulosida				Asteroidea
Asterodiscides truncatus	Valvatida				Asteroidea
Crossaster campbellicus	Valvatida				Asteroidea
Diplodontias miliaris	Valvatida				Asteroidea
Mediaster sladeni	Valvatida				Asteroidea
Nepanthia reinga	Valvatida				Asteroidea
Odontaster aucklandensis	Valvatida				Asteroidea
Odontaster benhami	Valvatida				Asteroidea
Odontaster meridionalis	Valvatida				Asteroidea
Ophidiaster macknighti	Valvatida				Asteroidea
Patiriella regularis	Valvatida				Asteroidea
Pentagonaster pulchellus	Valvatida				Asteroidea
Stegnaster inflatus	Valvatida				Asteroidea
Pteraster (Pteraster) robertsoni	Velatida				Asteroidea
Asteroidea					Asteroidea
Asteroporpa australiensis	Euryalida				Ophiuroidea
Astroceras elegans	Euryalida				Ophiuroidea
Astrothrombus vecors	Euryalida				Ophiuroidea
Ophiocreas sibogae	Euryalida				Ophiuroidea
Amphipholis squamata	Ophiurida				Ophiuroidea
Amphiura (A.) aster	Ophiurida				Ophiuroidea
Amphiura (A.) correcta	Ophiurida				Ophiuroidea
Amphiura (A.) pusilla	Ophiurida				Ophiuroidea
Amphiura (A.) spinipes	Ophiurida				Ophiuroidea
Clarkcoma	Ophiurida				Ophiuroidea
Macrophiothrix oliveri	Ophiurida				Ophiuroidea
Ophiacantha otagoensis	Ophiurida				Ophiuroidea
Ophiactis resiliens	Ophiurida				Ophiuroidea
Ophiomyxa brevirima	Ophiurida				Ophiuroidea
Ophionereis fasciata	Ophiurida				Ophiuroidea
Ophionereis novaezelandiae	Ophiurida				Ophiuroidea
Ophiopeza cylindrica	Ophiurida				Ophiuroidea

OTU	Order	Super order	Infraclass	Sub class	Class
Ophiopsammus assimilis	Ophiurida				Ophiuroidea
Ophiopsammus maculata	Ophiurida				Ophiuroidea
Ophiozonoida picta	Ophiurida				Ophiuroidea
Ophiuroidea					Ophiuroidea

PHYLUM ECHINODERMATA, SUB-PHYLUM CRINOZOA & SUB-PHYLUM ECHINOZOA

OTU	Order	Super order	Infraclass	Sub class	Class
*Argyrometra mortenseni**	Comatulida			Articulata	Crinoidea
Taeniogyrus dendyi	Apodida				Holothuroidea
Taeniogyrus dunedinensis	Apodida				Holothuroidea
Australostichopus mollis	Aspidochirotida				Holothuroidea
Bathyplotes moseleyi	Aspidochirotida				Holothuroidea
Amphicyclus thomsoni	Dendrochirotida				Holothuroidea
Echinocucumis hispida	Dendrochirotida				Holothuroidea
Heterothyone alba	Dendrochirotida				Holothuroidea
Heterothyone ocnoides	Dendrochirotida				Holothuroidea
Neothyonidium armatum	Dendrochirotida				Holothuroidea
Placothuria huttoni	Dendrochirotida				Holothuroidea
Squamocnus brevidentis	Dendrochirotida				Holothuroidea
Squamocnus niveus	Dendrochirotida				Holothuroidea
Heteromolpadia marenzelleri	Molpadida				Holothuroidea
Holothuroidea					Holothuroidea
Goniocidaris corona	Cidaroida			Cidaroidea	Echinoidea
Goniocidaris peltata	Cidaroida			Cidaroidea	Echinoidea
Goniocidaris umbraculum	Cidaroida			Cidaroidea	Echinoidea
Prionocidaris callista	Cidaroida			Cidaroidea	Echinoidea
Diadema palmeri	Diadematoida		Acroechinoidea	Euechinoidea	Echinoidea
Evechinus chloroticus	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Pseudechinus	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Pseudechinus flemingi	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Pseudechinus huttoni	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Brissopsis oldhami	Spatangoida	Atelostomata	Irregularia	Euechinoidea	Echinoidea
Cyclaster regalis	Spatangoida	Atelostomata	Irregularia	Euechinoidea	Echinoidea
Echinocardium cordatum	Spatangoida	Atelostomata	Irregularia	Euechinoidea	Echinoidea
Paramaretia	Spatangoida	Atelostomata	Irregularia	Euechinoidea	Echinoidea
Paramaretia tuberculata	Spatangoida	Atelostomata	Irregularia	Euechinoidea	Echinoidea
Spatangus multispinus	Spatangoida	Atelostomata	Irregularia	Euechinoidea	Echinoidea
Clypeaster	Clypeasteroida	Neognathostomata	Irregularia	Euechinoidea	Echinoidea
Clypeaster australasiae	Clypeasteroida	Neognathostomata	Irregularia	Euechinoidea	Echinoidea
Fellaster zelandiae	Clypeasteroida	Neognathostomata	Irregularia	Euechinoidea	Echinoidea
Peronella hinemoae	Clypeasteroida	Neognathostomata	Irregularia	Euechinoidea	Echinoidea
Echinoidea					Echinoidea

* Sub-Phylum Crinozoa. The remaining belong to Sub-Phylum Echinozoa.

PHYLUM FORAMINIFERA

OTU	Order	Super order	Infraclass	Sub class	Class
Granuloreticulosea					Granuloreticulosea

PHYLUM HEMICHORDATA

OTU	Order	Super order	Infraclass	Sub class	Class
Balanoglossus australiensis					Enteropneusta

PHYLUM MOLLUSCA

OTU	Order	Super order	Infraclass	Sub class	Class
Divaricella huttoniana	Lucinoida		Euheterodonta	Heterodonta	Bivalvia
Austrovenus stutchburyi	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Bassina yatei	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Cardita aoteana	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Dosinia	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Dosinia greyi	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Mactridae	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Oxyperas elongata	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Paphies subtriangulata	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Tawera spissa	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Venericardia purpurata	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Barbatia novaezealandiae	Arcoida			Pteriomorphia	Bivalvia
Glycymerididae	Arcoida			Pteriomorphia	Bivalvia
Limatula vigilis	Limoida			Pteriomorphia	Bivalvia
Aulacomya atra	Mytiloida			Pteriomorphia	Bivalvia
Modiolus areolatus	Mytiloida			Pteriomorphia	Bivalvia
Chlamys	Ostreoida			Pteriomorphia	Bivalvia
Mesopeplum convexum	Ostreoida			Pteriomorphia	Bivalvia
Pecten novaezelandiae	Ostreoida			Pteriomorphia	Bivalvia
Pectinidae	Ostreoida			Pteriomorphia	Bivalvia
Zygochlamys	Ostreoida			Pteriomorphia	Bivalvia
Zygochlamys delicatula	Ostreoida			Pteriomorphia	Bivalvia
Chiroteuthis joubini	Oegopsida	Decapodiformes		Coleoidea	Cephalopoda
Onychoteuthis	Oegopsida	Decapodiformes		Coleoidea	Cephalopoda
Sepiolidae	Sepiolida	Decapodiformes		Coleoidea	Cephalopoda
Octopus campbelli	Octopoda	Octopodiformes		Coleoidea	Cephalopoda
Ocythoe tuberculata	Octopoda	Octopodiformes		Coleoidea	Cephalopoda
Pinnoctopus cordiformis	Octopoda	Octopodiformes		Coleoidea	Cephalopoda
Cephalopoda					Cephalopoda
Argobuccinum pustulosum	Littorinimorpha			Caenogastropoda	Gastropoda
Fusitriton laudandus	Littorinimorpha			Caenogastropoda	Gastropoda
Ranella	Littorinimorpha			Caenogastropoda	Gastropoda
Semicassis pyrum	Littorinimorpha			Caenogastropoda	Gastropoda
Xenophora	Littorinimorpha			Caenogastropoda	Gastropoda
Alcithoe arabica	Neogastropoda			Caenogastropoda	Gastropoda
Alcithoe davegibbsi	Neogastropoda			Caenogastropoda	Gastropoda
Alcithoe ostenfeldi	Neogastropoda			Caenogastropoda	Gastropoda
Austrofusus glans	Neogastropoda			Caenogastropoda	Gastropoda
Penion cuvierianus	Neogastropoda			Caenogastropoda	Gastropoda
Armina	Nudibranchia		Opisthobranchia	Heterobranchia	Gastropoda
Dorididae	Nudibranchia		Opisthobranchia	Heterobranchia	Gastropoda
Doris wellingtonensis	Nudibranchia		Opisthobranchia	Heterobranchia	Gastropoda
Nudibranchia	Nudibranchia		Opisthobranchia	Heterobranchia	Gastropoda

Tritonia	Nudibranchia		Opisthobranchia	Heterobranchia	Gastropoda
Pleurobranchaea maculata	Pleurobranchomorpha		Opisthobranchia	Heterobranchia	Gastropoda
Thecosomata	Thecosomata		Opisthobranchia	Heterobranchia	Gastropoda
Astraea heliotropium				Vetigastropoda	Gastropoda
Gastropoda					Gastropoda
Polyplacophora					
Scaphopoda					

PHYLUM PHORONIDA

OTU	Order	Super order	Infraclass	Sub class	Class
Phoronis psammophila					

PHYLUM PORIFERA

OTU	Order	Super order	Infraclass	Sub class	Class
Leucettusa	Clathrinida			Calcinea	Calcarea
Leucettusa tubulosa	Clathrinida			Calcinea	Calcarea
Ancorina alata	Astrophorida				Demospongiae
Ancorina bellae	Astrophorida				Demospongiae
Astrophorida	Astrophorida				Demospongiae
Ecionemia alata	Astrophorida				Demospongiae
Ecionemia novaezealandiae	Astrophorida				Demospongiae
Geodia	Astrophorida				Demospongiae
Lamellomorpha	Astrophorida				Demospongiae
Penares tylotaster	Astrophorida				Demospongiae
Stelletta	Astrophorida				Demospongiae
Stelletta sandalinum	Astrophorida				Demospongiae
Stryphnus ariena	Astrophorida				Demospongiae
Stryphnus levis	Astrophorida				Demospongiae
Stryphnus spelunca	Astrophorida				Demospongiae
Tethyopsis	Astrophorida				Demospongiae
Tethyopsis mortenseni	Astrophorida				Demospongiae
Chondrosia	Chondrosida				Demospongiae
Chelonaplysilla violacea	Dendroceratida				Demospongiae
Dictyodendrilla	Dendroceratida				Demospongiae
Dictyodendrilla dendyi	Dendroceratida				Demospongiae
Aplysinopsis	Dictyoceratida				Demospongiae
Cacospongia	Dictyoceratida				Demospongiae
Coscinoderma	Dictyoceratida				Demospongiae
Dysidea	Dictyoceratida				Demospongiae
Psammocinia	Dictyoceratida				Demospongiae
Spongia	Dictyoceratida				Demospongiae
Aaptos globosum	Hadromerida				Demospongiae
Acanthella	Hadromerida				Demospongiae
Acanthoclada	Hadromerida				Demospongiae
Acanthoclada prostrata	Hadromerida				Demospongiae
Axinella	Hadromerida				Demospongiae
Bubaris	Hadromerida				Demospongiae
Ciocalypta	Hadromerida				Demospongiae
Ciocalypta polymastia	Hadromerida				Demospongiae
Cliona	Hadromerida				Demospongiae
Cliona celata	Hadromerida				Demospongiae
Homaxinella erecta	Hadromerida				Demospongiae
Hymeniacidon sphaerodigitata	Hadromerida				Demospongiae
Hymerhabdia	Hadromerida				Demospongiae

OTU	Order	Super order	Infraclass	Sub class	Class
Pararhaphoxya	Hadromerida				Demospongiae
Phakellia	Hadromerida				Demospongiae
Phakellia dendyi	Hadromerida				Demospongiae
Plicatellopsis	Hadromerida				Demospongiae
Polymastia	Hadromerida				Demospongiae
Polymastia crocea	Hadromerida				Demospongiae
Polymastia hirsuta	Hadromerida				Demospongiae
Polymastiidae	Hadromerida				Demospongiae
Protosuberites	Hadromerida				Demospongiae
Rhaphidhistia mirabilis	Hadromerida				Demospongiae
Stylissa	Hadromerida				Demospongiae
Suberites	Hadromerida				Demospongiae
Tentorium	Hadromerida				Demospongiae
Tethya amplexa	Hadromerida				Demospongiae
Trachycladus stylifer	Hadromerida				Demospongiae
Callyspongia	Haplosclerida				Demospongiae
Callyspongia ramosa	Haplosclerida				Demospongiae
Calyx imperialis	Haplosclerida				Demospongiae
Dactylia	Haplosclerida				Demospongiae
Dactylia palmata	Haplosclerida				Demospongiae
Haliclona	Haplosclerida				Demospongiae
Haliclona petrocalyx	Haplosclerida				Demospongiae
Pachypellina	Haplosclerida				Demospongiae
Petrosia	Haplosclerida				Demospongiae
Petrosia hebes	Haplosclerida				Demospongiae
Siphonochalina	Haplosclerida				Demospongiae
Xestospongia	Haplosclerida				Demospongiae
Xestospongia novaezealandiae	Haplosclerida				Demospongiae
Aciculites manawatawhi	Lithistid Demospongiae				Demospongiae
Aciculites pulchra	Lithistid Demospongiae				Demospongiae
Aciculites sulcus	Lithistid Demospongiae				Demospongiae
Homophymia stipitata	Lithistid Demospongiae				Demospongiae
Pleroma menoui	Lithistid Demospongiae				Demospongiae
Amphiastrella kirkpatricki	Poecilosclerida				Demospongiae
Asbestopluma	Poecilosclerida				Demospongiae
Biemna flabellata	Poecilosclerida				Demospongiae
Biemna rufescens	Poecilosclerida				Demospongiae
Chondropsidae	Poecilosclerida				Demospongiae
Chondropsis	Poecilosclerida				Demospongiae
Chondropsis kirki	Poecilosclerida				Demospongiae
Clathria	Poecilosclerida				Demospongiae
Clathria atoxa	Poecilosclerida				Demospongiae
Clathria scotti	Poecilosclerida				Demospongiae
Clathria terraenovae	Poecilosclerida				Demospongiae
Crambe	Poecilosclerida				Demospongiae
Crella	Poecilosclerida				Demospongiae
Crella incrustans	Poecilosclerida				Demospongiae
Crella novaezealandiae	Poecilosclerida				Demospongiae
Dendoricella	Poecilosclerida				Demospongiae
Desmacidon mamillatum	Poecilosclerida				Demospongiae
Guitarra fimbriata	Poecilosclerida				Demospongiae
Hamigera	Poecilosclerida				Demospongiae
Histodermella	Poecilosclerida				Demospongiae
Hymedesmia australis	Poecilosclerida				Demospongiae
Iophon laevistylus	Poecilosclerida				Demospongiae
Iophon minor	Poecilosclerida				Demospongiae

OTU	Order	Super order	Infraclass	Sub class	Class
Iophon proximum	Poecilosclerida				Demospongiae
Latrunculia	Poecilosclerida				Demospongiae
Latrunculia duckworthi	Poecilosclerida				Demospongiae
Latrunculia kaakaariki	Poecilosclerida				Demospongiae
Latrunculia millerae	Poecilosclerida				Demospongiae
Latrunculia oxydiscorhabda	Poecilosclerida				Demospongiae
Latrunculia wellingtonensis	Poecilosclerida				Demospongiae
Lissodendoryx	Poecilosclerida				Demospongiae
Mycale	Poecilosclerida				Demospongiae
Oceanapia	Poecilosclerida				Demospongiae
Paracornulum	Poecilosclerida				Demospongiae
Phorbas	Poecilosclerida				Demospongiae
Phorbas areolatus	Poecilosclerida				Demospongiae
Phorbas intermedia	Poecilosclerida				Demospongiae
Psammoclema	Poecilosclerida				Demospongiae
Raspailia	Poecilosclerida				Demospongiae
Raspailia compressa	Poecilosclerida				Demospongiae
Raspailia topsenti	Poecilosclerida				Demospongiae
Tedania	Poecilosclerida				Demospongiae
Tedania battershilli	Poecilosclerida				Demospongiae
Tedania connectens	Poecilosclerida				Demospongiae
Tedania diversirhaphidiophora	Poecilosclerida				Demospongiae
Tedania spinostylota	Poecilosclerida				Demospongiae
Tedania turbinata	Poecilosclerida				Demospongiae
Cinachyrella	Spirophorida				Demospongiae
Craniella	Spirophorida				Demospongiae
Tetilla	Spirophorida				Demospongiae
Symplectella rowi	Lyssacinosida			Hexasterophora	Hexactinellida
Hexactinellida					Hexactinellida

PHYLUM SIPUNCULA

OTU	Order	Super order	Infraclass	Sub class	Class
Sipunculidae	Golfingiida				Sipunculidea

PHYLUM XENACOELOMORPHA, SUB-PHYLUM ACOELOMORPHA

OTU	Order	Super order	Infraclass	Sub class	Class
Polychoerus gordoni	Acoela				

APPENDIX 3b: OPERATIONAL TAXONOMIC UNIT (OTU) *TRAWL* DATABASE

PHYLUM ANNELIDA

OTU	Order	Super order	Infraclass	Sub class	Class
Hirudinea					Clitellata
Aphrodita	Phyllodocida			Aciculata	Polychaeta
Glycera	Phyllodocida			Aciculata	Polychaeta
Nereididae	Phyllodocida			Aciculata	Polychaeta
Polynoidae	Phyllodocida			Aciculata	Polychaeta
Sabellidae	Sabellida			Canalipalpata	Polychaeta
Chaetopterus	Spionida			Canalipalpata	Polychaeta
Polychaeta					Polychaeta

PHYLUM ARTHROPODA

OTU	Order	Super order	Infraclass	Sub class	Class
Pantopoda*	Pantopoda				Pycnogonida
Artemia salina	Anostraca			Sarsostraca	Branchiopoda
Alpheus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Arctides antipodarum	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Cancer novaezelandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Chlorotocus novaezealandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Crangonidae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Decapoda	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Diacanthurus rubricatus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Galatheidae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Haliporoides sibogae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Ibacus alticrenatus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Jacquinotia edwardsii	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Jasus edwardsii	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax australis	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax garricki	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax longimanus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Leptomithrax longipes	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Lithodes	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Metanephrops challengeri	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Munida	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Munida gregaria	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Nectocarcinus antarcticus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Nectocarcinus bennetti	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Nematocarcinus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Notopandalus magnoculus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Oplophorus novaezeelandiae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Ovalipes catharus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Palinuridae	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Pasiphaea	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Pasiphaea barnardi	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Plagusia chabrus	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Sergestes spp.	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Sergia potens	Decapoda	Eucarida		Eumalacostraca	Malacostraca
Euphausia	Euphausiacea	Eucarida		Eumalacostraca	Malacostraca
Amphipoda	Amphipoda	Peracarida		Eumalacostraca	Malacostraca
Isopoda	Isopoda	Peracarida		Eumalacostraca	Malacostraca
Mysida	Mysida	Peracarida		Eumalacostraca	Malacostraca

OTU	Order	Super order	Infraclass	Sub class	Class
Squilla armata	Stomatopoda			Hoplocarida	Malacostraca
Maxillopoda					Maxillopoda
Crustacea					

*Sub-Phylum Chelicerata. The remainder belong to Sub-Phylum Crustacea.

PHYLUM BRACHIOPODA

OTU	Order	Super order	Infraclass	Sub class	Class
Brachiopoda					

PHYLUM BRYOZOA

OTU	Order	Super order	Infraclass	Sub class	Class
Celleporina grandis	Cheilostomatida				Gymnolaemata
Hippomenella vellicata	Cheilostomatida				Gymnolaemata
Bryozoa					

PHYLUM CHORDATA

OTU	Order	Super order	Infraclass	Sub class	Class
Pyura pachydermatina	Stolidobranchia				Ascidiacea
Ascidiacea					Ascidiacea

PHYLUM CNIDARIA

OTU	Order	Super order	Infraclass	Sub class	Class
Actinostolidae	Actiniaria			Hexacorallia	Anthozoa
Bunodactis chrysobathys	Actiniaria			Hexacorallia	Anthozoa
Hormathiidae	Actiniaria			Hexacorallia	Anthozoa
Flabellum	Scleractinia			Hexacorallia	Anthozoa
Stephanocyathus platypus	Scleractinia			Hexacorallia	Anthozoa
Pennatulacea	Pennatulacea			Octocorallia	Anthozoa
Anthozoa					Anthozoa
Stylasteridae	Anthoathecata			Hydroidolina	Hydrozoa
Hydrozoa					Hydrozoa

PHYLUM ECHINODERMATA

OTU	Order	Super order	Infraclass	Sub class	Class
*Cosmasterias dyscrita**	Forcipulatida				Asteroidea
*Pseudechinaster rubens**	Forcipulatida				Asteroidea
*Sclerasterias mollis**	Forcipulatida				Asteroidea
*Dipsacaster magnificus**	Paxillosida				Asteroidea
*Proserpinaster neozelanicus**	Paxillosida				Asteroidea
*Psilaster acuminatus**	Paxillosida				Asteroidea
*Crossaster multispinus**	Valvatida				Asteroidea
*Mediaster sladeni**	Valvatida				Asteroidea
*Odontaster**	Valvatida				Asteroidea
*Patiriella**	Valvatida				Asteroidea
*Patiriella regularis**	Valvatida				Asteroidea
*Diplopteraster**	Velatida				Asteroidea
*Peribolaster lictor**	Velatida				Asteroidea
*Pteraster bathamae**	Velatida				Asteroidea
Asteroidea*					Asteroidea

OTU	Order	Super order	Infraclass	Sub class	Class
*Bathypectinura heros**	Ophiurida				Ophiuroidea
*Ophiopsammus maculata**	Ophiurida				Ophiuroidea
Brittlestar*					Ophiuroidea
Bathyplotes spp.	Aspidochirotida				Holothuroidea
Pseudostichopus mollis	Aspidochirotida				Holothuroidea
Stichopus mollis	Aspidochirotida				Holothuroidea
Cidaridae	Cidaroida			Cidaroidea	Echinoidea
Goniocidaris umbraculum	Cidaroida			Cidaroidea	Echinoidea
Evechinus chloroticus	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Gracilechinus multidentatus	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Pseudechinus albocinctus	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Pseudechinus huttoni	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Pseudechinus novaezealandiae	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Temnopleuridae	Camarodonta	Echinacea	Carinacea	Euechinoidea	Echinoidea
Paramaretia peloria	Spatangoida	Atelostomata	Irregularia	Euechinoidea	Echinoidea
Spatangus multispinus	Spatangoida	Atelostomata	Irregularia	Euechinoidea	Echinoidea
Apatopygus recens	Cassiduloida	Neognathostomata	Irregularia	Euechinoidea	Echinoidea
Fellaster zelandiae	Clypeasteroida	Neognathostomata	Irregularia	Euechinoidea	Echinoidea
Peronella hinemoae	Clypeasteroida	Neognathostomata	Irregularia	Euechinoidea	Echinoidea
Echinoidea					Echinoidea
Echinoderms					

* Sub-Phylum Asterozoa. The remainder are Sub-Phylum Echinozoa.

PHYLUM MOLLUSCA

OTU	Order	Super order	Infraclass	Sub class	Class
Mactra murchisoni	Veneroida		Euheterodonta	Heterodonta	Bivalvia
Modiolarca impacta	Mytiloida			Pteriomorphia	Bivalvia
Mytilidae	Mytiloida			Pteriomorphia	Bivalvia
Mytilus galloprovincialis	Mytiloida			Pteriomorphia	Bivalvia
Perna canaliculus	Mytiloida			Pteriomorphia	Bivalvia
Mesopeplum convexum	Ostreoida			Pteriomorphia	Bivalvia
Ostrea chilensis	Ostreoida			Pteriomorphia	Bivalvia
Pecten novaezelandiae	Ostreoida			Pteriomorphia	Bivalvia
Zygochlamys delicatula	Ostreoida			Pteriomorphia	Bivalvia
Atrina zelandica	Pterioida			Pteriomorphia	Bivalvia
Bivalvia					Bivalvia
Argobuccinum pustulosum tumidum	Littorinimorpha			Caenogastropoda	Gastropoda
Fusitriton magellanicus	Littorinimorpha			Caenogastropoda	Gastropoda
Semicassis pyrum	Littorinimorpha			Caenogastropoda	Gastropoda
Alcithoe arabica	Neogastropoda			Caenogastropoda	Gastropoda
Alcithoe larochei	Neogastropoda			Caenogastropoda	Gastropoda
Alcithoe wilsonae	Neogastropoda			Caenogastropoda	Gastropoda
Austrofusus glans	Neogastropoda			Caenogastropoda	Gastropoda
Penion chathamensis	Neogastropoda			Caenogastropoda	Gastropoda
Provocator mirabilis	Neogastropoda			Caenogastropoda	Gastropoda
Volutidae	Neogastropoda			Caenogastropoda	Gastropoda
Aplysiomorpha	Anaspidea		Opisthobranchia	Heterobranchia	Gastropoda
Nudibranchia	Nudibranchia		Opisthobranchia	Heterobranchia	Gastropoda
Astraea heliotropium				Vetigastropoda	Gastropoda
Calliostoma selectum				Vetigastropoda	Gastropoda
Calliostoma turnerarum				Vetigastropoda	Gastropoda
Cookia sulcata				Vetigastropoda	Gastropoda

OTU	Order	Super order	Infraclass	Sub class	Class
Scutus breviculus				Vetigastropoda	Gastropoda
Gastropoda					Gastropoda
Scaphopoda					

PHYLUM PORIFERA

OTU	Order	Super order	Infraclass	Sub class	Class
Geodia vestigifera	Astrophorida				Demospongiae
Penares	Astrophorida				Demospongiae
Stelletta	Astrophorida				Demospongiae
Suberites affinis	Hadromerida				Demospongiae
Callyspongia	Haplosclerida				Demospongiae
Callyspongia ramosa	Haplosclerida				Demospongiae
Dactylia palmata	Haplosclerida				Demospongiae
Crella incrustans	Poecilosclerida				Demospongiae
Tetilla leptoderma	Spirophorida				Demospongiae
Demospongiae					Demospongiae
Hexactinellida					Hexactinellida
Porifera					

APPENDIX 4: TRAWL FISHING DATA

Table 4.1: Percentage of TCER trips each fishing year with between 1 and 146 tows per trip, based on a total of 222 787 tows.

No. tows per trip	2008	2009	2010	2011	2012	2008–12
1	13.2	11.3	10.9	10.7	10.3	11.3
2	17.3	21.1	20.2	22.3	21.2	20.4
3	10.2	9.4	10.0	9.4	10.2	9.8
4	7.7	6.9	7.8	7.1	8.0	7.5
5	5.1	5.0	5.1	5.0	5.2	5.1
6	5.8	5.6	5.8	5.2	5.6	5.6
7	5.8	5.6	5.1	5.3	4.9	5.3
8	5.2	5.0	4.8	5.4	5.4	5.1
9	4.1	4.2	4.1	3.9	3.7	4.0
10	3.7	3.6	3.7	3.9	4.0	3.8
11	3.5	3.8	3.7	3.0	3.3	3.5
12	3.2	3.2	3.4	3.3	3.3	3.3
13	2.5	2.4	2.2	2.3	2.3	2.3
14	2.2	2.2	2.5	2.4	2.3	2.3
15	2.1	2.2	2.1	2.1	1.9	2.1
16	1.9	1.9	1.9	1.9	1.9	1.9
17	1.4	1.6	1.3	1.5	1.4	1.4
18	1.3	1.3	1.4	1.5	1.5	1.4
19	0.7	1.2	1.0	1.1	0.8	1.0
20	1.0	0.7	0.9	0.9	0.8	0.9
21	0.4	0.5	0.5	0.6	0.6	0.5
22	0.4	0.5	0.5	0.4	0.4	0.4
23	0.4	0.3	0.4	0.4	0.5	0.4
24	0.2	0.3	0.2	0.3	0.3	0.2
25	0.3	0.1	0.1	0.1	0.2	0.1
26	0.1	0.1	0.1	0.1	0.1	0.1
27	0.1	0.1	0.0	0.0	0.1	0.1
28	0.1	0.0	0.0	0.0	0.1	0.1
29	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.0	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0	0.0	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0
51	0.0	0.0	0.0	0.0	0.0	0.0
52	0.0	0.0	0.0	0.0	0.0	0.0
56	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0
65	0.0	0.0	0.0	0.0	0.0	0.0
69	0.0	0.0	0.0	0.0	0.0	0.0
146	0.0	0.0	0.0	0.0	0.0	0.0
Total no. trips	6 348	6 553	7 397	6 723	6 823	33 834

Table 4.2: Number of tows reported on TCERs, by main target species and fishing year. Target species codes are defined in Table 3.

Target code	2008	2009	2010	2011	2012	All
BAR	1 989	1 484	1 214	1 086	1 307	7 080
BCO	8	2	10	1	9	30
BNS	0	0	0	1	2	3
BYX	1	0	1	0	0	2
ELE	588	689	850	607	717	3 451
EMA	0	0	0	0	0	0
FLA	16 726	16 526	18 862	14 667	16 535	83 316
GSH	164	559	699	802	486	2 710
GUR	4 092	4 482	5 929	5 859	6 276	26 638
HOK	113	63	173	140	66	555
HPB	43	34	41	31	15	164
JDO	1 554	1 239	1 474	1 027	836	6 130
JMA	1	1	9	11	1	23
LEA	62	77	222	150	281	792
LIN	88	66	100	110	61	425
MOK	72	78	54	136	85	425
PAD	58	8	9	27	17	119
QSC	95	205	95	21	40	456
RBT	0	0	0	0	0	0
RBY	0	2	0	0	6	8
RCO	2 834	2 684	2 611	2 671	2 453	13 253
RSK	3	8	72	63	25	171
SCH	68	96	57	83	72	376
SCI	0	0	0	0	0	0
SKI	5	27	32	79	22	165
SNA	1 953	2 119	2 027	2 421	2 191	10 711
SPD	260	386	318	187	151	1 302
SPE	25	25	118	151	35	354
SPO	16	67	132	112	156	483
SQU	400	29	73	62	79	643
STA	1 289	1 370	1 866	1 705	1 431	7 661
SWA	14	56	69	81	82	302
TAR	7 426	8 908	9 449	9 576	9 156	44 515
TRE	1 092	1 116	1 306	1 372	796	5 682
WAR	844	850	885	1 059	1 166	4 804
Others	11	1	12	13	1	38
	41 894	43 257	48 769	44 311	44 556	222 787

* Others includes: HAK, KAH, LDO, MDO, ORH, RSN, SDO, SPZ, and WWA.

Table 4.3: Number of tows reported on TCEPRs, by main target species and fishing year, and the percentage of the total tows for each target species, by vessel size category (A–D). Target species codes are defined in Table 3.

Target code	2008	2009	2010	2011	2012	Total tows	% vess A	% vess B	% vess C	% vess D
BAR	698	796	925	933	858	4 210	29.5	4.0	31.9	34.6
BCO	0	0	0	0	0	0	0.0	1.0	2.0	3.0
BNS	16	1	1	0	0	18	27.8	72.2	0.0	0.0
BYX	4	4	11	3	1	23	0.0	100.0	0.0	0.0
ELE	30	0	2	54	61	147	53.7	46.3	0.0	0.0
EMA	15	33	14	5	69	136	0.0	0.0	0.0	100.0
FLA	3	0	0	0	0	3	100.0	0.0	0.0	0.0
GSH	4	0	0	1	2	7	42.9	42.9	14.3	0.0
GUR	660	360	778	460	309	2 567	48.7	51.3	0.0	0.0
HOK	363	390	357	398	435	1 943	3.0	87.5	9.0	0.4
HPB	0	0	0	1	0	1	0.0	100.0	0.0	0.0
JDO	493	678	563	619	577	2 930	97.8	2.2	0.0	0.0
JMA	2 359	1 954	2 299	1 823	1 861	10 296	0.0	0.1	2.0	97.9
LEA	5	9	2	3	41	60	90.0	10.0	0.0	0.0
LIN	30	16	15	11	2	74	0.0	25.7	74.3	0.0
MOK	1	0	4	5	0	10	0.0	100.0	0.0	0.0
PAD	0	0	0	0	0	0	–	–	–	–
QSC	0	0	0	0	0	0	–	–	–	–
RBT	12	40	11	3	19	85	0.0	0.0	0.0	100.0
RBY	6	1	10	15	3	35	2.9	97.1	0.0	0.0
RCO	12	60	97	79	34	282	77.3	22.3	0.4	0.0
RSK	0	0	0	0	0	0	–	–	–	–
SCH	6	2	12	19	26	65	15.4	84.6	0.0	0.0
SCI	23	21	32	16	10	102	100.0	0.0	0.0	0.0
SKI	9	24	19	47	16	115	36.5	63.5	0.0	0.0
SNA	1 991	2 049	1 845	1 449	1 973	9 307	86.4	13.6	0.0	0.0
SPD	6	2	20	1	0	29	0.0	0.0	100.0	0.0
SPE	0	0	0	9	0	9	0.0	100.0	0.0	0.0
SPO	0	1	0	0	0	1	0.0	100.0	0.0	0.0
SQU	2 141	1 592	1 935	2 100	1 633	9 401	1.6	2.7	58.5	37.2
STA	14	0	11	25	14	64	1.6	98.4	0.0	0.0
SWA	217	163	124	181	115	800	4.1	6.6	89.1	0.1
TAR	2 850	2 617	2 521	2 247	2 062	12 297	64.3	35.7	0.0	0.0
TRE	1 679	1 911	1 543	1 971	1 771	8 875	65.3	34.7	0.0	0.0
WAR	176	126	136	136	156	730	11.8	33.2	50.7	4.4
Others*	15	18	4	3	7	47	–	–	–	–
	13 838	12 868	13 291	12 617	12 055	64 669	43.2	20.1	13.0	23.6

* Others includes: CDL, FRO, HAK, KAH, KIN, OEO, ORH, and WWA.

Table 4.4: Number of TCER tows in each Statistical Area, by fishing year and for all years combined, and the percent of the five year total in each area.

Statistical Area	2008	2009	2010	2011	2012	2008–12	%
002	362	328	299	338	270	1 597	0.72
003	959	809	1 008	744	684	4 204	1.89
004	27	7	13	4	4	55	0.02
005	801	895	859	633	498	3 686	1.65
006	230	463	338	521	399	1 951	0.88
007	2	0	1	2	3	8	0.00
008	294	310	332	217	332	1 485	0.67
009	506	466	575	636	448	2 631	1.18
010	490	734	714	542	365	2 845	1.28
011	741	551	770	619	704	3 385	1.52
012	838	915	1 185	831	851	4 620	2.07
013	4 045	4 345	4 641	4 832	4 202	22 065	9.90
014	1 999	1 902	1 486	1 916	1 819	9122	4.09
015	110	187	203	261	196	957	0.43
016	449	421	488	525	580	2 463	1.11
017	931	1 287	1 812	1 885	1 893	7 808	3.50
018	348	380	625	620	601	2 574	1.16
020	2 164	2 482	3 415	2 646	2 443	13 150	5.90
022	3 512	4 347	4 560	4 520	4 474	21 413	9.61
024	2 016	1 914	2 271	2 471	2 476	11 148	5.00
025	1 720	1 159	1 064	743	1 013	5 699	2.56
026	3 379	2 832	3 465	2 813	3 111	15 600	7.00
027	10	16	7	12	15	60	0.03
028	0	1	2	1	0	4	0.00
029	71	77	138	55	71	412	0.18
030	1 765	2 122	2 269	2 047	2 526	10 729	4.82
031	0	4	0	0	0	4	0.00
032	81	53	216	176	118	644	0.29
033	1 390	1 341	1 541	1 426	1 595	7 293	3.27
034	3 398	3 104	3 285	2 528	2 914	15 229	6.84
035	1 186	1 444	1 538	970	1 029	6 167	2.77
036	342	348	502	483	427	2 102	0.94
037	468	496	552	710	825	3 051	1.37
038	4 440	4 715	5 747	4 205	3963	23 070	10.36
039	612	713	741	939	931	3 936	1.77
040	180	223	195	197	261	1 056	0.47
041	549	661	851	785	725	3 571	1.60
042	290	364	251	287	526	1 718	0.77
043	1	0	0	0	0	1	0.00
044	0	0	0	1	0	1	0.00
045	313	219	168	273	419	1 392	0.62
046	200	126	163	218	332	1 039	0.47
047	460	283	242	326	241	1 552	0.70
801	1	39	13	85	73	211	0.09
unk	214	174	224	268	199	1 079	0.48
All areas	41 894	43 257	48 769	44 311	44 556	222 787	100.00

Table 4.5: Number of TCEPR tows in each Statistical Area, by fishing year and for all years combined, and the percent of the five year total in each area.

Statistical Area	2008	2009	2010	2011	2012	2008–12	%
002	46	30	22	28	117	243	0.38
003	245	265	282	261	256	1 309	2.02
004	72	92	52	103	59	378	0.58
005	799	974	775	987	867	4 402	6.81
006	515	613	548	479	652	2 807	4.34
007	0	1	0	1	0	2	0.00
008	547	452	557	551	439	2 546	3.94
009	916	933	719	906	972	4 446	6.88
010	733	743	906	791	865	4 038	6.24
011	220	229	292	404	436	1 581	2.44
012	280	328	337	281	281	1 507	2.33
013	223	291	328	177	83	1 102	1.70
014	610	619	606	364	29	2 228	3.45
015	240	152	221	105	27	745	1.15
016	212	217	145	198	188	960	1.48
017	77	49	76	61	90	353	0.55
018	79	31	50	29	34	223	0.34
020	119	42	91	142	86	480	0.74
022	239	548	724	917	684	3 112	4.81
024	3	90	87	178	43	401	0.62
025	87	70	90	85	158	490	0.76
026	84	96	87	195	173	635	0.98
027	306	231	280	290	305	1 412	2.18
028	1 785	1 403	1 485	1 526	1 199	7 398	11.44
029	31	32	87	48	58	256	0.40
030	3	0	9	10	12	34	0.05
033	2	2	0	2	0	6	0.01
034	219	68	44	133	112	576	0.89
035	249	99	45	79	48	520	0.80
036	305	232	119	93	93	842	1.30
037	458	477	638	358	487	2 418	3.74
038	22	8	1	0	0	31	0.05
039	38	44	65	42	47	236	0.36
040	521	340	451	348	411	2 071	3.20
041	1 219	861	898	600	617	4 195	6.49
042	627	453	555	496	395	2 526	3.91
045	556	578	514	348	472	2 468	3.82
046	254	218	177	162	222	1 033	1.60
047	299	468	449	452	541	2 209	3.42
504	313	225	321	212	275	1 346	2.08
801	159	121	46	46	62	434	0.67
Unk	126	143	112	129	160	670	1.04
All areas	13 838	12 868	13 291	12 617	12 055	64 669	100.00

Table 4.6: Comparison of TCER and TCEPR summary values for duration (h), speed (kn.), and derived distance (km), for the main fish species targeted by category A vessels, for all years combined. Species codes are given in Table 3. TCE is TCER and TCP is TCEPR.

Species	Form	No. tows	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
Duration								
GUR	TCE	26 638	0.25	3.00	3.50	3.56	4.00	10.00
	TCP	1 249	0.25	1.41	1.75	2.08	2.66	7.58
JDO	TCE	6 130	0.25	2.83	3.25	3.39	4.00	10.00
	TCP	2 866	0.25	1.45	2.00	2.26	3.00	7.50
SNA	TCE	10 711	0.20	2.00	2.75	2.69	3.25	9.75
	TCP	8 041	0.20	1.50	2.08	2.18	2.91	8.41
TAR	TCE	44 515	0.20	3.00	3.75	3.84	4.50	10.00
	TCP	7 909	0.25	2.75	3.50	3.64	4.33	10.00
TRE	TCE	5 682	0.33	2.83	3.25	3.25	3.75	9.28
	TCP	5 792	0.21	1.74	2.33	2.40	3.00	9.00
Speed								
GUR	TCE	26 638	1.5	2.7	2.9	2.9	3.0	4.2
	TCP	1 249	2.6	3.0	3.0	3.0	3.0	3.9
JDO	TCE	6 130	1.8	2.7	2.7	2.8	2.8	4.1
	TCP	2 866	2.5	2.9	3.0	3.0	3.0	4.0
SNA	TCE	10 711	1.8	2.8	3.0	3.0	3.2	4.2
	TCP	8 041	2.0	3.0	3.0	3.0	3.0	3.9
TAR	TCE	44 515	1.5	2.8	3.0	2.9	3.0	4.5
	TCP	7 909	2.0	3.0	3.0	3.0	3.0	4.0
TRE	TCE	5 682	1.8	3.2	3.4	3.4	3.6	4.4
	TCP	5 792	2.8	3.0	3.2	3.2	3.5	4.5
Distance								
GUR	TCE	26 638	1.11	15.97	19.26	19.03	22.22	59.26
	TCP	1 249	1.39	7.83	9.723	11.79	14.73	46.33
JDO	TCE	6 130	1.25	13.89	16.81	17.35	20.74	50.00
	TCP	2 866	1.39	7.94	11.11	12.33	16.56	41.67
SNA	TCE	10 711	0.78	11.20	15.00	14.91	18.33	50.56
	TCP	8 041	1.11	8.33	11.56	12.16	15.77	44.45
TAR	TCE	44 515	0.92	16.39	20.14	20.44	24.17	62.10
	TCP	7 909	1.39	15.28	19.45	20.19	24.06	58.06
TRE	TCE	5 682	1.83	17.22	20.53	20.50	23.98	61.67
	TCP	5 792	1.09	9.723	13.78	14.55	18.34	56.13

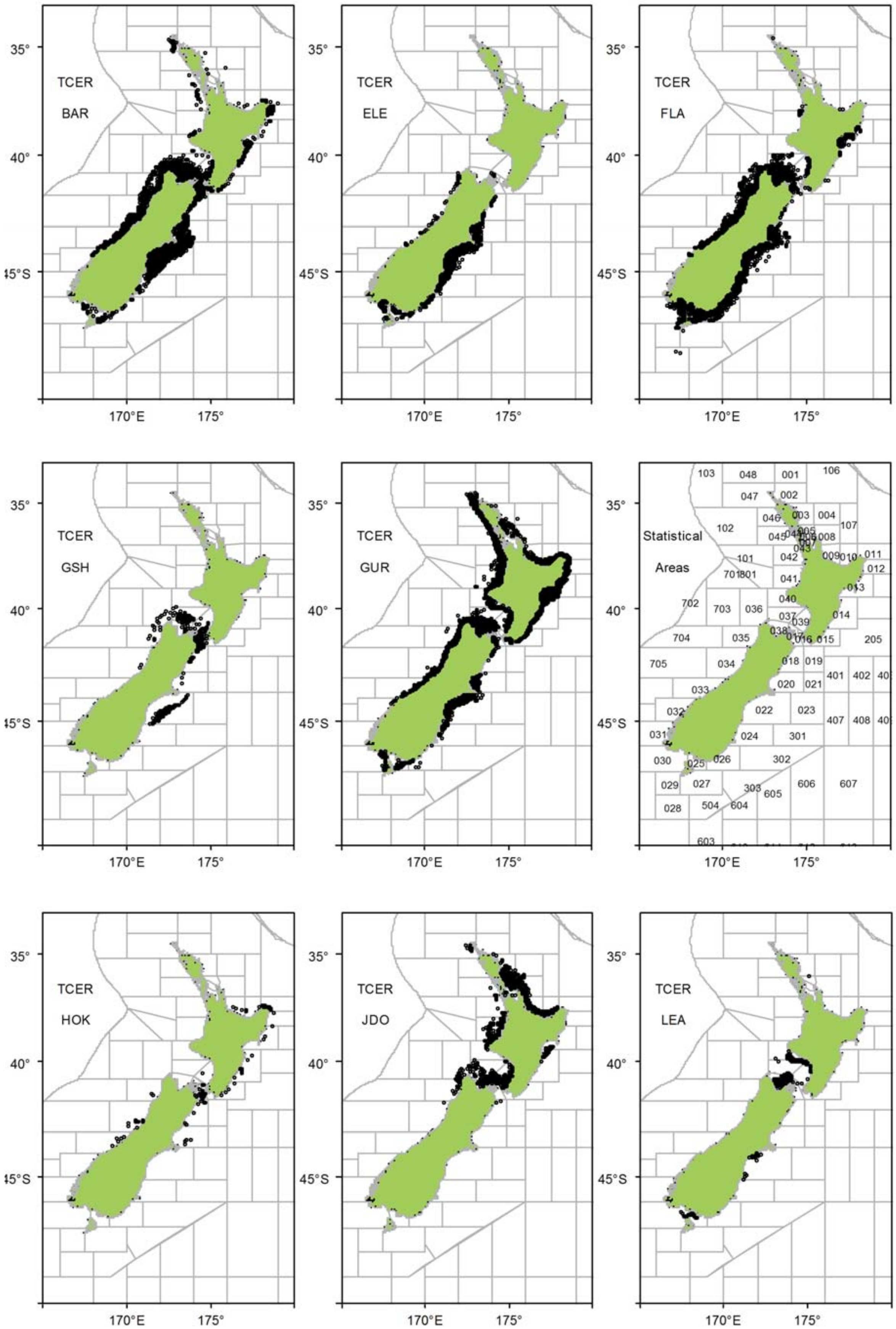

Figure 4.1: Plots of start locations of the trawl fishing effort reported on TCERs, for the main target species during fishing years 2008–12. Target species and total tows are given in Table 3.

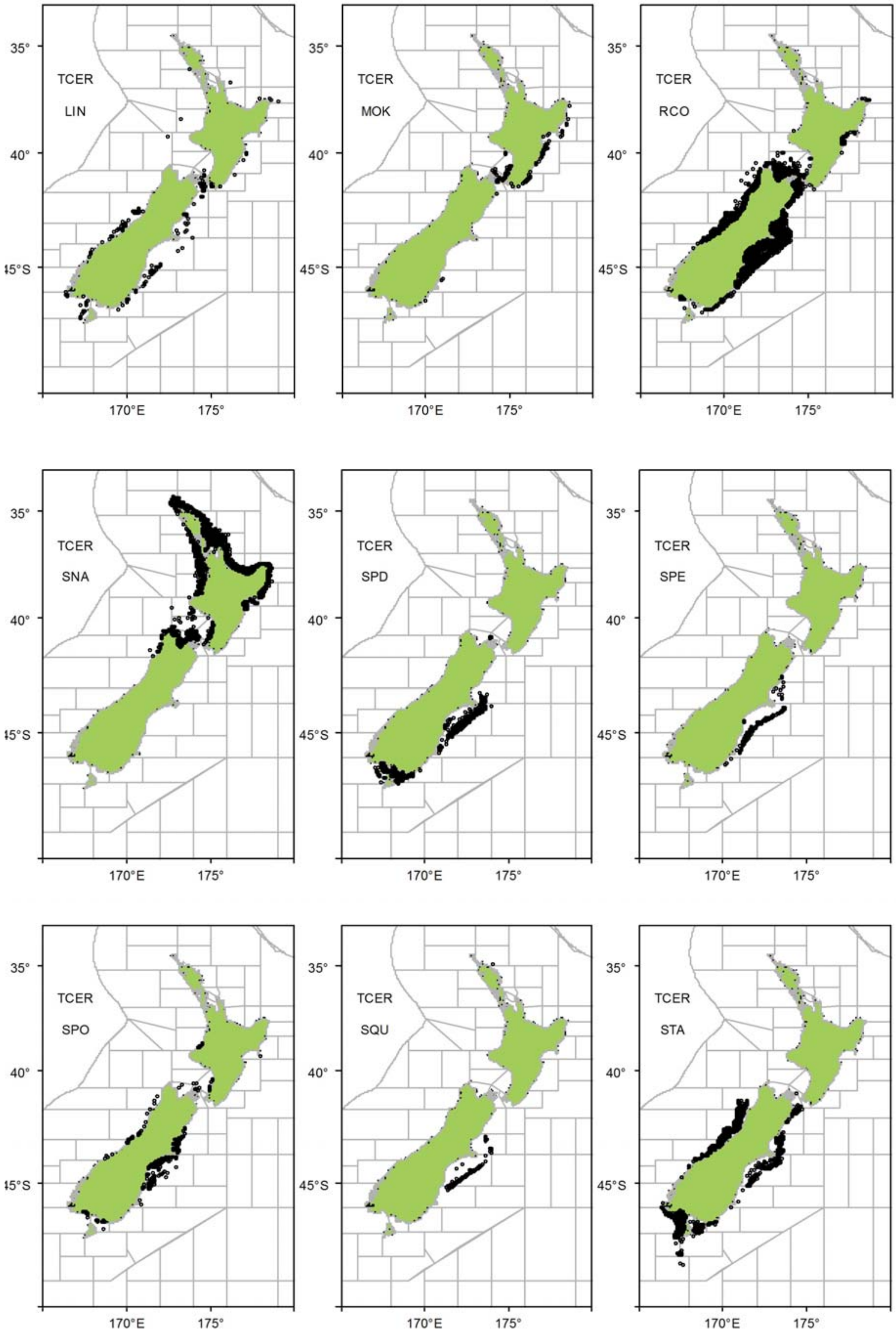

Figure 4.1 ***continued.***

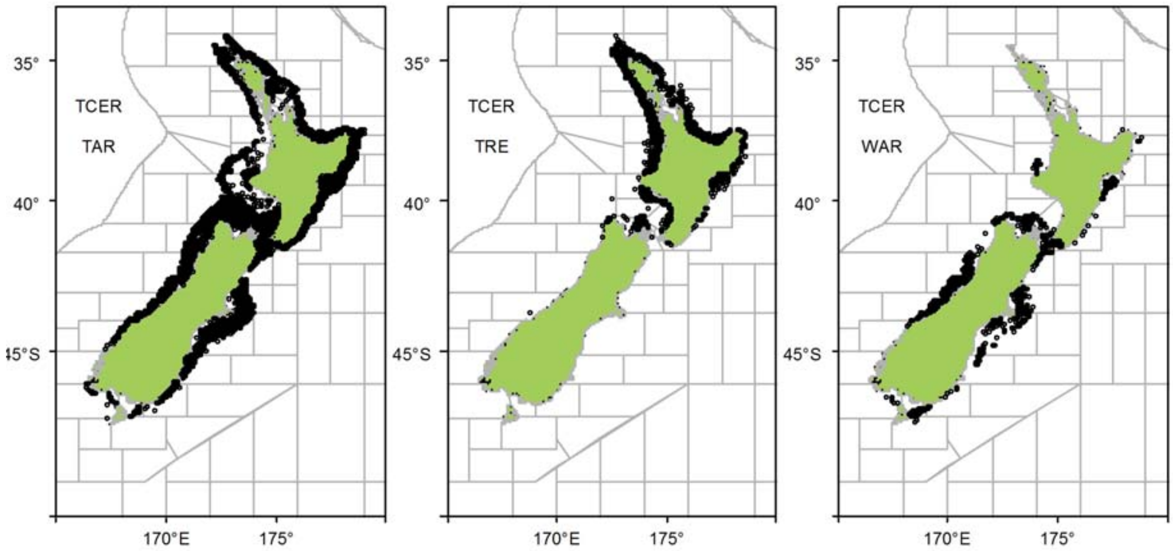

Figure 4.1 ***continued.***

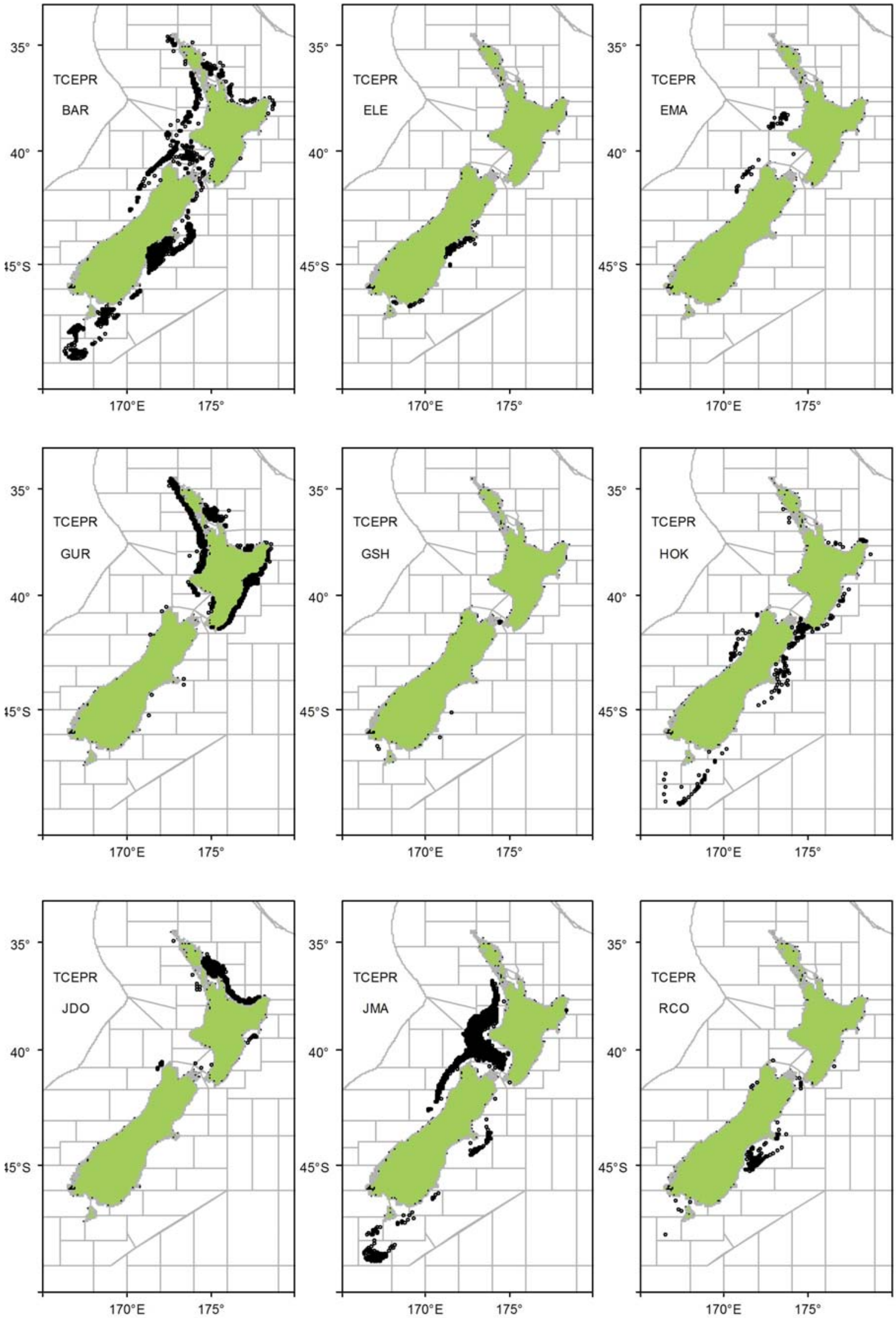

Figure 4.2: Plots of start locations of the trawl fishing effort reported on TCEPRs, for the main target species during fishing years 2008–12. Target species and total tows are given in Table 3.

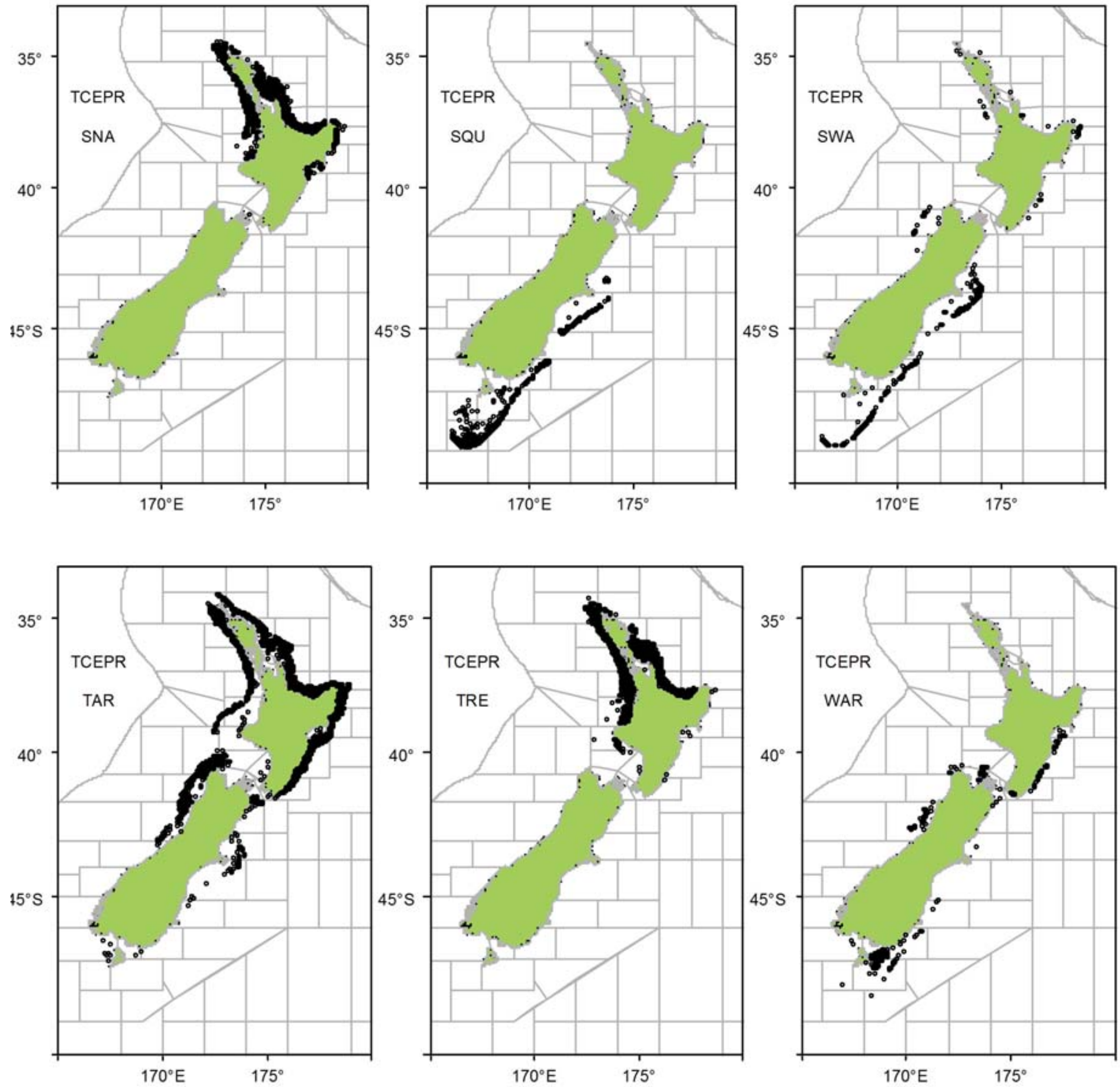

Figure 4.2 *continued.*

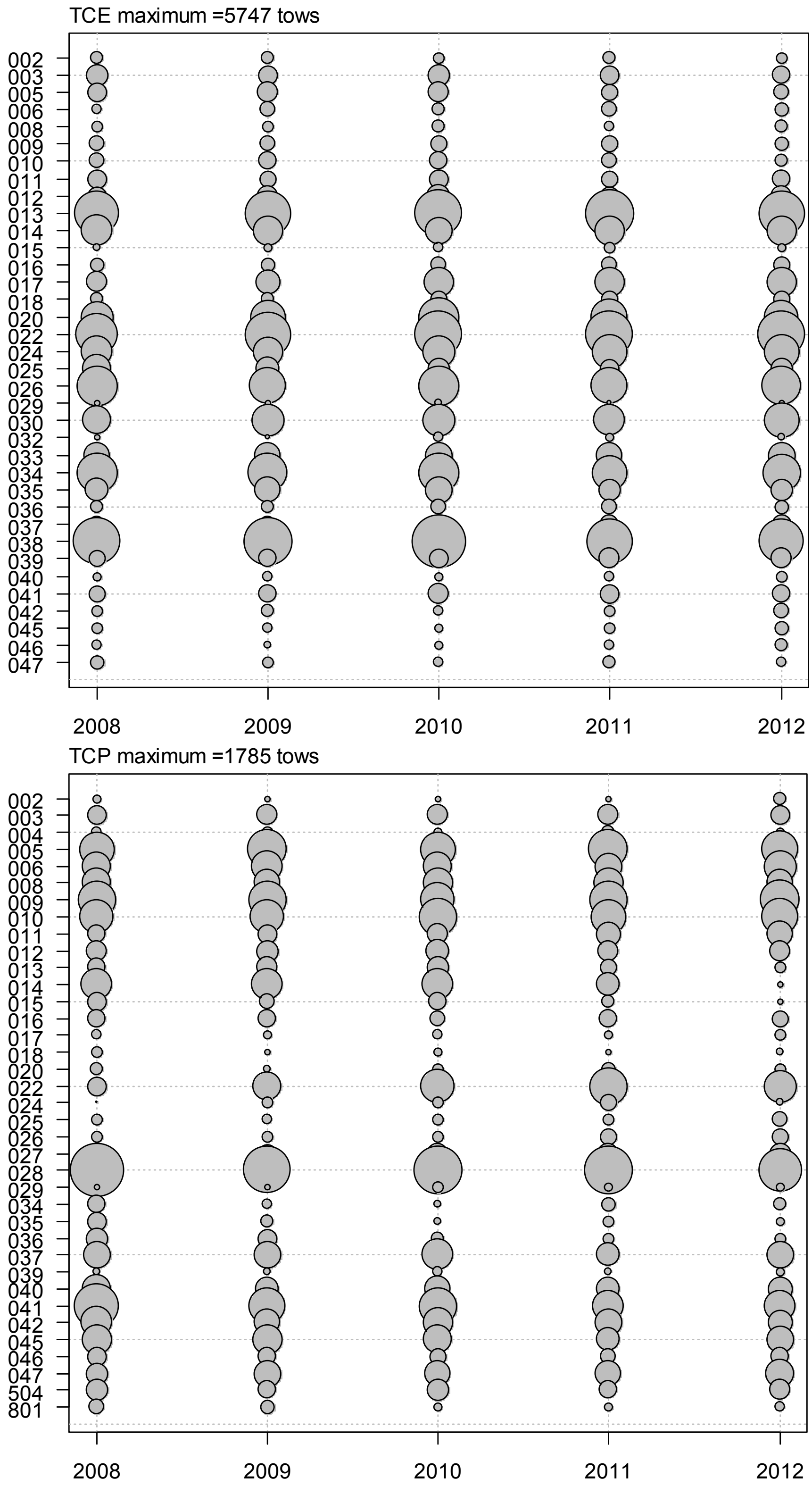

Figure 4.3: Distribution of the TCER (upper) and TCEPR (lower) data by the main Statistical Areas within the study area, for each fishing year. See Figure 2.3 in Appendix 2 for location of Statistical Areas. Data are given in Tables 4.4 and 4.5.

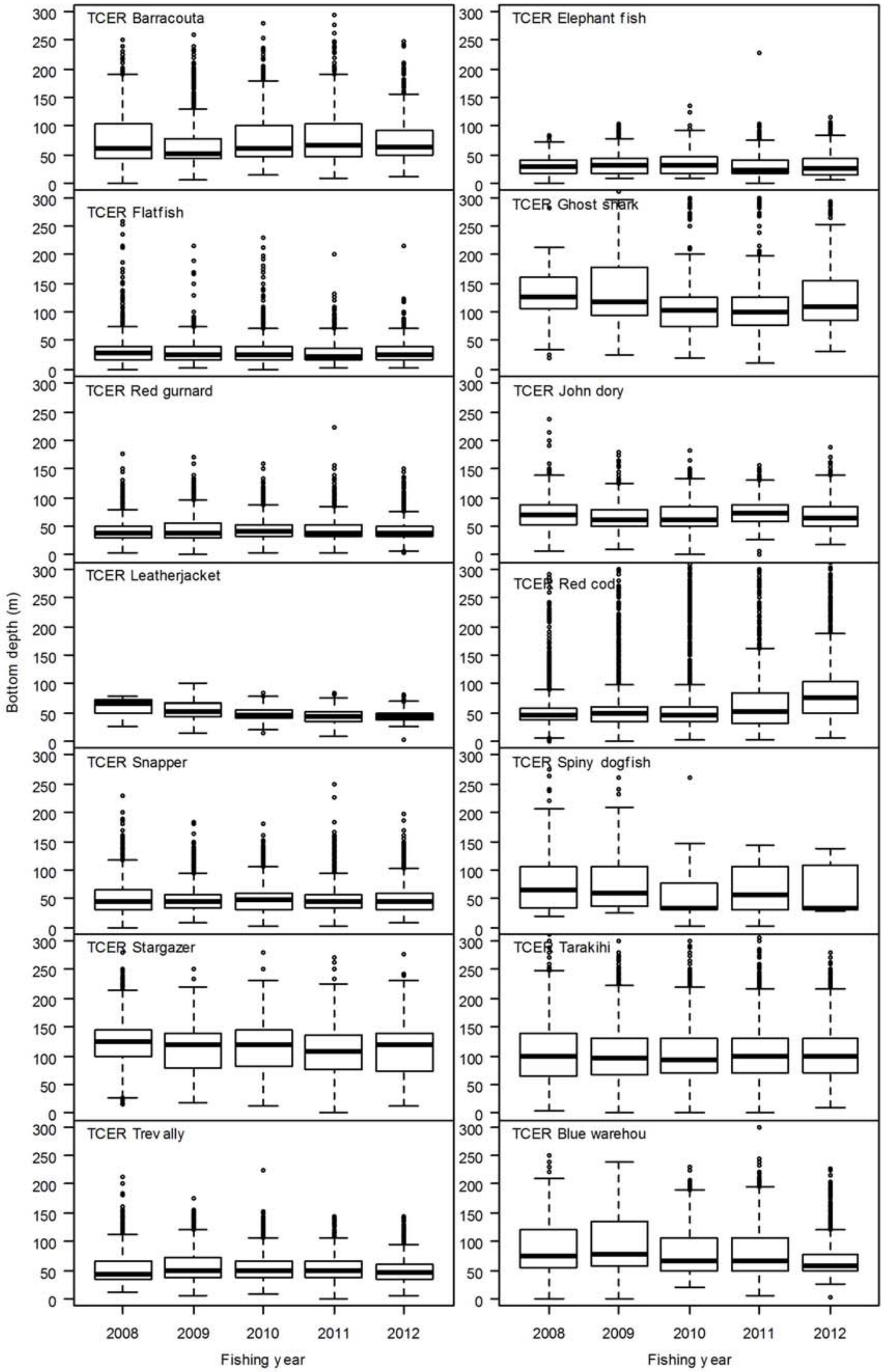

Figure 4.4a: Distribution of bottom depth data reported on TCERs by main target species.

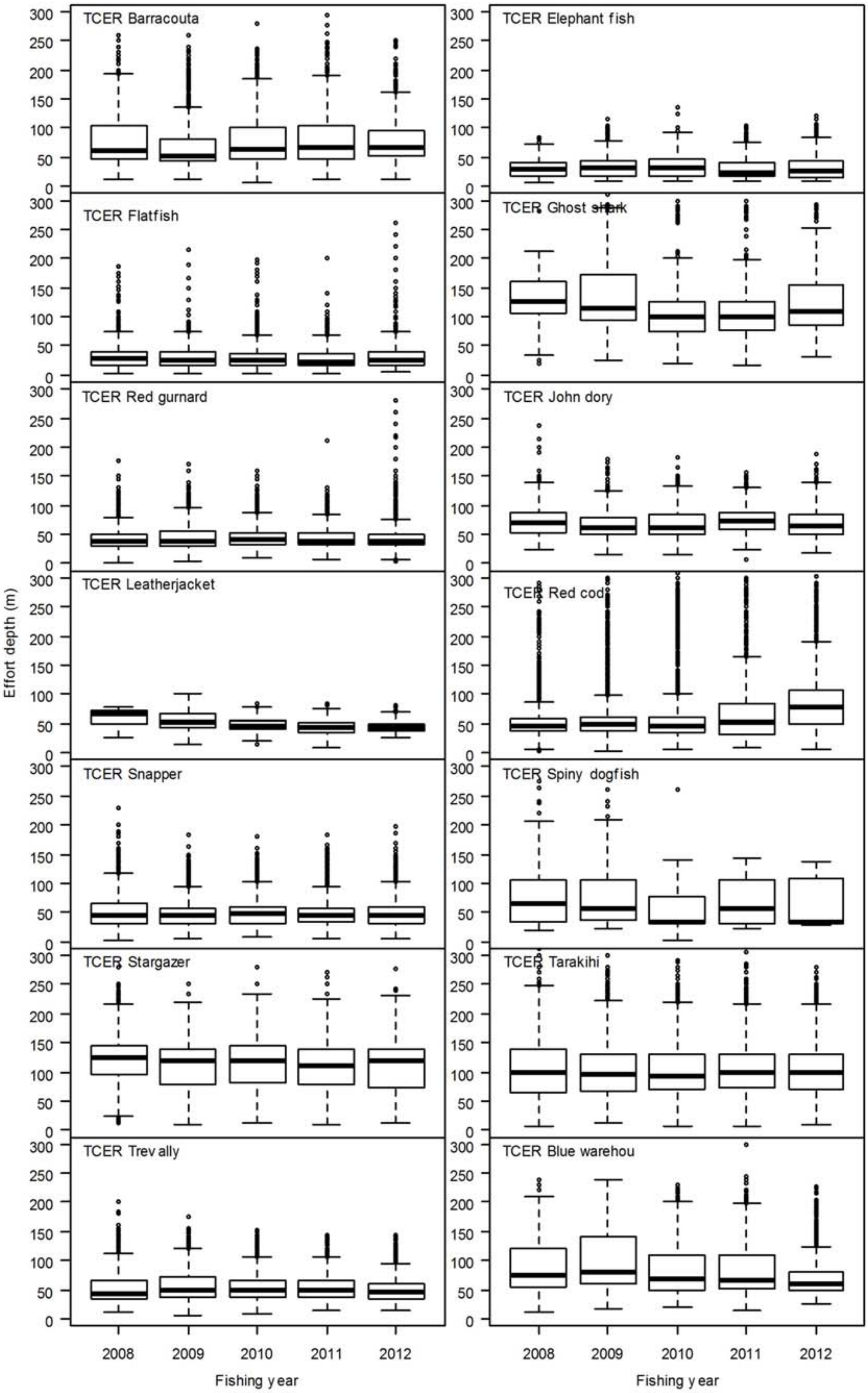

Figure 4.4b: Distribution of bottom depth data reported on TCERs by main target species.

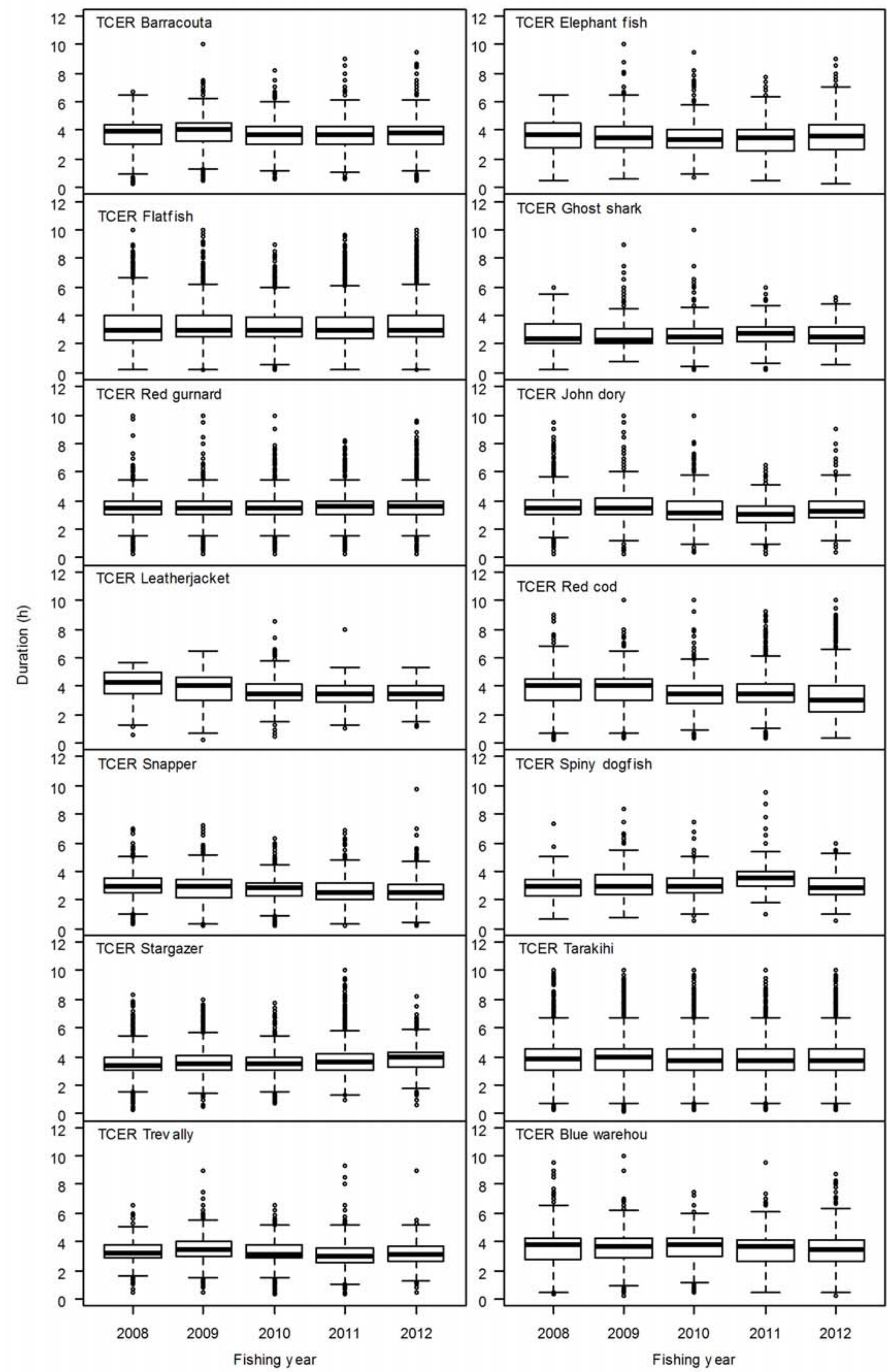

Figure 4.4c: Distribution of tow duration data reported on TCERs by main target species.

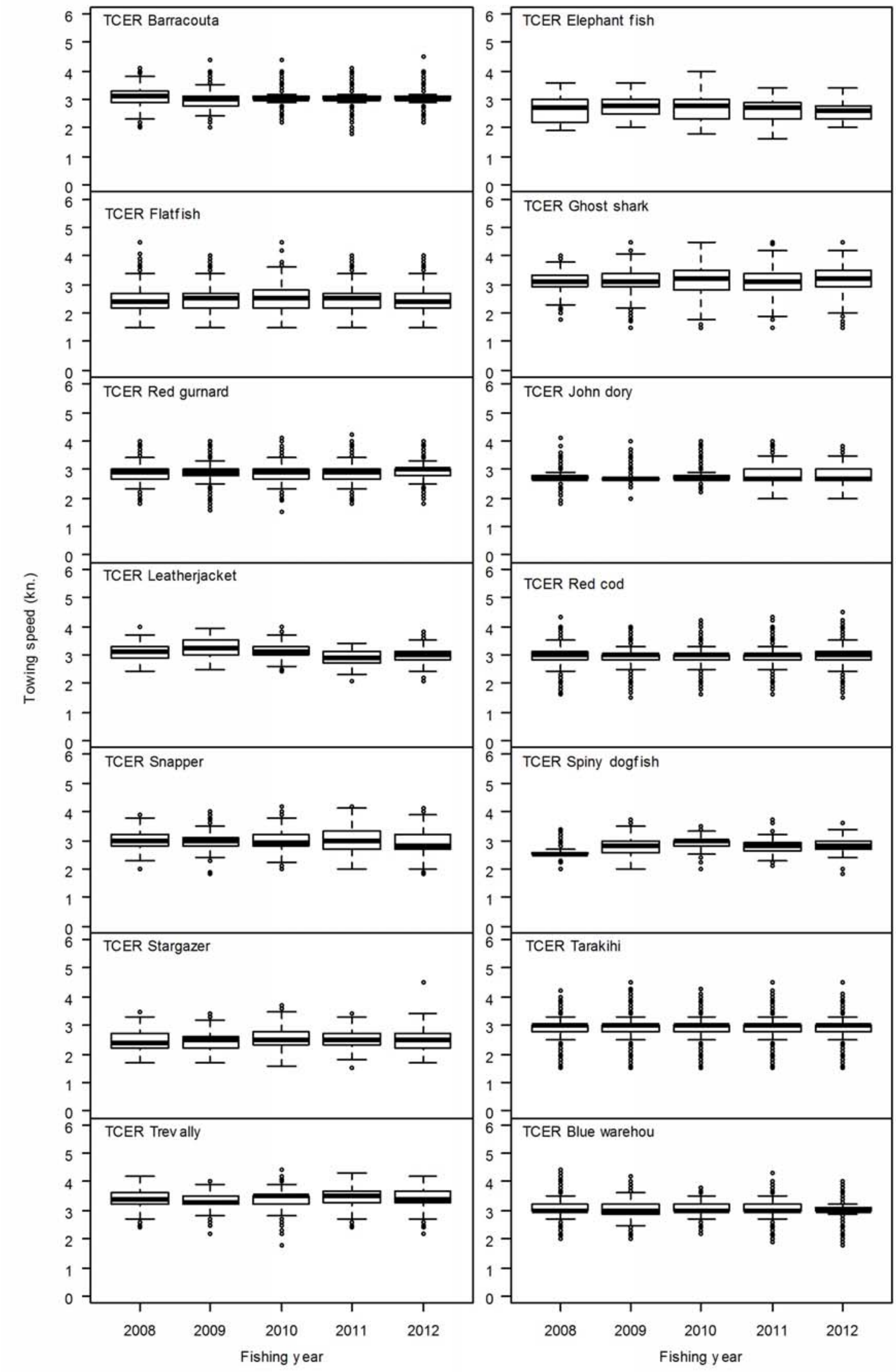

Figure 4.4d: Distribution of tow speed distance data reported on TCERs by main target species.

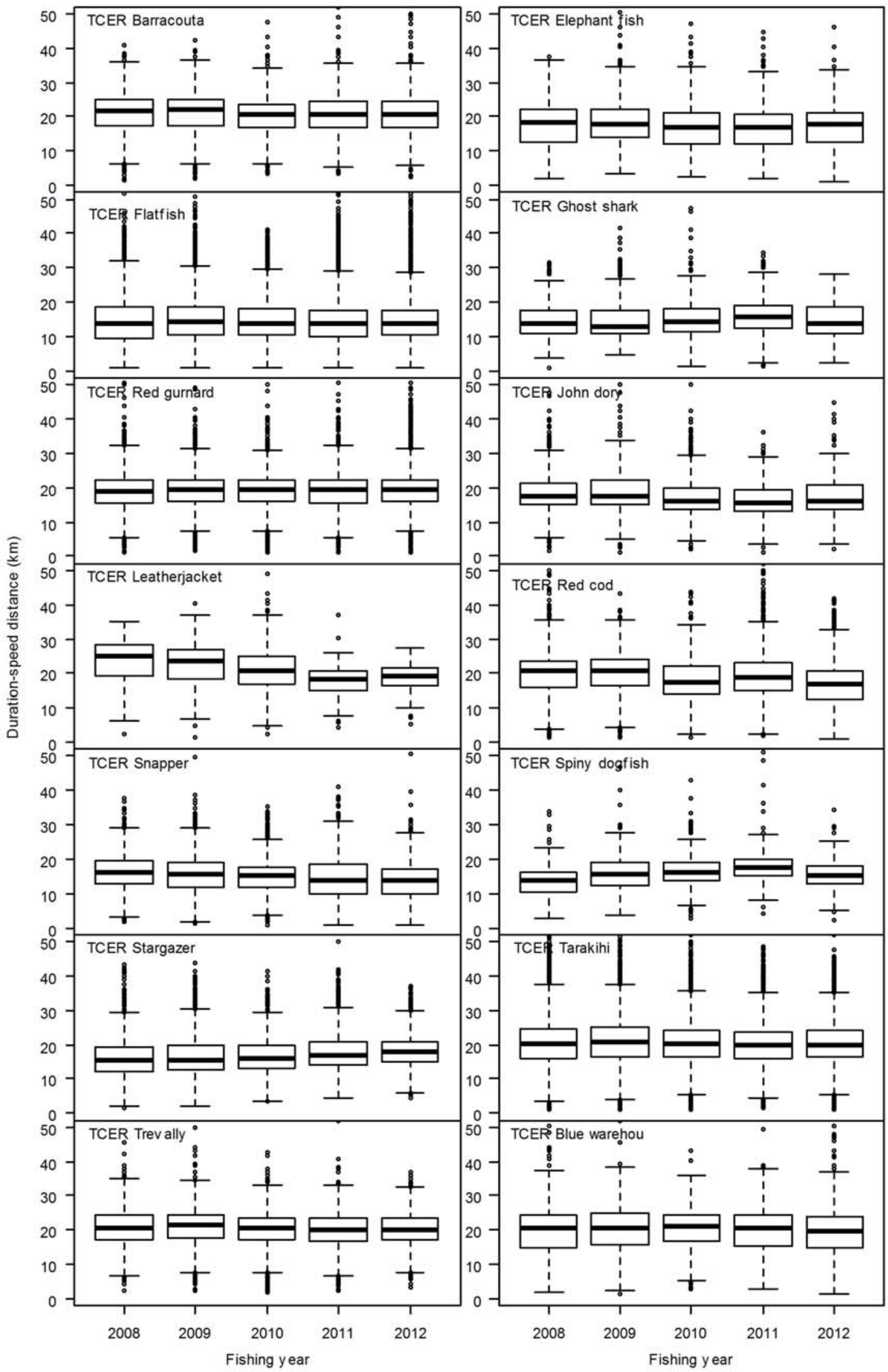

Figure 4.4e: Distribution of duration × speed distance data reported on TCERs by main target species.

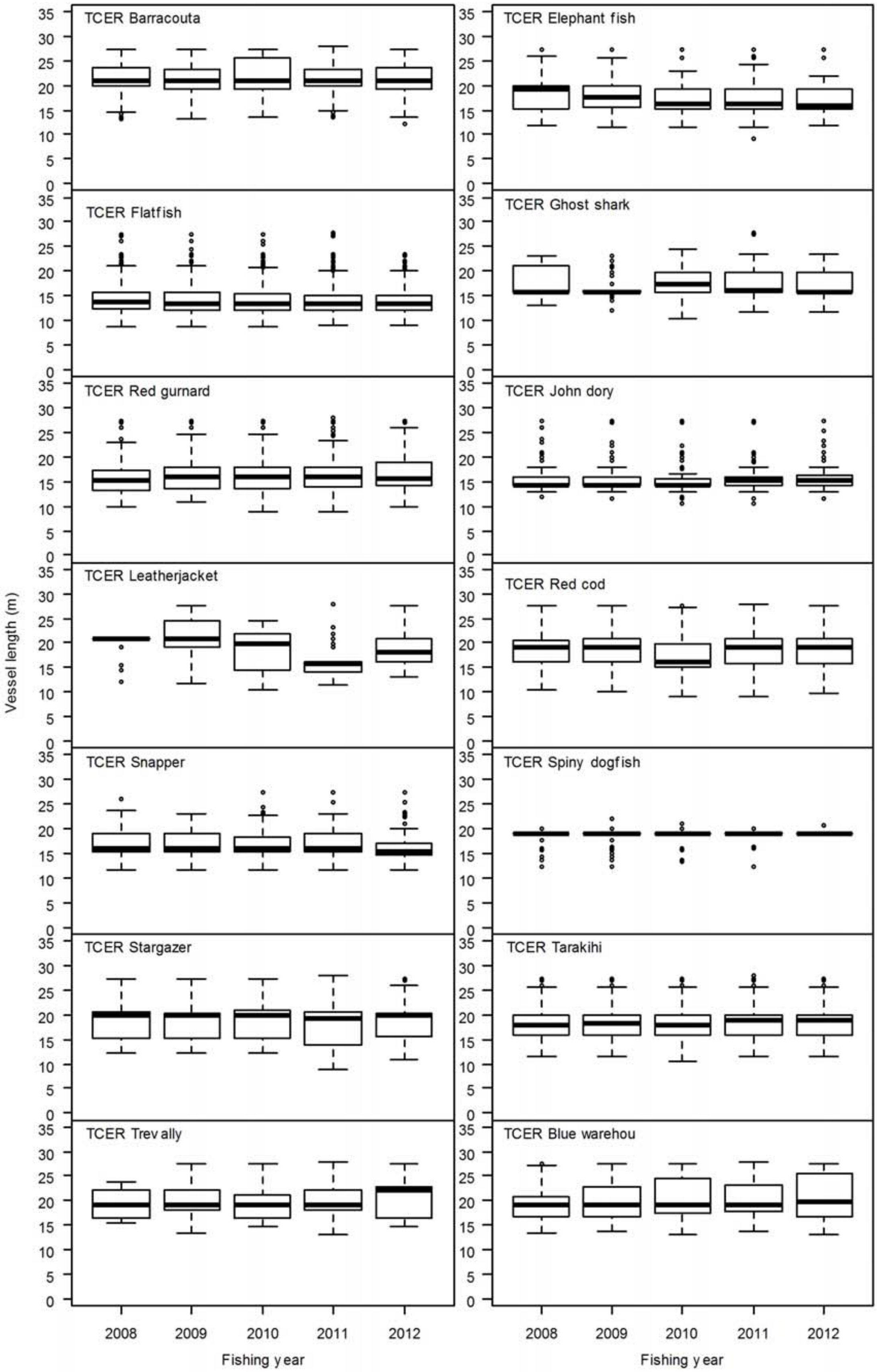

Figure 4.4f: Distribution of vessel length data reported for TCER vessels, by main target species.

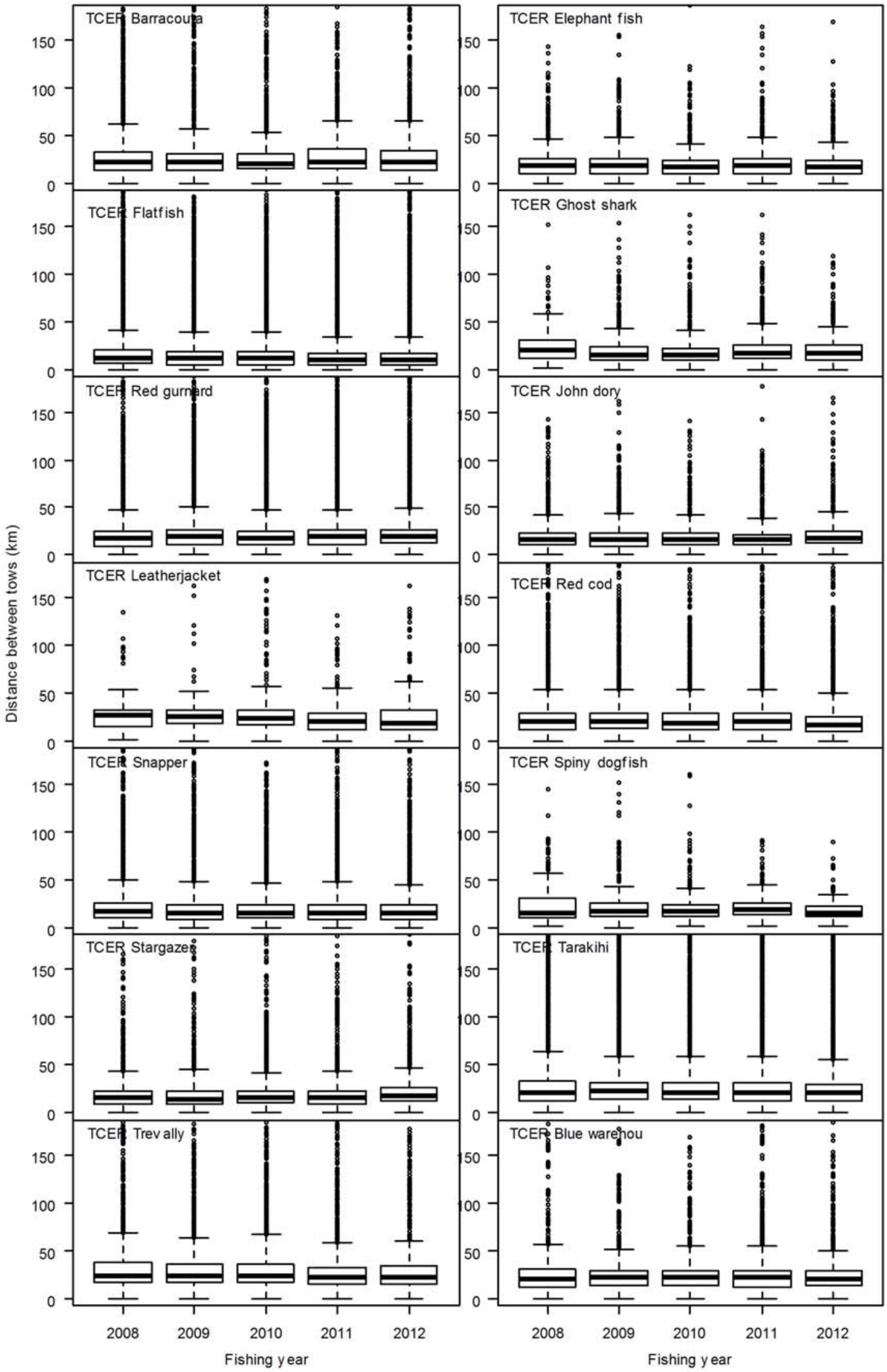

Figure 4.4g: Distribution of distance between start positions of consecutive tows for TCER trawl effort, by main target species.

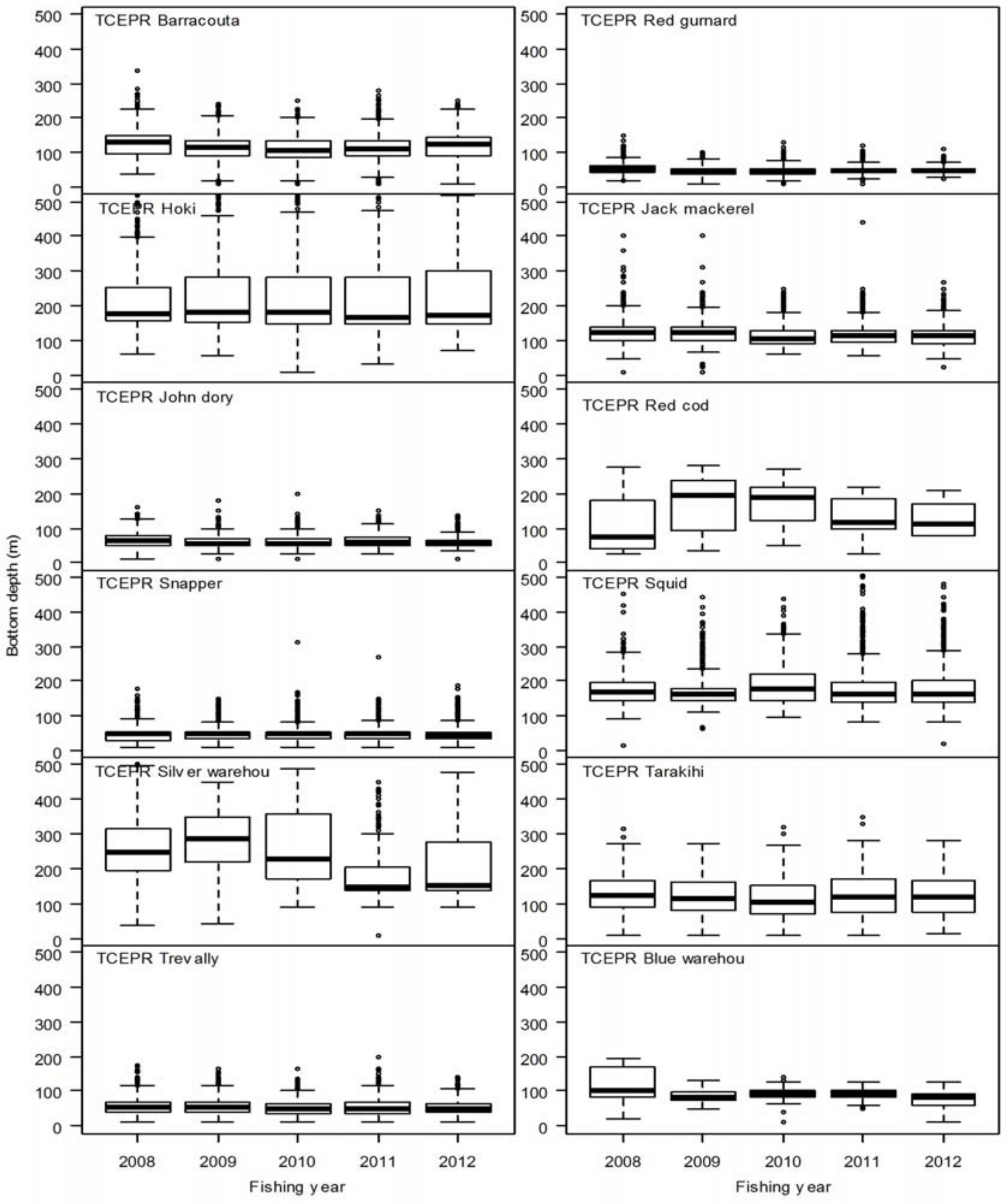

Figure 4.5a: Distribution of bottom depth data for TCEPR trawl effort, by main target species.

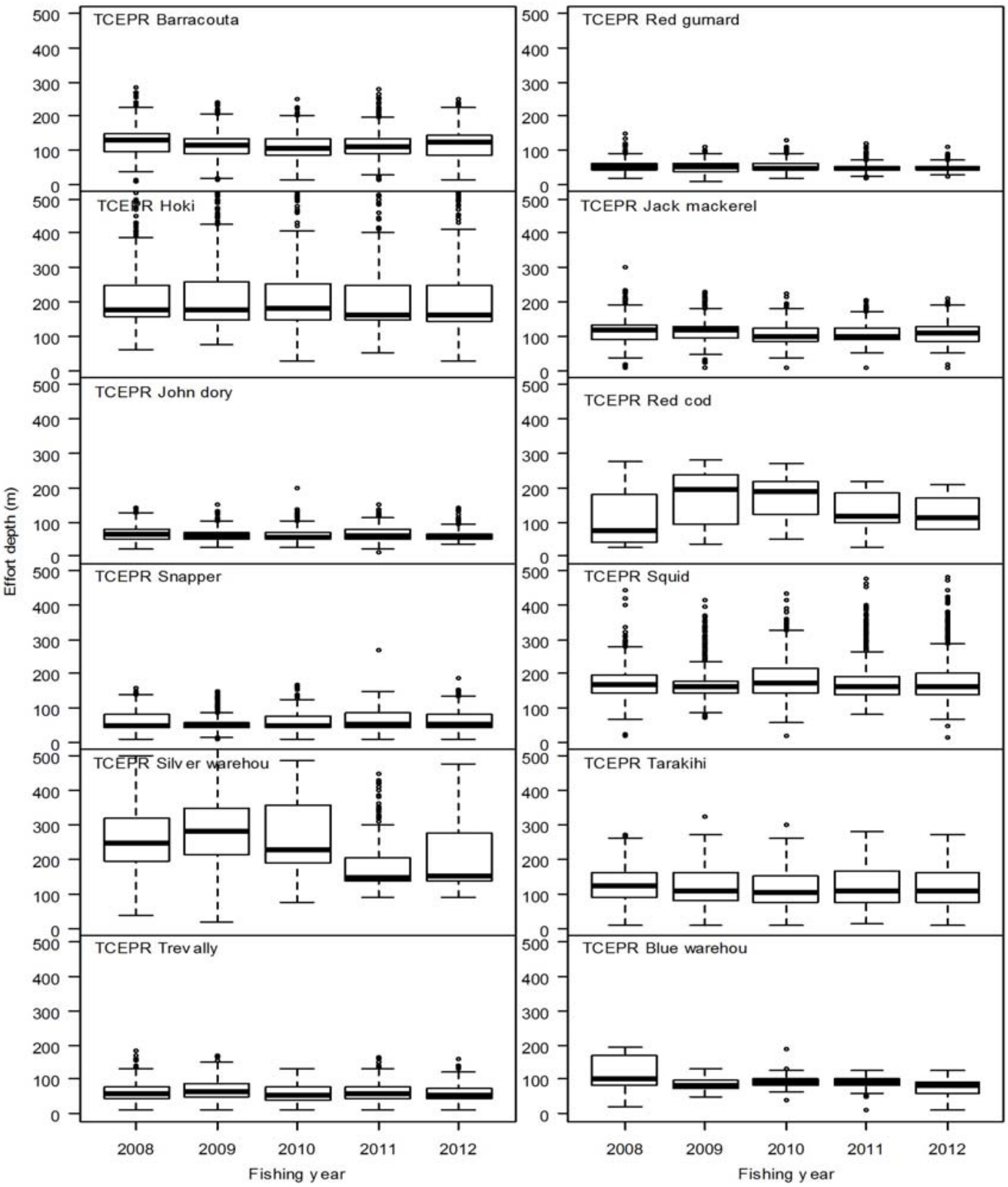

Figure 4.5b: Distribution of effort depth data for TCEPR trawl effort, by main target species.

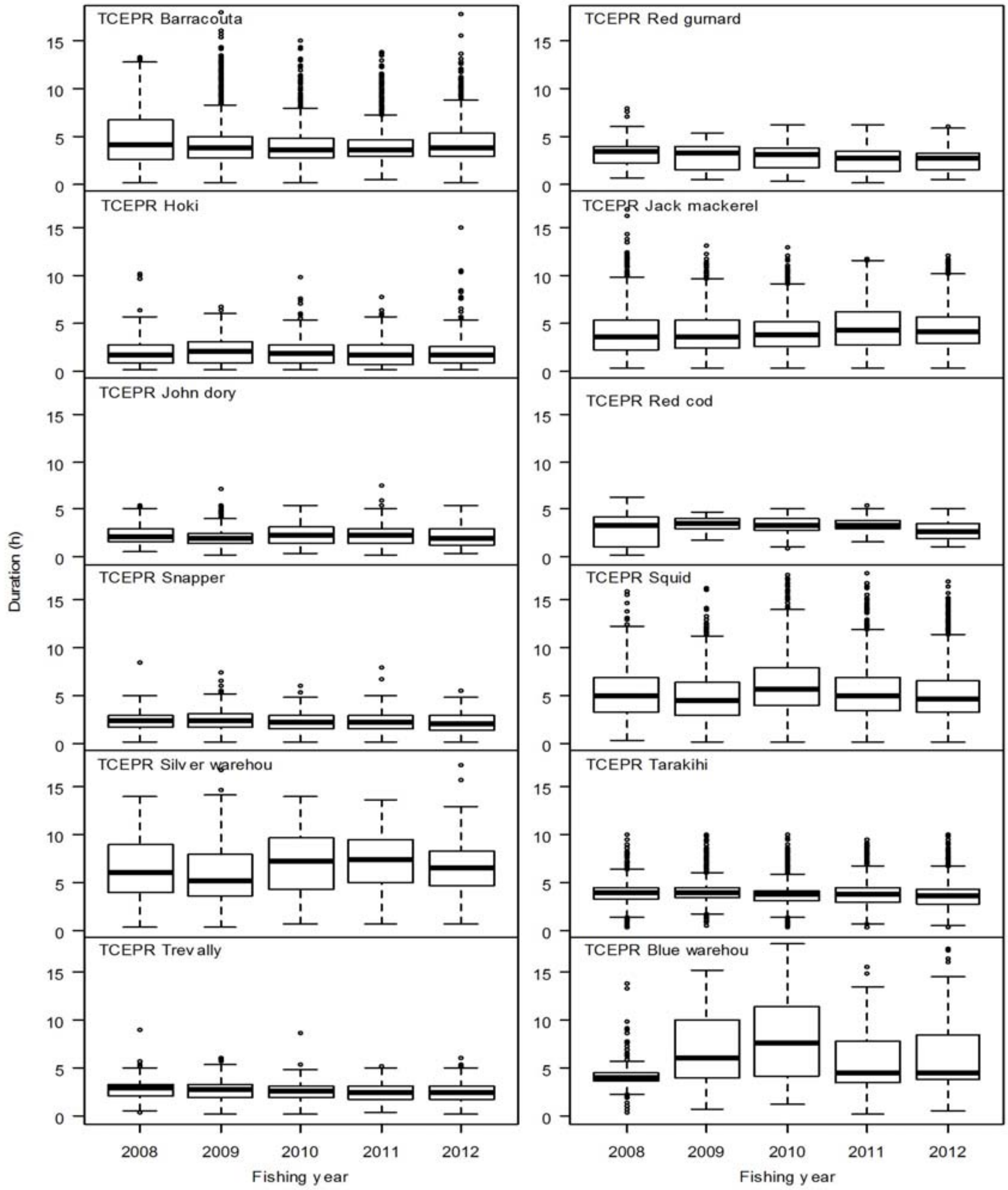

Figure 4.5c: Distribution of duration data for TCEPR trawl effort, by main target species.

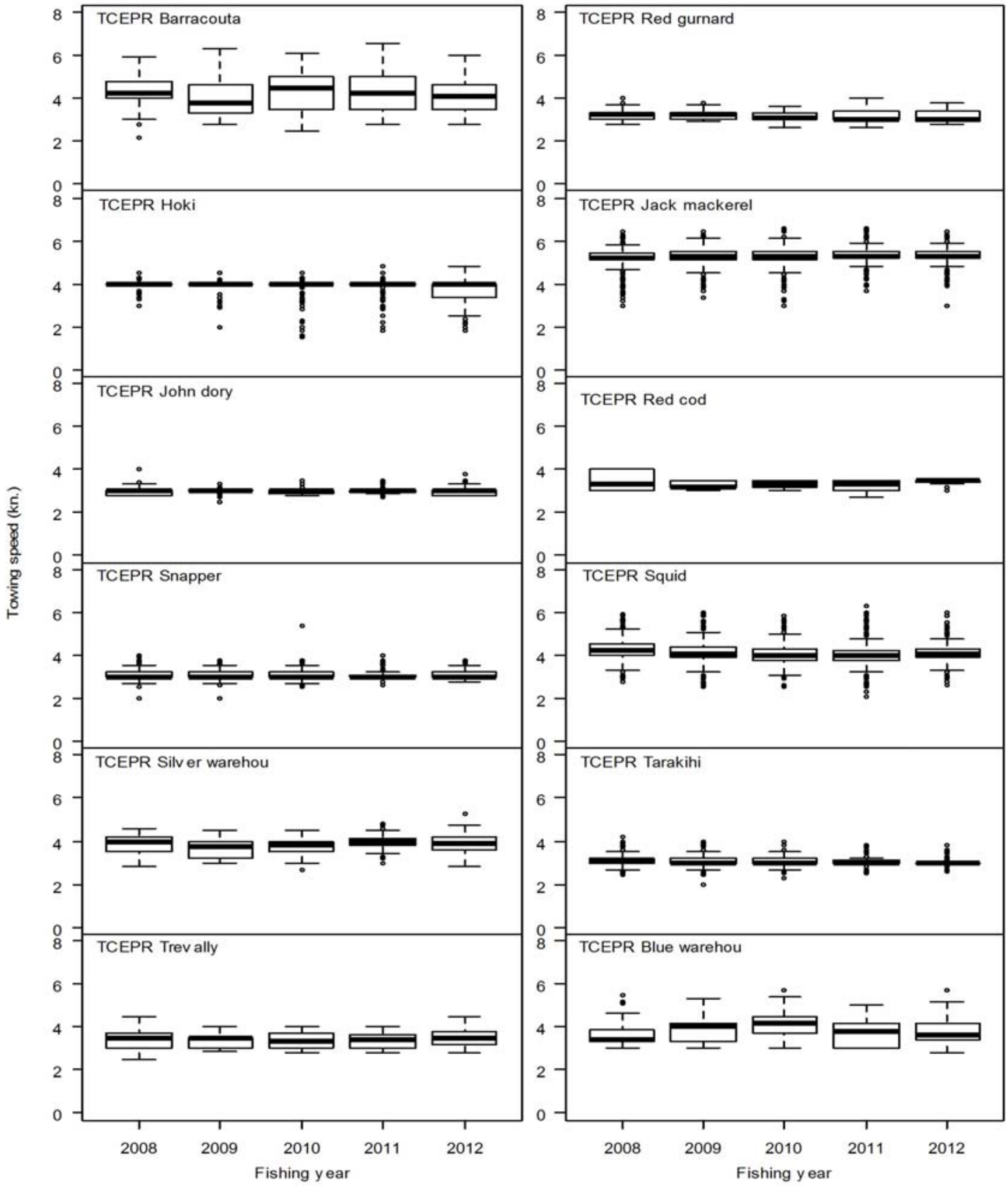

Figure 4.5d: Distribution of tow speed data for TCEPR trawl effort, by main target species.

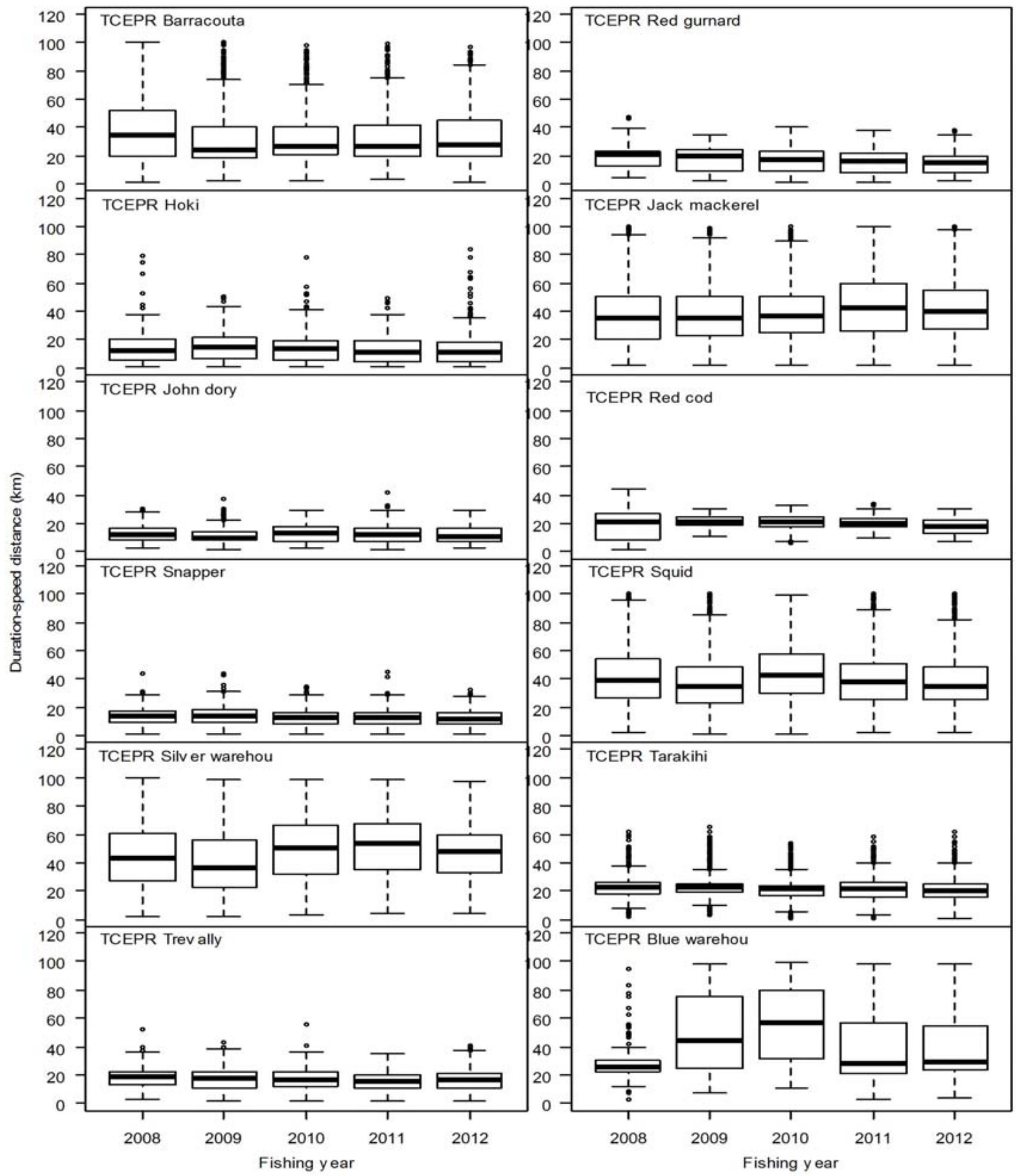

Figure 4.5e: Distribution of duration × speed distance data for TCEPR trawl effort, by main target species.

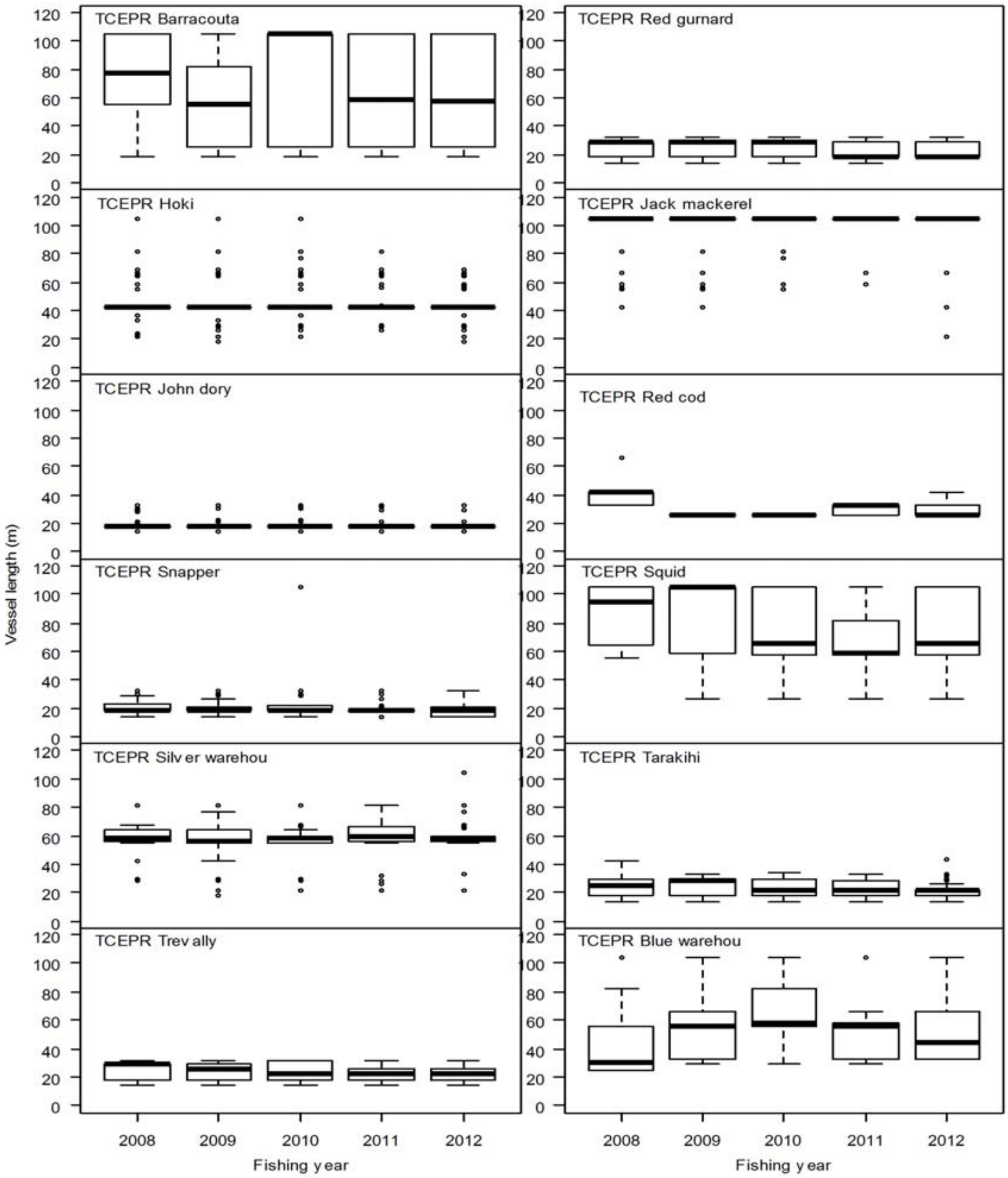

Figure 4.5f: Distribution of bottom depth data for TCEPR trawl effort, by main target species.

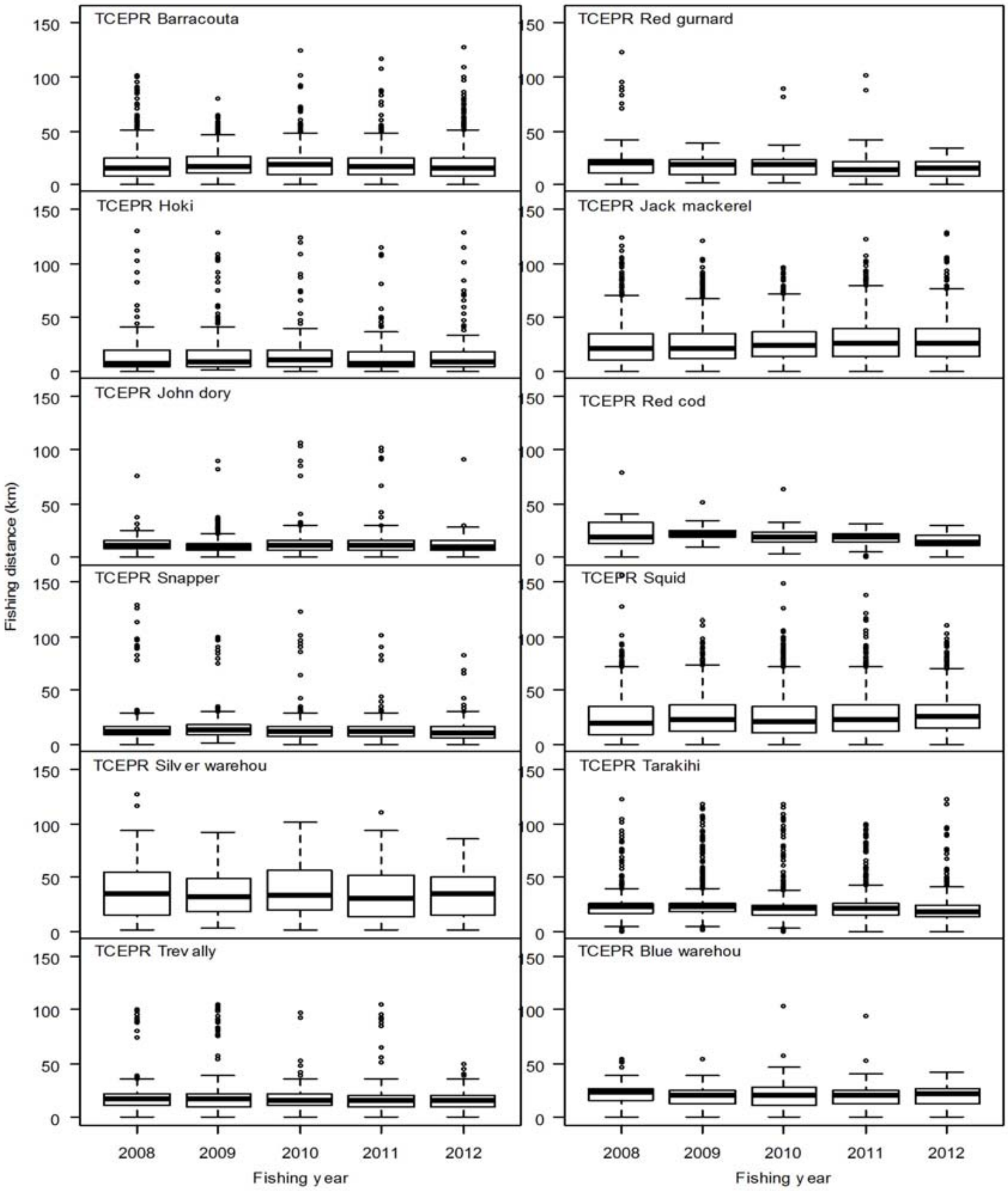

Figure 4.5g: Distribution of fishing distance data for TCEPR trawl effort, derived from start and finish positions, by main target species.

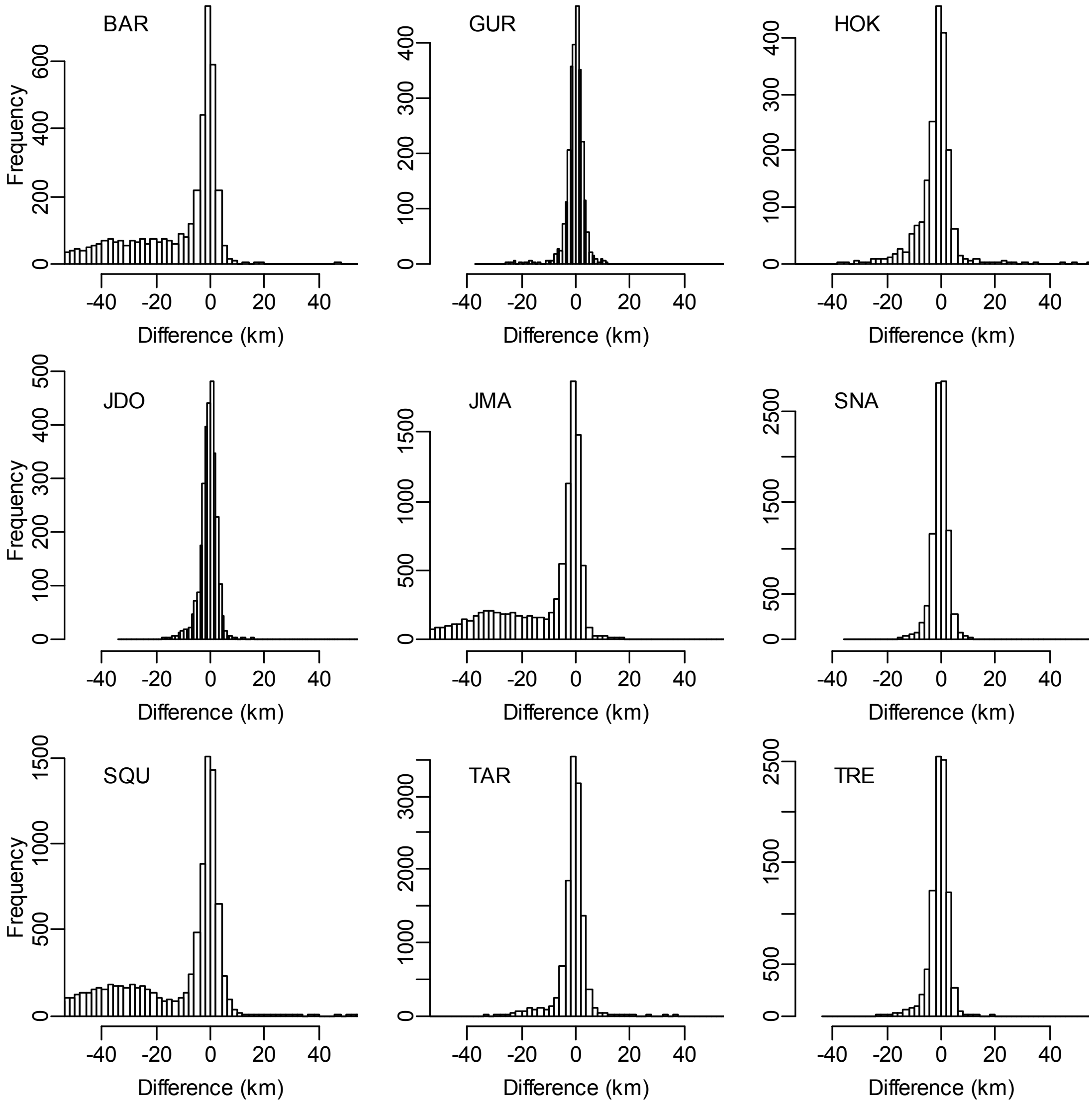

Figure 4.6: Distribution of the differences between the position-based distance and the distance generated from the reported duration and speed data for some of the main species targeted by category A vessels that reported on TCEPRs. Negative numbers indicate that the duration-speed distance was longer. Target species codes are defined in Table 3.

APPENDIX 5: CELL-BASED TRAWL SUMMARIES

Table 5.1: Number of tows reported on TCERs, by target species and fishing year. Target species codes are defined in Table 3.

Target code	2008	2009	2010	2011	2012	2008–12
BAR	1 988	1 484	1 214	1 086	1 307	7 079
BCO	8	2	10	1	9	30
BNS	0	0	0	1	0	1
BYX	0	0	0	0	0	0
ELE	588	689	850	607	717	3 451
EMA	0	0	0	0	0	0
FLA	16 717	16 523	18 853	14 661	16 527	83 281
GSH	164	559	699	801	486	2 709
GUR	4 072	4 476	5 927	5 853	6 259	26 587
HOK	37	25	114	75	37	288
HPB	43	34	41	31	15	164
JDO	1 554	1 239	1 474	1 027	836	6 130
JMA	1	1	9	11	1	23
LEA	62	77	222	150	281	792
LIN	88	65	100	109	61	423
MOK	72	78	54	136	85	425
PAD	58	8	8	27	17	118
QSC	89	201	95	21	40	446
RBT	0	0	0	0	0	0
RBY	0	1	0	0	6	7
RCO	2 830	2 682	2 607	2 670	2 447	13 236
RSK	3	8	72	63	25	171
SCH	68	95	57	83	72	375
SCI	0	0	0	0	0	0
SKI	5	27	32	79	22	165
SNA	1 953	2 119	2 026	2 420	2 190	10 708
SPD	259	386	318	187	151	1 301
SPE	25	25	118	151	35	354
SPO	16	67	132	111	156	482
SQU	399	29	67	62	76	633
STA	1 288	1 369	1 865	1 704	1 430	7 656
SWA	14	56	67	81	82	300
TAR	7 417	8 898	9 442	9 571	9 147	44 475
TRE	1 078	1 116	1 302	1 371	796	5 663
WAR	841	847	885	1 057	1 165	4 795
All	41 737	43 186	48 660	44 207	44 478	222 268

Table 5.2: Number of tows reported on TCEPRs, by target species and fishing year. Target species codes are defined in Table 3.

Target code	2008	2009	2010	2011	2012	2008–12
BAR	672	774	903	928	847	4 124
BCO	0	0	0	0	0	0
BNS	16	1	0	0	0	17
BYX	3	3	1	3	1	11
ELE	30	0	2	54	61	147
EMA	12	24	1	4	23	64
FLA	3	0	0	0	0	3
GSH	4	0	0	1	2	7
GUR	657	360	778	460	308	2 563
HOK	331	348	322	347	385	1 733
HPB	0	0	0	1	0	1
JDO	493	678	563	619	577	2 930
JMA	1 782	1 500	1 866	1 232	1 466	7 846
LEA	5	9	2	3	41	60
LIN	23	11	14	10	2	60
MOK	1	0	4	5	0	10
PAD	0	0	0	0	0	0
QSC	0	0	0	0	0	0
RBT	5	18	8	3	18	52
RBY	5	1	10	3	2	21
RCO	12	60	96	79	34	281
RSK	0	0	0	0	0	0
SCH	6	2	12	19	25	64
SCI	20	20	24	14	9	87
SKI	9	24	17	47	15	112
SNA	1 990	2 049	1 845	1 449	1 973	9 306
SPD	6	2	20	1	0	29
SPE	0	0	0	9	0	9
SPO	0	1	0	0	0	1
SQU	1 905	1 462	1 867	2 032	1 582	8 848
STA	14	0	11	25	14	64
SWA	198	148	116	172	110	744
TAR	2 839	2 614	2 514	2 229	2 051	12 247
TRE	1 675	1 911	1 542	1 971	1 770	8 869
WAR	173	125	118	132	152	700
All	12 859	12 095	12 583	11 710	11 318	60 565

Table 5.3: Aggregated swept area (km^2) estimated for effort reported on TCERs, by target species and fishing year. Target species codes are defined in Table 3.

Target codes	2008	2009	2010	2011	2012	2008–12
BAR	2 867.5	2 121.4	1 688.3	1 501.9	1 815.8	9 995.0
BCO	5.3	0.8	8.3	1.6	8.5	24.5
BNS	–	–	–	1.4	–	1.4
BYX	–	–	–	–	–	0.0
ELE	717.0	857.2	1 019.9	717.5	873.8	4 185.3
EMA	–	–	–	–	–	0.0
FLA	16 571.7	16 861.5	18 271.9	13 923.1	16 010.5	81 638.6
GSH	155.9	525.0	673.0	821.0	474.3	2 649.1
GUR	5 084.6	5 705.7	7 479.7	7 342.0	8 079.5	33 691.5
HAK	–	–	–	–	–	0.0
HOK	8.8	16.7	69.4	59.6	21.9	176.4
HPB	39.2	32.9	46.2	43.9	24.9	187.2
JDO	1 858.6	1 463.3	1 641.3	1 104.7	940.9	7 008.7
JMA	1.6	0.4	10.0	16.0	2.0	30.0
LEA	96.8	117.5	324.8	183.4	356.3	1 078.9
LIN	79.3	53.2	80.3	85.3	53.0	351.0
MOK	87.2	97.5	49.8	153.8	90.5	478.8
PAD	18.3	3.5	2.1	6.3	4.2	34.5
QSC	23.3	41.5	29.5	6.6	12.0	112.9
RBT	–	–	–	–	–	0.0
RBY	–	1.0	–	–	6.2	7.2
RCO	3 755.2	3 643.5	3 141.9	3 435.2	2 766.0	16 741.8
RSK	3.1	11.6	83.9	81.1	36.3	216.0
SCH	112.2	168.3	81.6	125.9	112.9	600.9
SCI	–	–	–	–	–	0.0
SKI	3.7	45.9	45.7	110.8	23.9	230.0
SNA	2 101.5	2 130.8	2 036.5	2 291.3	2 008.4	10 568.5
SPD	260.8	430.7	372.7	232.0	167.2	1 463.4
SPE	20.2	28.7	119.8	191.6	39.0	399.3
SPO	22.3	90.9	167.4	167.2	224.0	671.8
SQU	477.6	35.9	88.0	63.8	68.2	733.5
STA	1 433.4	1 563.0	2 176.2	2 064.4	1 767.1	9 004.1
SWA	19.7	75.2	89.5	113.0	111.1	408.6
TAR	10 076.2	12 298.0	12 894.1	12 760.8	12 397.7	60 426.7
TRE	1 447.9	1 585.5	1 758.2	1 838.0	1 062.3	7 691.9
WAR	1 105.3	1 079.8	1 158.8	1 347.6	1 541.7	6 233.3
All	48 454.2	51 087.0	55 608.7	50 791.0	51 099.7	257 040.6

Table 5.4: Aggregated swept area (km^2) estimated for effort reported on TCEPRs, by target species and fishing year. Target species codes are defined in Table 3.

Target codes	2008	2009	2010	2011	2012	2008–12
BAR	1 556.9	1 352.0	1 723.7	1 768.3	1 722.7	8 123.7
BCO	–	–	–	–	–	0.0
BNS	15.2	1.7	–	–	–	16.9
BYX	8.7	3.3	0.3	5.6	1.2	19.2
ELE	66.9	–	3.8	84.0	65.1	219.9
EMA	42.7	49.6	1.1	3.7	36.4	133.6
FLA	5.5	–	–	–	–	5.5
GSH	2.9	–	–	0.6	4.0	7.5
GUR	1 017.6	526.6	1 107.5	580.9	367.5	3 600.0
HOK	172.6	228.6	147.6	93.1	150.2	792.2
HPB	–	–	–	1.8	–	1.8
JDO	431.1	531.7	511.5	550.1	466.1	2 490.5
JMA	5 295.8	4 245.3	5 698.7	4 236.4	4 821.5	24 297.7
LEA	4.5	6.8	2.0	2.6	31.4	47.2
LIN	50.0	62.1	52.1	22.2	3.8	190.2
MOK	2.0	–	6.8	9.0	–	17.8
PAD	–	–	–	–	–	0.0
QSC	–	–	–	–	–	0.0
RBT	11.5	34.7	17.4	5.1	21.9	90.6
RBY	3.2	0.3	9.5	1.6	1.5	16.0
RCO	22.2	89.1	119.2	114.6	40.2	385.3
RSK	–	–	–	–	–	0.0
SCH	10.9	3.7	31.1	52.5	64.6	162.8
SCI	18.4	20.5	28.1	25.7	6.5	99.2
SKI	21.2	43.7	23.4	48.8	16.3	153.4
SNA	2 012.3	2 138.6	1 717.6	1 282.9	1 654.8	8 806.2
SPD	24.6	4.8	81.8	5.2	–	116.4
SPE	–	–	–	14.1	–	14.1
SPO	–	2.2	–	–	–	2.2
SQU	5 149.6	4 493.6	6 001.1	6 564.9	5 289.6	27 498.7
STA	30.1	–	18.9	48.1	28.1	125.2
SWA	765.5	538.7	470.7	755.3	413.6	2 943.9
TAR	4 659.1	4 555.8	3 817.0	3 263.9	2 683.8	18 979.6
TRE	2 374.6	2 591.0	1 954.1	2 282.8	2 152.3	11 354.7
WAR	348.5	217.3	185.1	194.4	285.0	1 230.4
All	24 124.1	21 742.0	23 729.9	22 018.3	20 328.1	111 942.4

Table 5.5: Number of tows reported on TCERs and TCEPRs, by target species and vessel size category. Target species codes are defined in Table 3. Category A vessels are 6–28 m long; B vessels are 28–46 m long; C vessels are 46–80 m long; and D vessels are > 80 m.

Target	TCER					TCEPR	TCER and
code	A vessels	A vessels	B vessels	C vessels	D vessels	Total	TCEPR
BAR	7 079	1 241	168	1 316	1 399	4 124	11 203
BCO	30	0	0	0	0	0	30
BNS	1	5	12	0	0	17	18
BYX	0	0	11	0	0	11	11
ELE	3 451	79	68	0	0	147	3 598
EMA	0	0	0	0	64	64	64
FLA	83 281	3	0	0	0	3	83 284
GSH	2 709	3	3	1	0	7	2 716
GUR	26 587	1 247	1 316	0	0	2 563	29 150
HOK	288	25	1 183	78	2	1 288	1 288
HPB	164	0	1	0	0	1	165
JDO	6 130	2 866	64	0	0	2 930	9 060
JMA	23	1	8	201	7 636	7 846	7 869
LEA	792	54	6	0	0	60	852
LIN	423	0	18	42	0	60	483
MOK	425	0	10	0	0	10	435
PAD	118	0	0	0	0	0	118
QSC	446	0	0	0	0	0	446
RBT	0	0	0	0	52	52	52
RBY	7	1	20	0	0	21	28
RCO	13 236	217	63	1	0	281	13 517
RSK	171	0	0	0	0	0	171
SCH	375	10	54	0	0	64	439
SCI	0	87	0	0	0	87	87
SKI	165	40	72	0	0	112	277
SNA	10 708	8 040	1 265	0	1	9 306	20 014
SPD	1 301	0	0	29	0	29	1 330
SPE	354	0	9	0	0	9	363
SPO	482	0	1	0	0	1	483
SQU	633	143	252	5 310	3 143	8 848	9 481
STA	7656	1	63	0	0	64	7 720
SWA	300	33	52	658	1	744	1 044
TAR	44 475	7 859	4 388	0	0	12 247	56 722
TRE	5 663	5 790	3 079	0	0	8 869	14 532
WAR	4 795	86	242	347	25	700	5 495
All	222 268	27 831	12 428	7 983	12 323	60 565	282 833

Table 5.6: Aggregated swept area (km^2) estimated for effort reported on TCERs and TCEPRs, by target species and vessel size category. Target species codes are defined in Table 3. Category A vessels are 6–28 m long; B vessels are 28–46 m long; C vessels are 46–80 m long; and D vessels are > 80 m.

Target code	TCER A vessels	TCEPR A vessels	TCEPR B vessels	TCEPR C vessels	TCEPR D vessels	TCEPR Total	TCER and TCEPR
BAR	9 995.0	1 476.8	290.8	3 054.3	3 301.7	8 123.7	18 118.9
BCO	24.5	0.0	0.0	0.0	0.0	0.0	24.5
BNS	1.4	5.7	11.1	0.0	0.0	16.9	18.3
BYX	–	0.0	19.2	0.0	0.0	19.2	19.2
ELE	4 185.3	89.4	130.5	0.0	0.0	219.9	4 405.2
EMA	–	0.0	0.0	0.0	133.6	133.6	133.6
FLA	81 638.6	5.5	0.0	0.0	0.0	5.5	81 644.1
GSH	2 649.1	1.9	4.6	1.1	0.0	7.5	2 656.6
GUR	33 691.5	985.3	2 614.7	0.0	0.0	3 600.0	37 291.5
HOK	176.4	14.3	477.0	297.5	3.3	792.2	968.6
HPB	187.2	0.0	1.8	0.0	0.0	1.8	189.0
JDO	7 008.7	2 352.5	138.0	0.0	0.0	2 490.5	9 499.3
JMA	30.0	1.4	12.8	940.7	23 342.8	24 297.7	24 327.7
LEA	1 078.9	37.9	9.2	0.0	0.0	47.2	1 126.1
LIN	351.0	0.0	18.6	171.6	0.0	190.2	541.2
MOK	478.8	0.0	17.8	0.0	0.0	17.8	496.6
PAD	34.5	0.0	0.0	0.0	0.0	0.0	34.5
QSC	112.9	0.0	0.0	0.0	0.0	0.0	112.9
RBT	0.0	0.0	0.0	0.0	90.6	90.6	90.6
RBY	7.2	0.6	15.4	0.0	0.0	16.0	23.2
RCO	16 741.8	280.3	98.9	6.0	0.0	385.3	17 127.0
RSK	216.0	0.0	0.0	0.0	0.0	0.0	216.0
SCH	600.9	17.0	145.8	0.0	0.0	162.8	763.7
SCI	0.0	99.2	0.0	0.0	0.0	99.2	99.2
SKI	230.0	39.1	114.3	0.0	0.0	153.4	383.4
SNA	10 568.5	6 680.4	2 123.0	0.0	2.8	8 806.2	19 374.6
SPD	1 463.4	0.0	0.0	116.4	0.0	116.4	1 579.8
SPE	399.3	0.0	14.1	0.0	0.0	14.1	413.4
SPO	671.8	0.0	2.2	0.0	0.0	2.2	674.0
SQU	733.5	172.2	390.5	18 044.6	8891.8	27 498.7	28 232.2
STA	9 004.1	1.6	123.6	0.0	0.0	125.2	9 129.3
SWA	408.6	34.0	83.6	2 825.2	1.1	2 943.9	3 352.4
TAR	60 426.7	9 387.0	9 592.6	0.0	0.0	18 979.6	79 406.4
TRE	7 691.9	5 670.8	5 683.9	0.0	0.0	11 354.7	19 046.6
WAR	6 233.3	133.0	491.7	554.6	51.1	1 230.4	7 463.6
All	257 040.6	27 486.1	22 625.7	26 012.0	57 141.1	111 942.4	368 983.0

Table 5.7: Number of tows reported on TCERs, by Statistical Area and fishing year. Statistical Areas are shown in Figure 2.3.

Area	2008	2009	2010	2011	2012	2008–12
002	361	328	299	338	270	1 596
003	959	809	1 008	744	684	4 204
004	27	7	13	4	4	55
005	801	895	859	633	498	3 686
006	230	463	338	521	399	1 951
007	2	0	1	2	3	8
008	294	310	332	217	332	1 485
009	502	464	574	634	447	2 621
010	490	732	709	541	364	2 836
011	735	550	767	616	699	3 367
012	838	915	1 184	825	851	4 613
013	4 033	4 343	4 639	4 826	4 194	22 035
014	1 998	1 902	1 486	1 916	1 819	9 121
015	110	187	203	261	196	957
016	443	418	485	524	576	2 446
017	865	1 271	1 779	1 836	1 881	7 632
018	348	379	623	620	601	2 571
020	2 162	2 480	3 413	2 645	2 438	13 138
022	3 508	4 345	4 550	4 519	4 465	21 387
024	2 016	1 914	2 270	2 471	2 476	11 147
025	1 720	1 159	1 064	743	1 013	5 699
026	3 372	2 828	3 463	2 812	3 111	15 586
027	10	16	7	12	15	60
028	0	1	2	1	0	4
029	71	77	138	55	71	412
030	1 764	2 121	2 269	2 046	2 526	10 726
031	0	4	0	0	0	4
032	81	53	216	176	115	641
033	1 385	1 336	1 539	1 424	1 593	7 277
034	3 393	3 082	3 255	2 510	2 902	15 142
035	1 182	1 444	1 538	970	1 026	6 160
036	342	348	501	483	427	2 101
037	468	496	552	708	825	3 049
038	4 438	4 715	5 744	4 202	3 963	23 062
039	610	713	741	939	930	3 933
040	180	223	195	197	261	1 056
041	549	658	851	784	724	3 566
042	285	364	251	286	525	1 711
043	1	0	0	0	0	1
045	308	218	167	273	417	1 383
046	187	126	161	216	326	1 016
047	458	283	242	326	241	1 550
801	1	39	13	85	73	211
unk	210	170	219	266	197	1 062
Sum	41 737	43 186	48 660	44 207	44 478	222 268

Table 5.8: Number of tows reported on TCEPRs, by Statistical Area and fishing year. Statistical Areas are shown in Figure 2.3.

Area	2008	2009	2010	2011	2012	2008–12
002	46	30	22	28	117	243
003	243	265	282	260	255	1 305
004	72	92	52	103	59	378
005	793	974	775	987	867	4 396
006	515	613	548	479	652	2 807
007	0	1	0	1	0	2
008	547	452	557	547	437	2 540
009	914	931	717	904	969	4 435
010	726	741	903	785	858	4 013
011	216	229	289	395	429	1 558
012	279	327	337	271	279	1 493
013	220	291	327	177	83	1 098
014	610	619	596	362	29	2 216
015	237	151	209	105	26	728
016	186	182	109	97	103	677
017	62	24	39	28	45	198
018	76	30	43	22	25	196
020	110	41	78	120	65	414
022	226	538	717	905	672	3 058
024	3	90	87	178	43	401
025	87	70	79	83	158	477
026	80	90	86	187	169	612
027	287	202	247	280	288	1 304
028	1 566	1 252	1 415	1 393	1 160	6 786
029	29	31	79	46	55	240
030	3	0	9	10	12	34
033	2	2	0	2	0	6
034	158	35	39	100	82	414
035	221	88	36	42	23	410
036	287	204	110	67	80	748
037	396	432	583	306	416	2 133
038	22	8	1	0	0	31
039	37	42	46	32	47	204
040	429	274	386	290	376	1 755
041	996	699	719	446	453	3 313
042	582	420	478	389	350	2 219
045	547	562	511	341	454	2 415
046	253	218	176	162	221	1 030
047	299	468	449	452	541	2 209
504	281	188	313	202	262	1 246
801	97	63	31	14	19	224
unk	119	126	103	112	139	599
Sum	12 859	12 095	12 583	11 710	11 318	60 565

Table 5.9: Aggregated swept area (km^2) estimated for effort reported on TCERs, by Statistical Area and fishing year. Statistical Areas are shown in Figure 2.3.

Area	2008	2009	2010	2011	2012	2008–12
002	475.0	464.9	391.5	468.9	361.6	2161.9
003	1 173.0	998.3	1 128.1	788.6	698.8	4 786.7
004	46.6	13.7	25.6	6.4	6.5	98.7
005	863.1	949.6	856.9	536.9	419.7	3 626.2
006	172.3	298.9	237.4	293.9	226.3	1 228.7
007	1.3	–	0.0	1.0	1.1	3.4
008	355.0	379.1	406.6	246.2	371.5	1 758.5
009	631.3	571.5	778.5	760.8	559.3	3 301.5
010	644.5	916.2	899.5	664.1	415.3	3 539.6
011	810.3	599.3	869.9	675.7	849.4	3 804.5
012	1 097.8	1 228.7	1 617.1	1 093.4	1 167.2	6 204.1
013	4 857.1	5 305.4	5 709.5	5 998.0	5 161.6	27 031.6
014	2 402.1	2 348.6	1 828.7	2 352.7	2 236.1	11 168.2
015	140.7	270.3	282.9	318.1	261.4	1 273.4
016	351.4	335.0	423.0	422.1	537.2	2 068.7
017	693.3	1 105.7	1 504.9	1 688.0	1 774.6	6 766.5
018	341.2	427.1	751.5	682.4	693.0	2 895.1
020	2 949.7	3 429.9	4 565.4	3 728.1	3 246.0	17 919.2
022	4 602.1	5 753.2	5 920.3	5 914.7	5 576.8	27 767.1
024	1 482.6	1 339.7	1 580.4	1 823.3	1 673.5	7 899.6
025	1 545.8	1 038.8	939.1	708.5	997.5	5 229.7
026	2 084.7	1 738.8	2 330.1	1 893.2	2 152.9	10 199.8
027	9.3	15.8	6.2	16.6	23.1	70.9
028	–	0.7	2.4	1.0	–	4.2
029	64.1	78.3	140.6	54.9	74.9	412.8
030	1 595.7	1 961.7	2 127.1	2 000.6	2 534.9	10 219.9
031	–	2.2	–	–	–	2.2
032	82.9	48.9	200.8	148.3	107.7	588.6
033	1 884.5	1 830.0	1 964.4	1 907.0	2 251.7	9 837.7
034	5 405.8	4 874.4	4 786.9	3 848.5	4 577.1	23 492.8
035	1 940.5	2 278.2	2 230.4	1 414.0	1 571.9	9 435.1
036	602.9	619.9	833.6	748.5	654.9	3 459.8
037	718.2	755.3	806.3	989.6	1 219.3	4 488.6
038	4 524.4	5 035.3	5 626.4	4 135.5	3 859.8	23 181.5
039	857.7	1 083.4	1 043.7	1 238.2	1 225.0	5 447.9
040	291.2	374.2	297.8	282.4	406.2	1 651.8
041	728.8	885.3	1 113.4	964.2	938.1	4 629.8
042	326.9	467.2	259.3	330.3	581.4	1 965.1
043	0.3	–	–	–	–	0.3
045	489.4	337.6	237.7	406.1	559.2	2 030.0
046	299.7	206.2	256.9	339.4	461.0	1 563.2
047	711.1	475.2	390.3	495.5	335.1	2 407.2
801	2.0	63.7	25.4	154.5	128.1	373.5
unk	197.8	180.8	212.3	251.1	202.9	1 044.9
All	48 454.2	51 087.0	55 608.7	50 791.0	51 099.7	257 040.6

Table 5.10: Aggregated swept area (km²) estimated for effort reported on TCEPRs, by Statistical Area and fishing year. Statistical Areas are shown in Figure 2.3.

Area	2008	2009	2010	2011	2012	2008–12
002	69.0	62.1	27.1	43.8	157.2	359.1
003	256.4	265.4	318.9	282.4	282.6	1 405.8
004	121.4	155.1	97.2	195.6	121.4	690.7
005	605.9	753.0	631.4	796.9	638.9	3 426.1
006	369.3	470.7	387.7	323.7	399.6	1 951.0
007	–	6.9	–	1.7	–	8.7
008	706.3	545.6	701.6	666.8	551.0	3 171.3
009	796.9	744.6	605.9	774.7	732.9	3 655.1
010	734.2	769.2	819.7	735.0	779.2	3 837.3
011	198.0	214.7	265.6	348.3	386.4	1 413.0
012	352.7	443.7	462.8	365.9	352.7	1 977.8
013	407.8	541.4	626.9	332.4	151.8	2 060.2
014	1 217.5	1 291.7	1 205.2	765.6	62.7	4 542.7
015	395.1	314.4	378.7	190.0	43.6	1 321.8
016	78.5	70.6	42.7	24.1	34.7	250.6
017	34.7	13.0	29.1	10.7	18.6	106.2
018	39.5	16.6	23.8	9.6	16.5	106.1
020	175.6	101.1	184.6	313.2	175.3	949.8
022	532.0	972.8	1 445.2	1 945.5	1 442.4	6 337.9
024	4.0	87.4	84.9	197.3	34.2	407.8
025	170.0	83.5	128.7	141.0	314.1	837.4
026	197.3	208.7	204.6	491.9	423.3	1 525.8
027	851.3	719.0	860.7	923.0	987.3	4 341.3
028	4 199.6	3 714.5	4 389.7	4 720.2	3 810.8	20 834.8
029	86.5	113.1	177.3	77.2	120.3	574.5
030	1.2	–	13.8	16.3	22.3	53.5
033	5.2	3.7	–	3.9	–	12.8
034	304.9	54.3	23.3	121.7	80.7	585.0
035	753.1	201.0	133.8	131.9	56.1	1 275.8
036	761.9	520.2	274.4	170.2	214.9	1 941.6
037	1 205.6	1 170.2	1 728.0	966.4	1 380.9	6 451.1
038	35.8	23.9	3.6	–	–	63.3
039	123.1	83.5	120.1	82.0	124.2	532.9
040	1 285.4	787.9	1 221.7	936.7	1 310.3	5 542.1
041	2 561.8	1 963.7	2 095.0	1 612.8	1 405.7	9 639.1
042	1 129.7	820.6	883.7	817.9	680.4	4 332.3
045	1 013.2	1 047.3	745.6	517.5	691.0	4 014.7
046	523.7	486.4	312.2	287.7	423.6	2 033.6
047	619.2	947.8	750.3	755.8	874.8	3 947.8
504	782.8	676.7	1 101.8	794.1	891.0	4 246.4
801	279.5	157.3	91.5	32.0	33.1	593.4
unk	138.2	118.6	130.9	95.1	101.4	584.2
All	24 124.1	21 742.0	23 729.9	22 018.3	20 328.1	111 942.4

Table 5.11: Total number of tows reported on TCERs and TCEPRs, by Statistical Area and target species for species where ≥ 30 tows exist (BNS, BYX, and RBY data are not shown separately but are included in the totals). Statistical Areas are shown in Figure 2.3 and target species are defined in Table 3.

Area	BAR	BCO	ELE	EMA	FLA	GSH	GUR	HOK	HPB	JDO	JMA	LEA	LIN	MOK	PAD	QSC
002	1	0	0	0	1	0	5	0	0	0	0	0	0	0	0	0
003	35	0	0	0	0	0	91	0	0	2061	0	3	0	0	0	0
004	3	0	0	0	0	0	2	0	0	6	0	0	0	0	0	0
005	14	0	0	0	0	0	713	0	0	3433	1	40	0	0	0	0
006	2	0	0	0	0	0	207	0	0	801	0	0	0	0	0	0
007	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0
008	23	0	0	0	0	0	73	0	0	766	0	10	1	0	0	0
009	30	0	0	0	1	0	80	6	0	257	0	0	0	0	0	0
010	12	0	0	0	1	0	292	6	0	218	0	0	1	0	0	0
011	17	0	0	0	0	0	158	94	0	0	0	0	5	0	0	0
012	35	0	0	0	0	0	743	3	0	0	1	0	0	1	0	0
013	18	0	0	0	1631	0	11854	4	0	54	0	0	0	18	0	0
014	53	0	0	0	3219	0	3227	29	0	50	0	0	5	64	0	0
015	11	0	0	0	3	0	407	19	0	0	0	0	6	31	0	0
016	34	0	0	0	41	11	267	655	0	13	1	0	33	89	0	0
017	206	0	5	0	1755	2312	563	262	31	82	2	46	27	83	0	0
018	181	0	40	0	12	75	14	155	0	2	1	0	8	3	0	0
020	588	1	250	0	4469	3	208	47	34	0	18	0	88	0	0	0
022	3839	0	2553	0	6459	125	1103	15	72	0	182	17	38	0	0	0
024	798	3	355	0	8380	4	68	0	9	0	0	1	56	2	26	17
025	259	8	121	0	4300	0	167	0	0	0	1	19	1	0	0	0
026	54	14	156	0	14388	1	27	3	6	0	10	0	21	1	76	429
027	294	0	0	0	18	0	0	9	0	0	10	0	15	0	0	0
028	212	0	0	0	2	0	0	34	0	0	263	0	9	0	0	0
029	203	0	0	0	7	0	0	0	0	0	15	0	1	0	0	0
030	15	0	72	0	5304	2	200	0	0	0	0	7	45	0	0	0
031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
032	22	0	0	0	6	0	4	0	0	0	0	0	6	0	0	0
033	684	0	15	0	1936	0	203	5	0	0	4	0	47	0	0	0
034	818	1	11	0	8691	2	531	11	0	1	31	0	30	0	0	0
035	295	0	19	7	4028	9	423	4	0	41	121	0	1	0	0	0
036	426	0	0	2	57	10	122	0	0	64	358	0	1	0	0	0
037	629	0	0	1	216	102	432	0	5	46	1994	215	0	2	0	0
038	974	3	0	0	17545	27	823	0	2	74	6	307	0	0	0	0
039	115	0	0	0	455	15	693	0	3	612	141	51	1	130	0	0
040	39	0	0	0	0	0	482	0	0	62	1626	103	0	0	0	0
041	54	0	0	48	32	0	2291	0	3	300	2425	0	0	0	0	0
042	60	0	0	0	2	0	1321	0	0	18	442	0	0	0	0	0
043	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
045	53	0	0	0	0	0	569	2	0	5	16	0	2	0	0	0
046	3	0	0	0	0	0	364	1	0	0	0	0	0	0	0	0
047	48	0	0	0	0	0	282	0	0	13	0	0	0	0	0	0
504	3	0	0	0	0	0	0	5	0	0	2	0	10	0	0	0
801	1	0	0	6	0	0	0	0	0	0	166	0	0	0	0	0
unk	42	0	1	0	325	18	140	207	0	78	32	33	25	11	16	0
All	11203	30	3598	64	83284	2716	29150	1576	165	9060	7869	852	483	435	118	446

Table 5.11 *continued*

Area	RBT	RCO	RSK	SCH	SCI	SKI	SNA	SPD	SPE	SPO	SQU	STA	SWA	TAR	TRE	WAR	All
002	0	0	0	3	0	0	649	0	0	0	1	0	1	868	310	0	1839
003	0	0	0	3	0	2	1867	0	0	0	0	0	0	950	497	0	5509
004	0	0	0	1	2	0	15	0	0	0	0	0	0	391	13	0	433
005	0	0	0	0	1	0	3259	0	0	0	0	0	0	71	550	0	8082
006	0	0	0	0	0	0	3707	0	0	0	0	0	0	6	35	0	4758
007	0	0	0	0	0	0	6	0	0	0	0	0	0	0	1	0	10
008	0	0	0	2	19	8	1358	0	0	0	0	0	0	1116	646	0	4025
009	0	0	0	0	14	1	1828	0	0	0	0	0	2	1970	2862	0	7056
010	0	0	0	0	0	5	2172	0	0	0	0	0	2	2870	1266	1	6849
011	0	5	0	1	0	29	157	0	0	0	0	0	15	4434	10	0	4925
012	0	0	0	0	1	25	239	0	0	0	0	0	102	4920	26	4	6106
013	0	81	0	0	1	10	295	0	0	1	0	0	0	8906	123	132	23133
014	0	76	0	2	21	176	63	0	0	0	0	0	18	4237	27	57	11337
015	0	1	0	0	24	3	0	0	0	0	0	0	20	1124	2	14	1685
016	0	21	0	16	0	4	2	0	0	0	0	1	4	1184	13	733	3123
017	0	1018	0	9	0	0	148	3	0	4	0	8	5	1053	37	171	7830
018	0	333	0	1	0	0	0	0	3	4	0	233	5	1647	0	50	2767
020	0	3151	18	19	0	0	0	25	8	52	52	236	89	3002	0	1194	13552
022	0	4923	149	38	4	0	0	419	85	306	650	341	368	2655	0	104	24445
024	0	311	2	0	0	0	0	38	264	16	341	14	6	798	0	39	11548
025	0	15	0	1	0	0	0	669	0	13	2	187	1	36	0	376	6176
026	0	63	0	2	0	0	0	15	3	0	422	21	92	356	0	38	16198
027	6	0	0	0	0	0	0	10	0	0	600	21	155	2	0	224	1364
028	32	0	0	0	0	0	0	0	0	0	6196	2	40	0	0	0	6790
029	2	1	0	0	0	0	0	0	0	0	14	406	1	1	0	1	652
030	0	27	0	1	0	0	0	149	0	35	0	4828	0	64	0	11	10760
031	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4
032	0	1	0	0	0	0	0	0	0	0	0	5	0	594	0	3	641
033	0	744	0	2	0	2	0	0	0	9	0	340	1	2671	1	618	7283
034	2	1098	0	17	0	9	0	0	0	20	0	988	4	2488	0	803	15556
035	3	657	0	4	0	0	14	0	0	4	0	82	30	821	2	5	6570
036	2	14	0	23	0	0	32	0	0	0	0	0	1	1680	24	33	2849
037	0	32	0	19	0	0	76	0	0	2	0	0	1	918	81	411	5182
038	0	896	2	10	0	0	1755	0	0	1	0	0	1	198	56	413	23093
039	0	27	0	109	0	0	266	0	0	10	0	0	0	1306	181	22	4137
040	0	0	0	17	0	0	12	0	0	0	0	0	0	209	261	0	2811
041	0	1	0	3	0	0	175	0	0	6	0	0	0	564	951	26	6879
042	0	0	0	20	0	0	562	0	0	0	0	0	3	123	1379	0	3930
043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
045	0	0	0	30	0	0	736	0	0	0	0	0	2	469	1914	0	3798
046	0	0	0	52	0	0	61	0	0	0	0	0	0	375	1190	0	2046
047	0	0	0	18	0	1	268	0	0	0	0	0	2	1120	2007	0	3759
504	4	0	0	0	0	0	0	0	0	0	1152	0	70	0	0	0	1246
801	0	0	0	0	0	0	0	0	0	0	0	0	0	262	0	0	435
unk	1	21	0	16	0	2	292	2	0	0	51	3	3	263	67	12	1661
All	52	13517	171	439	87	277	20014	1330	363	483	9481	7720	1044	56722	14532	5495	282833

Table 5.12: Percentage of the total effort given in Table 5.11 that was reported on TCERs, by Statistical Area and target species. Statistical Areas are shown in Figure 2.3 and target species are defined in Table 3.

Area	BAR	BCO	BNS	BYX	ELE	EMA	FLA	GSH	GUR	HOK	HPB	JDO	JMA	LEA	LIN	MOK	PAD	QSC
002	0.0	–	–	–	–	–	100.0	–	100.0	–	–	–	–	–	–	–	–	–
003	5.7	–	–	–	–	–	–	–	35.2	–	–	77.6	–	33.3	–	–	–	–
004	33.3	–	–	–	–	–	–	–	50.0	–	–	100.0	–	–	–	–	–	–
005	7.1	–	–	–	–	–	–	–	10.9	–	–	53.0	100.0	0.0	–	–	–	–
006	0.0	–	–	–	–	–	–	–	6.3	–	–	51.8	–	–	–	–	–	–
007	–	–	–	–	–	–	–	–	0.0	–	–	100.0	–	–	–	–	–	–
008	0.0	–	–	–	–	–	–	–	58.9	–	–	75.2	–	0.0	100.0	–	–	–
009	3.3	–	–	–	–	–	100.0	–	93.8	50.0	–	53.7	–	–	–	–	–	–
010	41.7	–	–	–	–	–	100.0	–	72.6	83.3	–	69.3	–	–	100.0	–	–	–
011	88.2	–	–	–	–	–	–	–	98.1	85.1	–	–	–	–	100.0	–	–	–
012	83.3	–	–	0.0	–	–	–	–	98.3	66.7	–	–	0.0	–	–	100.0	–	–
013	100.0	–	–	14.3	–	–	100.0	–	96.8	100.0	–	77.8	–	–	–	100.0	–	–
014	98.1	–	0.0	0.0	–	–	100.0	–	87.9	34.5	–	82.0	–	–	60.0	90.6	–	–
015	100.0	–	6.7	0.0	–	–	100.0	–	59.5	28.6	–	–	–	–	33.3	90.3	–	–
016	85.3	–	–	0.0	–	–	100.0	100.0	98.1	2.6	–	100.0	50.0	–	100.0	98.9	–	–
017	97.1	–	–	–	100.0	–	100.0	99.9	100.0	45.0	100.0	100.0	50.0	100.0	100.0	100.0	–	–
018	95.6	–	–	100.0	100.0	–	100.0	100.0	100.0	11.9	–	100.0	0.0	–	100.0	100.0	–	–
020	57.0	100.0	–	–	99.2	–	100.0	100.0	99.5	28.2	100.0	–	0.0	–	100.0	–	–	–
022	50.4	–	–	–	94.9	–	100.0	100.0	99.8	0.0	98.6	–	0.0	100.0	100.0	–	–	–
024	64.7	100.0	–	–	100.0	–	100.0	75.0	98.5	–	100.0	–	–	100.0	100.0	100.0	100.0	100.0
025	22.6	100.0	–	–	97.5	–	100.0	–	100.0	–	–	–	0.0	84.2	0.0	–	–	–
026	25.5	100.0	–	–	92.3	–	100.0	0.0	100.0	0.0	100.0	–	0.0	–	71.4	100.0	100.0	100.0
027	0.7	–	–	–	–	–	100.0	–	–	0.0	–	–	0.0	–	0.0	–	–	–
028	0.0	–	–	–	–	–	100.0	–	–	0.0	–	–	0.0	–	0.0	–	–	–
029	0.0	–	–	–	–	–	100.0	–	–	0.0	–	–	0.0	–	0.0	–	–	–
030	100.0	–	–	–	100.0	–	100.0	0.0	100.0	–	–	–	–	85.7	88.9	–	–	–
031	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
032	100.0	–	100.0	–	–	–	100.0	–	100.0	–	–	–	–	–	100.0	–	–	–
033	100.0	–	–	–	100.0	–	100.0	–	100.0	100.0	–	–	100.0	–	100.0	–	–	–
034	78.5	100.0	–	–	100.0	0.0	100.0	100.0	99.8	69.8	–	100.0	2.2	–	93.3	–	–	–
035	68.4	–	–	–	100.0	0.0	100.0	100.0	100.0	53.3	–	63.4	0.0	–	0.0	–	–	–
036	81.7	–	–	–	–	0.0	100.0	100.0	98.4	–	–	64.1	0.0	–	100.0	–	–	–
037	88.5	–	–	–	–	0.0	100.0	100.0	98.6	–	100.0	100.0	0.1	99.5	–	100.0	–	–
038	99.5	100.0	–	–	–	–	100.0	100.0	100.0	–	100.0	100.0	83.3	100.0	–	–	–	–
039	90.4	–	–	–	–	–	99.3	100.0	94.5	100.0	100.0	99.5	2.3	100.0	100.0	100.0	–	–
040	19.5	–	–	–	–	–	–	–	95.4	–	–	100.0	0.0	98.1	–	–	–	–
041	36.4	–	–	–	–	0.0	100.0	–	94.9	–	100.0	100.0	0.0	–	100.0	–	–	–
042	19.7	–	–	–	–	–	100.0	–	89.5	–	–	77.8	0.0	–	–	–	–	–
043	–	–	–	–	–	–	–	–	–	–	–	100.0	–	–	–	–	–	–
045	9.4	–	–	–	–	–	–	–	78.4	0.0	–	60.0	0.0	–	50.0	–	–	–
046	0.0	–	–	–	–	–	–	–	84.9	0.0	–	–	–	–	–	–	–	–
047	62.5	–	–	–	–	–	–	–	73.4	–	–	92.3	–	–	–	–	–	–
504	0.0	–	–	–	–	–	–	–	–	0.0	–	–	0.0	–	0.0	–	–	–
801	0.0	–	–	–	–	0.0	–	–	–	–	–	–	0.0	–	–	–	–	–
unk	95.2	–	–	–	100.0	–	100.0	100.0	81.4	11.1	–	69.2	2.4	97.0	88.0	100.0	100.0	–
All	62.8	100.0	15.0	8.7	95.9	0.0	99.9	99.7	91.2	22.0	99.4	67.7	0.2	92.9	87.6	97.7	100.0	100.0

Table 5.12 *continued*

Area	RBT	RBY	RCO	RSK	SCH	SCI	SKI	SNA	SPD	SPE	SPO	SQU	STA	SWA	TAR	TRE	WAR	All
002	–	–	–	–	66.7	–	–	89.8	–	–	–	100.0	–	0.0	83.4	90.3	–	86.8
003	–	–	–	–	100.0	–	50.0	88.2	–	–	–	–	–	–	75.1	41.4	–	76.3
004	–	–	–	–	0.0	0.0	–	20.0	–	–	–	–	–	–	11.0	7.7	–	12.7
005	–	–	–	–	–	0.0	–	52.7	–	–	–	–	–	–	73.2	2.9	–	45.6
006	–	–	–	–	–	–	–	40.7	–	–	–	–	–	–	66.7	25.7	–	41.0
007	–	–	–	–	–	–	–	100.0	–	–	–	–	–	–	–	0.0	–	80.0
008	–	0.0	–	–	0.0	0.0	0.0	41.8	–	–	–	–	–	–	18.3	14.4	–	36.9
009	–	83.3	–	–	–	0.0	0.0	30.5	–	–	–	–	–	0.0	33.2	41.4	–	37.1
010	–	33.3	–	–	–	–	0.0	32.5	–	–	–	–	–	50.0	45.1	36.2	100.0	41.4
011	–	–	100.0	–	100.0	–	20.7	70.7	–	–	–	–	–	93.3	66.9	90.0	–	68.4
012	–	0.0	–	–	–	0.0	40.0	70.7	–	–	–	–	–	55.9	72.9	96.2	100.0	75.5
013	–	–	100.0	–	–	0.0	100.0	71.2	–	–	100.0	–	–	–	93.2	97.6	90.9	95.2
014	–	0.0	98.7	–	100.0	0.0	67.6	52.4	–	–	–	–	–	50.0	61.6	96.3	42.1	80.4
015	–	0.0	100.0	–	–	0.0	66.7	–	–	–	–	–	–	95.0	56.5	50.0	42.9	56.5
016	–	–	95.2	–	100.0	–	100.0	100.0	–	–	–	–	100.0	100.0	99.2	100.0	98.5	73.1
017	–	–	99.6	–	100.0	–	–	99.3	100.0	–	100.0	–	87.5	100.0	98.7	100.0	98.8	96.2
018	–	–	100.0	–	100.0	–	–	–	–	100.0	100.0	–	98.3	80.0	97.4	–	96.0	92.6
020	–	–	99.8	100.0	100.0	–	–	–	76.0	100.0	100.0	50.0	100.0	42.4	99.0	–	99.9	96.6
022	0.0	–	95.0	100.0	100.0	0.0	–	–	94.7	97.6	100.0	53.5	100.0	37.7	99.2	–	100.0	87.4
024	–	–	95.8	100.0	–	–	–	–	100.0	97.3	100.0	75.7	100.0	50.0	99.2	–	87.2	96.5
025	–	–	93.3	–	100.0	–	–	–	100.0	–	100.0	0.0	98.4	0.0	91.7	–	30.4	92.1
026	–	–	100.0	–	100.0	–	–	–	100.0	100.0	–	0.0	100.0	0.0	100.0	–	30.0	96.2
027	0.0	–	–	–	–	–	–	–	90.0	–	–	0.0	100.0	0.0	100.0	–	3.3	4.3
028	0.0	–	–	–	–	–	–	–	–	–	–	0.0	100.0	0.0	–	–	–	0.1
029	0.0	–	0.0	–	–	–	–	–	–	–	–	0.0	99.5	0.0	100.0	–	0.0	61.7
030	–	–	88.9	–	100.0	–	–	–	100.0	–	100.0	–	99.8	–	84.4	–	81.8	99.7
031	–	–	–	–	–	–	–	–	–	–	–	–	100.0	–	–	–	–	100.0
032	–	–	100.0	–	–	–	–	–	–	–	–	–	100.0	–	100.0	–	100.0	100.0
033	–	100.0	100.0	–	100.0	–	100.0	–	–	–	100.0	–	98.8	100.0	99.9	100.0	100.0	99.9
034	0.0	–	100.0	–	100.0	–	100.0	–	–	–	100.0	–	96.2	75.0	96.4	–	90.5	96.5
035	0.0	–	99.5	–	100.0	–	–	100.0	–	–	100.0	–	98.8	0.0	83.7	100.0	100.0	92.3
036	0.0	–	100.0	–	100.0	–	–	100.0	–	–	–	–	–	0.0	83.6	100.0	75.8	71.4
037	–	–	96.9	–	100.0	–	–	100.0	–	–	50.0	–	–	100.0	94.6	95.1	96.8	55.8
038	–	–	100.0	100.0	100.0	–	–	100.0	–	–	100.0	–	–	100.0	99.5	100.0	94.2	99.9
039	–	–	100.0	–	96.3	–	–	100.0	–	–	100.0	–	–	–	99.5	98.9	100.0	94.3
040	–	–	–	–	100.0	–	–	100.0	–	–	–	–	–	–	97.6	73.6	–	33.8
041	–	–	100.0	–	66.7	–	–	55.4	–	–	100.0	–	–	–	57.6	61.0	100.0	46.0
042	–	–	–	–	5.0	–	–	23.7	–	–	–	–	–	0.0	9.8	25.7	–	40.4
043	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100.0
045	–	–	–	–	30.0	–	–	18.2	–	–	–	–	–	0.0	40.5	31.1	–	36.0
046	–	–	–	–	76.9	–	–	11.5	–	–	–	–	–	–	50.1	39.7	–	49.7
047	–	–	–	–	83.3	–	0.0	26.9	–	–	–	–	–	0.0	53.9	30.4	–	41.2
504	0.0	–	–	–	–	–	–	–	–	–	–	0.0	–	0.0	–	–	0.0	0.0
801	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80.5	–	–	32.7
unk	0.0	–	100.0	–	100.0	–	100.0	48.3	100.0	–	–	0.0	100.0	0.0	65.8	59.7	100.0	62.2
All	0.0	19.4	97.9	100.0	85.4	0.0	59.6	53.5	97.8	97.5	99.8	6.4	99.2	28.6	78.4	39.0	86.8	77.7

Table 5.13: Aggregated swept area (km²) estimated for effort reported on TCERs and TCEPRs, by Statistical Area and target species (note the data for BNS, BYX, and RBY are not shown separately but are included in the totals). Statistical Areas are shown in Figure 2.3 and target species are defined in Table 3.

Area	BAR	BCO	ELE	EMA	FLA	GSH	GUR	HOK	HPB	JDO	JMA	LEA	LIN	MOK	PAD	QSC
002	1.2	–	–	–	0.5	–	4.9	–	–	–	–	–	–	–	–	–
003	38.7	–	–	–	–	–	83.4	–	–	2338.7	–	2.4	–	–	–	–
004	6.1	–	–	–	–	–	7.7	–	–	7.9	–	–	–	–	–	–
005	13.9	–	–	–	–	–	492.7	–	–	3152.9	1.6	25.4	–	–	–	–
006	2.3	–	–	–	–	–	124.1	–	–	547.1	–	–	–	–	–	–
007	–	–	–	–	–	–	1.7	–	–	1.3	–	–	–	–	–	–
008	31.4	–	–	–	–	–	69.6	–	–	823.2	–	8.9	0.3	–	–	–
009	39.0	–	–	–	0.8	–	97.6	5.2	–	308.6	–	–	–	–	–	–
010	16.1	–	–	–	0.8	–	337.3	5.5	–	295.5	–	–	2.0	–	–	–
011	19.5	–	–	–	–	–	191.4	86.3	–	–	–	–	4.2	–	–	–
012	50.9	–	–	–	–	–	989.8	3.6	–	–	1.4	–	–	2.2	–	–
013	24.5	–	–	–	1335.9	–	15368.8	4.4	–	88.2	–	–	–	19.9	–	–
014	76.3	–	–	–	2815.1	–	4609.1	34.0	–	80.2	–	–	6.9	98.8	–	–
015	15.5	–	–	–	2.5	–	612.3	22.6	–	–	–	–	8.3	42.1	–	–
016	30.5	–	–	–	28.3	6.8	252.9	227.9	–	13.8	0.2	–	22.9	95.7	–	–
017	206.1	–	2.6	–	1292.5	2126.6	498.3	85.4	27.7	59.6	3.9	40.7	28.3	56.9	–	–
018	196.8	–	37.6	–	5.9	84.7	17.3	59.2	–	3.4	0.2	–	4.3	2.9	–	–
020	1016.4	0.2	296.7	–	5276.4	5.4	240.9	81.1	33.2	–	43.7	–	68.9	–	–	–
022	6513.5	–	3434.2	–	7340.7	167.9	1493.5	75.2	106.7	–	452.3	21.9	33.8	–	–	–
024	862.2	1.5	292.4	–	5344.3	4.9	61.5	–	6.5	–	–	1.5	38.8	1.8	10.1	4.3
025	454.3	5.5	94.4	–	3752.1	–	140.2	–	–	–	3.6	23.1	3.9	–	–	–
026	128.9	13.7	119.3	–	9543.2	1.1	17.7	13.8	5.0	–	25.5	–	19.4	0.8	18.1	108.7
027	677.8	–	–	–	14.6	–	–	26.4	–	–	27.0	–	51.4	–	–	–
028	527.6	–	–	–	1.7	–	–	96.0	–	–	615.2	–	41.0	–	–	–
029	459.8	–	–	–	6.8	–	–	–	–	–	38.0	–	0.0	–	–	–
030	21.9	–	53.8	–	4619.1	4.0	149.5	–	–	–	–	7.0	29.7	–	–	–
031	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
032	29.5	–	–	–	4.0	–	4.3	–	–	–	–	–	3.2	–	–	–
033	942.0	–	26.7	–	2863.6	–	315.7	6.9	–	–	6.9	–	58.4	–	–	–
034	1079.6	1.6	16.6	–	13629.8	2.9	925.9	41.7	–	1.4	40.5	–	25.7	–	–	–
035	719.7	–	30.1	19.9	6015.2	13.1	608.2	28.5	–	74.0	289.4	–	2.4	–	–	–
036	760.7	–	–	5.2	83.4	17.3	169.1	–	–	107.1	1036.7	–	1.4	–	–	–
037	1061.8	–	–	4.1	265.8	154.2	585.7	–	3.8	69.7	6071.3	316.6	–	2.4	–	–
038	1363.8	2.0	–	–	16488.5	36.4	1009.3	–	1.3	78.1	7.4	394.0	–	–	–	–
039	163.1	–	–	–	641.9	18.0	965.6	–	3.7	825.3	403.2	69.5	1.6	161.9	–	–
040	87.1	–	–	–	–	–	744.5	–	–	97.5	5295.3	176.2	–	–	–	–
041	138.8	–	–	75.3	28.5	–	2733.5	–	1.1	413.4	8017.0	–	–	–	–	–
042	107.4	–	–	–	2.2	–	1431.0	–	–	20.5	1388.3	–	–	–	–	–
043	–	–	–	–	–	–	–	–	–	0.3	–	–	–	–	–	–
045	86.6	–	–	–	–	–	824.6	2.2	–	6.7	33.6	–	3.4	–	–	–
046	3.8	–	–	–	–	–	517.4	0.0	–	–	–	–	–	–	–	–
047	74.9	–	–	–	–	–	439.4	–	–	19.3	–	–	–	–	–	–
504	2.4	–	–	–	–	–	–	14.7	–	–	3.9	–	60.3	–	–	–
801	0.7	–	–	29.1	–	–	–	–	–	–	456.4	–	–	–	–	–
unk	65.6	0.0	0.8	0.0	240.0	13.4	155.1	47.9	0.0	65.6	65.3	38.7	20.7	11.2	6.3	0.0
All	18118.6	24.5	4405.2	133.6	81644.1	2656.6	37291.5	968.6	189.0	9499.3	24327.7	1126.1	541.2	496.6	34.5	112.9

Table 5.13 *continued*

Area	RBT	RCO	RSK	SCH	SCI	SKI	SNA	SPD	SPE	SPO	SQU	STA	SWA	TAR	TRE	WAR	All
002	–	–	–	5.1	–	–	763.8	–	–	–	1.2	–	5.3	1326.2	412.8	–	2521.0
003	–	–	–	5.1	–	3.2	1976.4	–	–	–	–	–	–	1309.1	435.5	–	6192.5
004	–	–	–	2.7	0.6	–	27.8	–	–	–	–	–	–	722.6	14.1	–	789.4
005	–	–	–	–	5.9	–	2910.6	–	–	–	–	–	–	74.3	375.0	–	7052.2
006	–	–	–	–	–	–	2462.8	–	–	–	–	–	–	16.2	27.2	–	3179.7
007	–	–	–	–	–	–	2.1	–	–	–	–	–	–	–	6.9	–	12.0
008	–	–	–	1.9	33.9	19.5	1501.7	–	–	–	–	–	–	1772.5	666.4	–	4929.8
009	–	–	–	–	13.9	1.9	1543.2	–	–	–	–	–	1.8	2223.1	2716.6	–	6956.6
010	–	–	–	–	–	3.3	1902.3	–	–	–	–	–	2.6	3399.8	1408.2	0.7	7377.0
011	–	5.8	–	0.8	–	20.6	178.2	–	–	–	–	–	12.5	4687.6	10.8	–	5217.6
012	–	–	–	–	0.4	16.3	316.4	–	–	–	–	–	143.8	6611.4	32.0	5.6	8181.9
013	–	90.3	–	–	2.6	12.3	408.3	–	–	1.4	–	–	–	11355.1	154.9	213.5	29091.9
014	–	79.9	–	3.5	20.1	285.4	102.7	–	–	–	–	–	32.0	7300.6	42.1	108.9	15710.9
015	–	0.5	–	–	21.1	3.7	–	–	–	–	–	–	16.3	1809.9	4.4	21.0	2595.2
016	–	19.5	–	25.2	–	2.4	1.1	–	–	–	–	0.8	4.0	1120.0	11.0	455.3	2319.2
017	–	998.0	–	9.5	–	–	119.3	1.5	–	2.8	–	10.2	5.9	1151.3	33.4	112.3	6872.7
018	–	284.9	–	0.9	–	–	–	–	1.9	5.6	–	312.6	4.7	1912.7	–	65.5	3001.2
020	–	4335.8	25.5	24.0	–	–	–	42.0	10.0	57.7	53.9	395.2	271.8	4862.5	–	1727.8	18868.9
022	–	5895.3	184.7	56.3	0.6	–	–	624.8	139.7	437.5	919.0	476.4	1178.8	4383.5	–	168.7	34105.0
024	–	251.2	3.6	–	–	–	–	33.4	259.7	20.4	345.0	16.8	6.1	696.0	–	45.6	8307.4
025	–	13.4	–	0.6	–	–	–	680.5	–	7.7	5.1	189.7	2.0	39.4	–	651.6	6067.1
026	–	41.9	–	2.9	–	–	–	15.4	2.2	–	1047.1	15.9	222.3	280.3	–	82.3	11725.5
027	12.7	–	–	–	–	–	–	16.0	–	–	2521.9	20.6	653.7	3.3	–	386.7	4412.1
028	55.6	–	–	–	–	–	–	–	–	–	19309.1	2.4	190.2	–	–	–	20839.0
029	2.4	6.0	–	–	–	–	–	–	–	–	43.8	408.9	17.9	0.8	–	3.0	987.4
030	–	25.2	–	0.5	–	–	–	164.1	–	38.1	–	5073.2	–	69.5	–	17.7	10273.4
031	–	–	–	–	–	–	–	–	–	–	–	2.2	–	–	–	–	2.2
032	–	1.6	–	–	–	–	–	–	–	–	–	4.5	–	537.3	–	4.2	588.6
033	–	1037.6	–	2.5	–	3.4	–	–	–	16.2	–	503.3	1.2	3251.5	1.4	812.0	9850.5
034	4.3	1795.5	–	31.9	–	8.7	–	–	–	51.7	–	1561.4	11.3	3743.3	–	1104.0	24077.7
035	2.6	1035.7	–	6.7	–	–	18.0	–	–	5.5	–	132.2	202.4	1497.6	1.7	7.9	10710.9
036	6.3	19.7	–	38.3	–	–	48.7	–	–	–	–	–	1.3	3021.3	33.2	51.7	5401.4
037	–	39.9	–	34.8	–	–	73.8	–	–	2.6	–	–	1.1	1475.3	118.4	658.6	10939.8
038	–	1092.2	2.1	14.9	–	–	1796.3	–	–	1.3	–	–	1.3	243.0	52.7	660.2	23244.8
039	–	36.2	–	173.4	–	–	376.3	–	–	15.7	–	–	–	1826.5	265.0	34.0	5980.9
040	–	–	–	29.5	–	–	14.9	–	–	–	–	–	–	338.4	410.5	–	7193.9
041	–	1.8	–	4.6	–	–	248.1	–	–	9.9	–	–	–	993.8	1555.2	48.0	14269.0
042	–	–	–	47.7	–	–	854.6	–	–	–	–	–	4.9	259.9	2180.9	–	6297.4
043	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.3
045	–	–	–	80.9	–	–	986.1	–	–	–	–	–	3.4	1099.9	2917.3	–	6044.6
046	–	–	–	103.5	–	–	86.5	–	–	–	–	–	–	860.5	2025.0	–	3596.7
047	–	–	–	32.7	–	2.3	395.6	–	–	–	–	–	3.3	2326.5	3061.2	–	6355.1
504	4.7	–	–	–	–	–	–	–	–	–	3820.5	–	339.8	–	–	–	4246.4
801	–	–	–	–	–	–	–	–	–	–	–	–	–	480.7	–	–	966.9
unk	2.0	19.0	0.0	23.4	0.0	0.4	259.2	2.1	0.0	0.0	165.4	3.1	10.7	323.3	73.0	16.9	1629.2
All	90.6	17127.0	216.0	763.7	99.2	383.4	19374.6	1579.8	413.4	674.0	28232.2	9129.3	3352.4	79406.4	19046.6	7463.6	368983.0

Table 5.14: Percentage of the total aggregated swept area (km^2) given in Table 5.13 that was reported on TCERs, by Statistical Area and target species. Statistical Areas are shown in Figure 2.3 and target species are defined in Table 3.

Area	BAR	BCO	BNS	BYX	ELE	EMA	FLA	GSH	GUR	HOK	HPB	JDO	JMA	LEA	LIN	MOK	PAD	QSC
002	0.0	–	–	–	–	–	100.0	–	100.0	–	–	–	–	–	–	–	–	–
003	5.2	–	–	–	–	–	–	–	39.2	–	–	80.5	–	37.5	–	–	–	–
004	34.4	–	–	–	–	–	–	–	19.5	–	–	100.0	–	–	–	–	–	–
005	7.2	–	–	–	–	–	–	–	16.1	–	–	61.0	100.0	0.0	–	–	–	–
006	0.0	–	–	–	–	–	–	–	8.4	–	–	54.6	–	–	–	–	–	–
007	–	–	–	–	–	–	–	–	0.0	–	–	100.0	–	–	–	–	–	–
008	0.0	–	–	–	–	–	–	–	66.9	–	–	76.3	–	0.0	100.0	–	–	–
009	1.5	–	–	–	–	–	100.0	–	96.6	61.5	–	59.5	–	–	–	–	–	–
010	40.4	–	–	–	–	–	100.0	–	81.9	83.3	–	75.1	–	–	100.0	–	–	–
011	92.3	–	–	–	–	–	–	–	98.0	92.0	–	–	–	–	100.0	–	–	–
012	82.3	–	–	0.0	–	–	–	–	98.1	69.4	–	–	0.0	–	–	100.0	–	–
013	100.0	–	–	0.6	–	–	100.0	–	95.3	100.0	–	70.3	–	–	–	100.0	–	–
014	99.0	–	0.0	0.0	–	–	100.0	–	82.6	32.1	–	76.4	–	–	71.0	86.3	–	–
015	100.0	–	6.7	0.0	–	–	100.0	–	55.4	33.7	–	–	–	–	28.9	90.3	–	–
016	85.6	–	–	0.0	–	–	100.0	100.0	98.5	2.2	–	100.0	66.7	–	100.0	99.8	–	–
017	97.4	–	–	–	100.0	–	100.0	99.9	100.0	30.3	100.0	100.0	25.5	100.0	100.0	100.0	–	–
018	95.5	–	–	100.0	100.0	–	100.0	100.0	100.0	19.8	–	100.0	0.0	–	100.0	100.0	–	–
020	42.8	100.0	–	–	98.7	–	100.0	100.0	99.3	21.6	100.0	–	0.0	–	100.0	–	–	–
022	39.2	–	–	–	94.4	–	100.0	100.0	99.8	0.0	98.3	–	0.0	100.0	100.0	–	–	–
024	68.9	100.0	–	–	100.0	–	100.0	87.8	96.9	–	100.0	–	–	100.0	100.0	100.0	100.0	100.0
025	17.4	100.0	–	–	96.8	–	100.0	–	100.0	–	–	–	0.0	75.8	0.0	–	–	–
026	5.6	100.0	–	–	83.4	–	100.0	0.0	100.0	0.0	100.0	–	0.0	–	46.9	100.0	100.0	100.0
027	0.5	–	–	–	–	–	100.0	–	–	0.0	–	–	0.0	–	0.0	–	–	–
028	0.0	–	–	–	–	–	100.0	–	–	0.0	–	–	0.0	–	0.0	–	–	–
029	0.0	–	–	–	–	–	100.0	–	–	0.0	–	–	0.0	–	–	–	–	–
030	100.0	–	–	–	100.0	–	100.0	0.0	100.0	–	–	–	–	85.7	89.6	–	–	–
031	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
032	100.0	–	100.0	–	–	–	100.0	–	100.0	–	–	–	–	–	100.0	–	–	–
033	100.0	–	–	–	100.0	–	100.0	–	100.0	100.0	–	–	100.0	–	100.0	–	–	–
034	88.2	100.0	–	–	100.0	0.0	100.0	100.0	99.8	19.4	–	100.0	1.7	–	97.7	–	–	–
035	44.6	–	–	–	100.0	0.0	100.0	100.0	100.0	3.0	–	53.1	0.0	–	0.0	–	–	–
036	68.2	–	–	–	–	0.0	100.0	100.0	97.9	–	–	52.4	0.0	–	100.0	–	–	–
037	74.1	–	–	–	–	0.0	100.0	100.0	98.1	–	100.0	100.0	0.0	99.7	–	100.0	–	–
038	99.5	100.0	–	–	–	–	100.0	100.0	100.0	–	100.0	100.0	32.0	100.0	–	–	–	–
039	85.2	–	–	–	–	–	99.1	100.0	91.5	100.0	100.0	99.5	1.0	100.0	100.0	100.0	–	–
040	9.7	–	–	–	–	–	–	–	94.4	–	–	100.0	0.0	98.5	–	–	–	–
041	19.4	–	–	–	–	0.0	100.0	–	91.7	–	100.0	100.0	0.0	–	100.0	–	–	–
042	16.2	–	–	–	–	–	100.0	–	82.5	–	–	80.5	0.0	–	–	–	–	–
043	–	–	–	–	–	–	–	–	–	–	–	100.0	–	–	–	–	–	–
045	8.5	–	–	–	–	–	–	–	73.2	0.0	–	58.8	0.0	–	70.6	–	–	–
046	0.0	–	–	–	–	–	–	–	80.5	–	–	–	–	–	–	–	–	–
047	58.5	–	–	–	–	–	–	–	67.3	–	–	88.6	–	–	–	–	–	–
504	0.0	–	–	–	–	–	–	–	–	0.0	–	–	0.0	–	0.0	–	–	–
801	0.0	–	–	–	–	0.0	–	–	–	–	–	–	0.0	–	–	–	–	–
unk	87.8	–	–	–	100.0	–	100.0	100.0	88.6	12.1	–	74.8	1.5	97.4	59.9	100.0	100.0	–
All	50.3	100.0	7.7	0.9	95.0	0.0	100.0	99.7	90.3	18.7	99.0	73.8	0.1	95.8	64.9	96.4	100.0	100.0

Table 5.14 *continued*

Area	RBT	RBY	RCO	RSK	SCH	SCI	SKI	SNA	SPD	SPE	SPO	SQU	STA	SWA	TAR	TRE	WAR	All
002	–	–	–	–	78.4	–	–	90.7	–	–	–	100.0	–	0.0	81.7	90.9	–	85.8
003	–	–	–	–	100.0	–	59.4	85.9	–	–	–	–	–	–	73.7	45.7	–	77.3
004	–	–	–	–	0.0	0.0	–	10.8	–	–	–	–	–	–	11.5	9.9	–	12.5
005	–	–	–	–	–	0.0	–	53.5	–	–	–	–	–	–	69.2	3.8	–	51.4
006	–	–	–	–	–	–	–	37.0	–	–	–	–	–	–	25.9	16.9	–	38.6
007	–	–	–	–	–	–	–	100.0	–	–	–	–	–	–	–	0.0	–	28.1
008	–	0.0	–	–	0.0	0.0	0.0	40.2	–	–	–	–	–	–	20.4	17.9	–	35.7
009	–	98.0	–	–	–	0.0	0.0	40.0	–	–	–	–	–	0.0	39.8	55.6	–	47.5
010	–	34.5	–	–	–	–	0.0	36.6	–	–	–	–	–	38.5	51.9	40.1	100.0	48.0
011	–	–	100.0	–	100.0	–	31.1	74.2	–	–	–	–	–	94.4	71.4	88.0	–	72.9
012	–	0.0	–	–	–	0.0	56.4	68.2	–	–	–	–	–	57.0	73.2	93.8	100.0	75.8
013	–	–	100.0	–	–	0.0	100.0	64.5	–	–	100.0	–	–	–	90.1	96.3	90.3	92.9
014	–	0.0	97.5	–	100.0	0.0	64.2	41.5	–	–	–	–	–	41.9	53.6	94.8	33.7	71.1
015	–	0.0	100.0	–	–	0.0	56.8	–	–	–	–	–	–	92.6	46.5	50.0	25.4	48.8
016	–	–	94.9	–	100.0	–	100.0	100.0	–	–	–	–	100.0	100.0	99.2	100.0	98.8	85.5
017	–	–	99.6	–	100.0	–	–	99.3	100.0	–	100.0	–	80.4	100.0	98.3	100.0	99.1	97.8
018	–	–	100.0	–	100.0	–	–	–	–	100.0	100.0	–	97.9	91.5	98.0	–	95.1	96.3
020	–	–	99.8	100.0	100.0	–	–	–	63.3	100.0	100.0	46.1	100.0	22.0	99.2	–	99.9	94.2
022	0.0	–	94.4	100.0	100.0	0.0	–	–	84.3	97.5	100.0	48.9	100.0	17.2	98.9	–	100.0	79.3
024	–	–	94.3	100.0	–	–	–	–	100.0	95.9	100.0	74.6	100.0	34.4	97.9	–	86.2	95.1
025	–	–	90.4	–	100.0	–	–	–	100.0	–	100.0	0.0	96.2	0.0	83.8	–	24.8	82.2
026	–	–	100.0	–	100.0	–	–	–	100.0	100.0	–	0.0	100.0	0.0	100.0	–	14.2	86.3
027	0.0	–	–	–	–	–	–	–	83.1	–	–	0.0	100.0	0.0	100.0	–	2.2	1.4
028	0.0	–	–	–	–	–	–	–	–	–	–	0.0	100.0	0.0	–	–	–	0.0
029	0.0	–	0.0	–	–	–	–	–	–	–	–	0.0	99.1	0.0	100.0	–	0.0	34.7
030	–	–	69.4	–	100.0	–	–	–	100.0	–	100.0	–	99.6	–	76.7	–	79.8	99.5
031	–	–	–	–	–	–	–	–	–	–	–	–	100.0	–	–	–	–	100.0
032	–	–	100.0	–	–	–	–	–	–	–	–	–	100.0	–	100.0	–	100.0	100.0
033	–	100.0	100.0	–	100.0	–	100.0	–	–	–	100.0	–	98.2	100.0	99.9	100.0	100.0	99.9
034	0.0	–	100.0	–	100.0	–	100.0	–	–	–	100.0	–	95.1	25.0	95.0	–	88.6	96.5
035	0.0	–	99.3	–	100.0	–	–	100.0	–	–	100.0	–	98.3	0.0	79.5	100.0	100.0	85.2
036	0.0	–	100.0	–	100.0	–	–	100.0	–	–	–	–	–	0.0	79.5	100.0	66.0	56.6
037	–	–	94.5	–	100.0	–	–	100.0	–	–	15.4	–	–	100.0	92.6	93.6	95.5	32.3
038	–	–	100.0	100.0	100.0	–	–	100.0	–	–	100.0	–	–	100.0	97.1	100.0	93.2	99.7
039	–	–	100.0	–	96.2	–	–	100.0	–	–	100.0	–	–	–	99.4	98.5	100.0	87.8
040	–	–	–	–	100.0	–	–	100.0	–	–	–	–	–	–	97.0	71.8	–	16.2
041	–	–	100.0	–	52.2	–	–	52.0	–	–	100.0	–	–	–	55.0	58.3	100.0	23.4
042	–	–	–	–	3.4	–	–	21.8	–	–	–	–	–	0.0	8.5	24.7	–	25.1
043	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100.0
045	–	–	–	–	22.9	–	–	15.4	–	–	–	–	–	0.0	35.1	29.4	–	32.7
046	–	–	–	–	66.7	–	–	9.7	–	–	–	–	–	–	45.2	33.6	–	43.5
047	–	–	–	–	84.1	–	0.0	19.5	–	–	–	–	–	0.0	47.6	27.4	–	37.9
504	0.0	–	–	–	–	–	–	–	–	–	–	0.0	–	0.0	–	–	0.0	0.0
801	–	–	–	–	–	–	–	–	–	–	–	–	–	–	77.7	–	–	21.1
unk	0.0	–	100.0	–	100.0	–	100.0	51.7	100.0	–	–	0.0	100.0	0.0	69.8	70.0	100.0	61.1
All	0.0	29.0	97.8	100.0	78.7	0.0	60.0	54.5	92.6	96.6	99.7	2.3	98.6	12.2	76.1	40.4	78.2	65.6

Table 5.15: Number of cells with trawl effort, by fishing year, and the number of tows reported on TCERs and TCEPRs for each target species for 2008–12. Target species codes are given in Table 3.

Target	No. of cells contacted						No. of tows
code	2008	2009	2010	2011	2012	2008–12	2008–12
BAR	3 022	2 641	2 477	2 504	2 605	4 948	11 203
BCO	17	2	27	7	15	60	30
BNS	32	6	0	7	0	32	18
BYX	19	11	2	15	4	51	11
ELE	537	660	636	721	628	1 168	3 598
EMA	93	73	3	6	54	175	64
FLA	2 184	2 204	2 207	2 017	2 131	3 298	83 284
GSH	223	327	401	491	264	862	2716
GUR	2 429	2 605	2 960	2 964	3 068	4 548	29 150
HOK	254	326	343	280	262	911	1576
HPB	105	89	111	120	61	291	165
JDO	1 074	989	1 195	1 020	958	2 061	9 060
JMA	1 551	1 480	1 452	1 343	1 291	2 302	7 869
LEA	159	217	291	330	343	621	852
LIN	282	243	312	270	179	797	483
MOK	115	153	101	190	122	378	435
PAD	24	10	9	14	5	42	118
QSC	25	13	24	22	32	67	446
RBT	30	46	42	10	46	143	52
RBY	12	8	29	10	31	71	28
RCO	1 768	1 618	1 675	1 807	1 746	2 770	13 517
RSK	12	37	72	107	88	242	171
SCH	295	390	324	451	380	1 229	439
SCI	54	54	85	91	21	207	87
SKI	55	89	124	203	103	326	277
SNA	1 901	1 902	1 807	1 792	1 831	2 906	20 014
SPD	448	484	469	298	186	845	1 330
SPE	50	70	232	197	89	364	363
SPO	68	160	344	271	423	733	483
SQU	565	467	605	693	570	1 083	9 481
STA	819	927	1 148	1 133	911	1 726	7 720
SWA	570	445	414	459	397	1 119	1 044
TAR	4 714	5 090	5 034	5 094	5 073	6 971	56 722
TRE	1 772	2 001	1 792	1 748	1 504	2 979	14 532
WAR	1 234	1 089	1 090	1 007	1 045	2 251	5 495
All	8 967	9 023	9 009	8 925	8 875	10 283	282 833

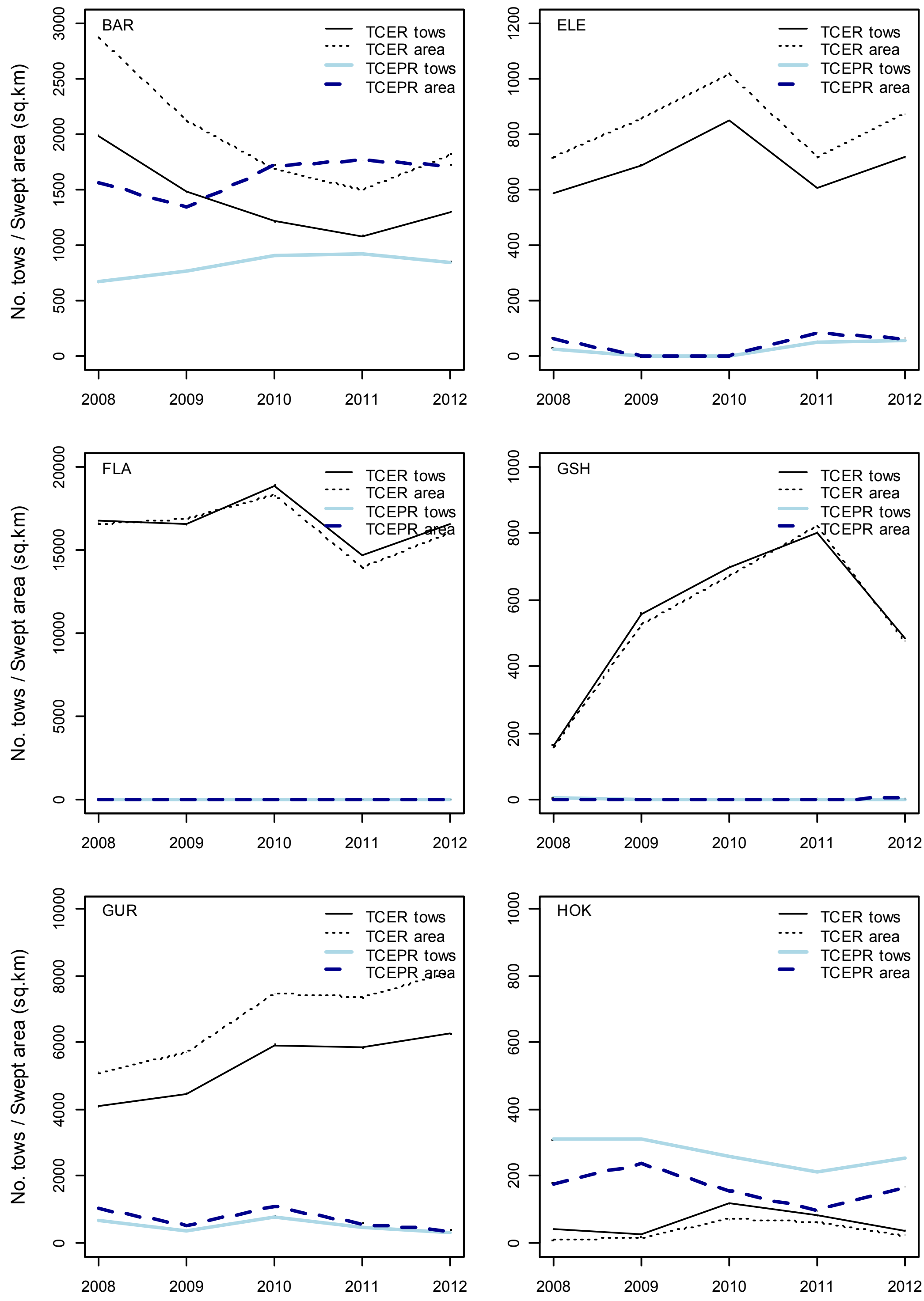

Figure 5.1: Number of tows contacted by trawl gear and the aggregated swept area, for a given target species, by fishing year and form type. Target species codes are defined in Table 3.

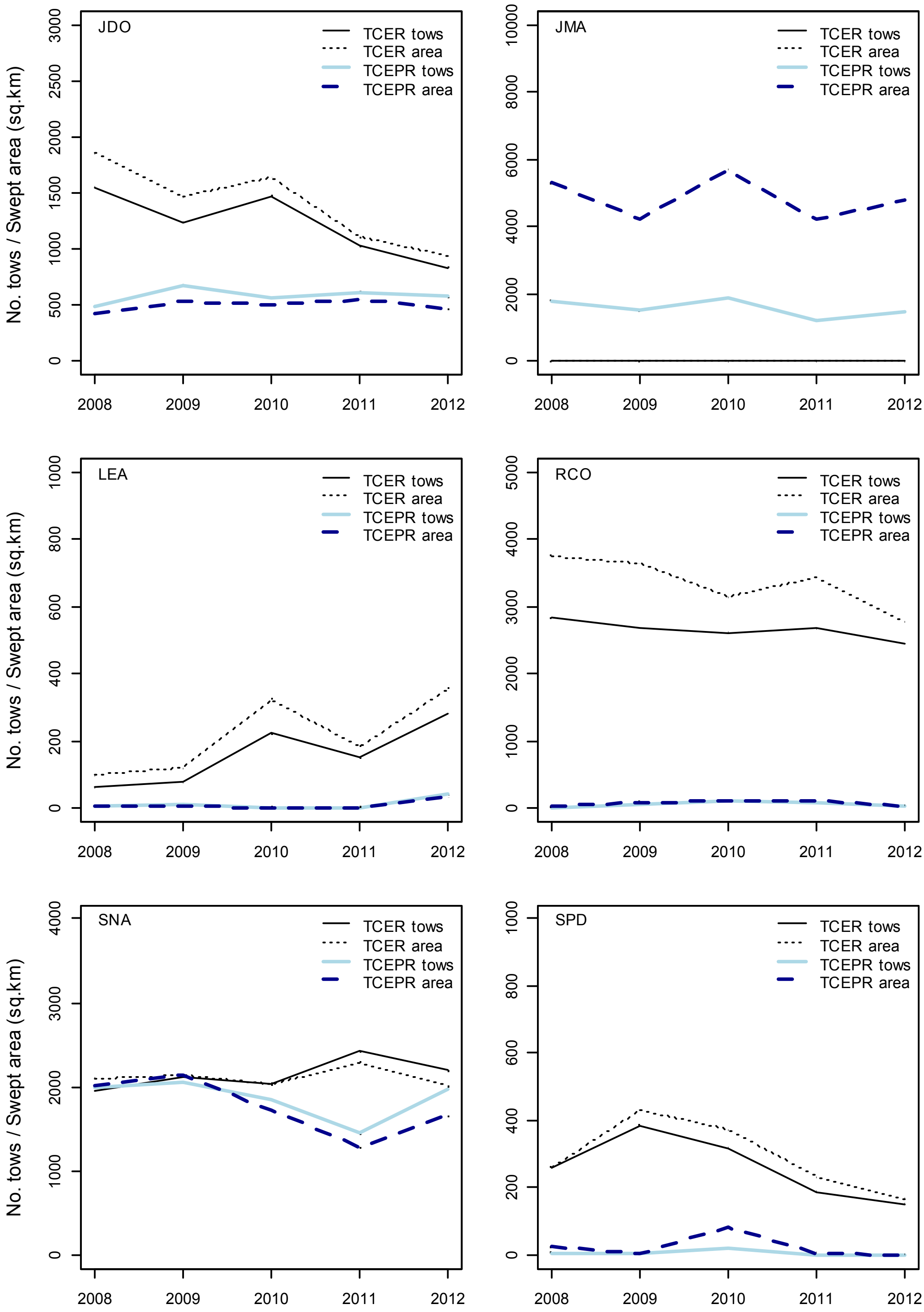

Figure 5.1 ***continued.***

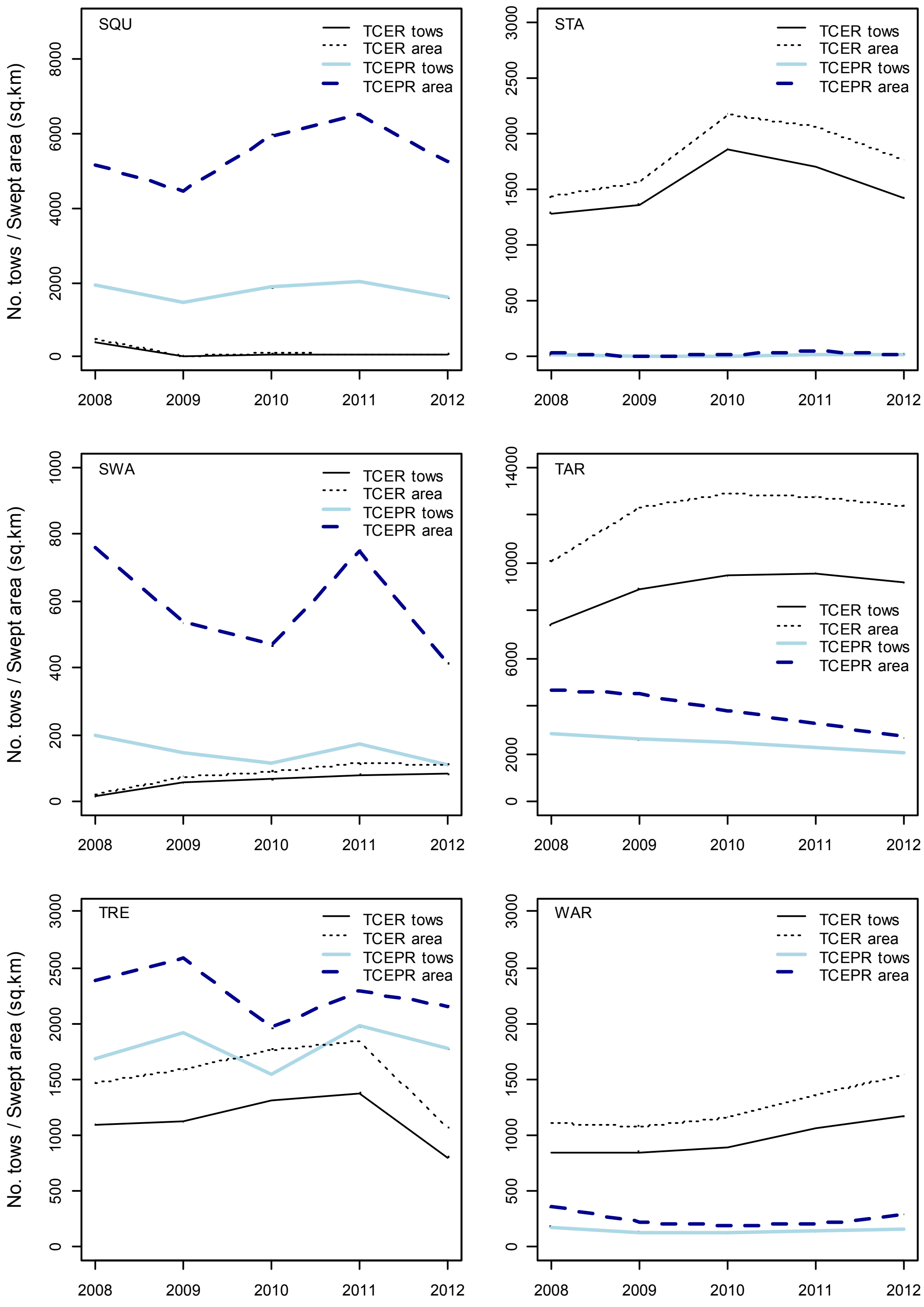

Figure 5.1 *continued.*

APPENDIX 6: TRAWL FOOTPRINT SUMMARY

Table 6.1: Total cell footprint (km^2), by fishing year, for each target species. Target species codes are given in Table 3.

Target code	2008	2009	2010	2011	2012	2008–12
BAR	3 892.2	3 096.6	2 941.2	2 852.6	3 092.1	12 875.0
BCO	5.3	0.8	8.3	1.6	8.3	24.1
BNS	14.4	1.7	0.0	1.4	0.0	17.0
BYX	8.7	3.3	0.3	5.6	1.2	19.2
ELE	686.5	762.6	886.5	707.5	794.7	2 958.5
EMA	42.6	47.8	1.1	3.7	35.2	127.5
FLA	8 285.9	8 808.9	9 144.7	7 689.4	8 413.2	18 485.3
GSH	149.9	393.0	516.6	630.2	366.8	1 342.2
GUR	4 736.7	4 864.1	6 251.8	5 906.9	6 586.3	17 926.8
HOK	148.1	215.1	198.8	140.7	154.9	728.3
HPB	38.3	32.6	45.4	45.4	24.7	181.6
JDO	1 857.4	1 630.7	1 795.5	1 384.5	1 237.4	5 449.3
JMA	4 606.6	3 722.3	4 616.8	3 566.5	3 993.3	13 847.8
LEA	94.0	120.3	301.6	181.8	359.6	963.3
LIN	126.5	113.0	130.7	105.9	56.3	511.8
MOK	82.7	86.5	54.1	147.5	81.1	376.9
PAD	16.1	3.5	2.0	5.5	3.9	28.5
QSC	17.6	21.1	22.6	6.4	11.5	67.2
RBT	11.5	33.9	17.3	5.0	21.7	89.0
RBY	3.2	1.3	9.4	1.6	7.7	23.0
RCO	2 969.5	2 856.1	2 644.6	2 850.6	2 383.0	10 255.5
RSK	3.1	11.6	59.7	69.5	35.9	155.5
SCH	120.7	167.4	110.9	176.2	173.2	727.2
SCI	18.2	20.3	27.4	25.7	6.5	96.1
SKI	24.3	81.7	66.2	150.2	39.6	333.2
SNA	3 486.4	3 507.4	3 167.2	3 019.0	3 055.0	11 240.4
SPD	276.1	414.2	416.1	224.3	155.5	1 309.5
SPE	19.8	28.1	114.1	176.2	38.0	346.7
SPO	22.3	90.2	165.6	161.5	219.1	635.3
SQU	2 036.1	1 530.7	1 959.6	2 376.7	1 903.4	4 122.9
STA	1 213.1	1 327.0	1 793.9	1 774.8	1 459.6	5 308.6
SWA	690.9	525.8	481.1	745.4	469.9	2 276.2
TAR	11 644.8	12 978.4	12 703.5	12 560.6	11 828.0	38 947.8
TRE	3 286.2	3 568.1	3 132.5	3 472.4	2 766.9	11 087.9
WAR	1 303.1	1 107.7	1 168.9	1 287.2	1 425.6	4 806.0
All	45 901.0	46 074.4	48 322.7	46 300.2	45 349.6	113 779.4

Table 6.2: Change (%) in the total footprint from one year to the next (thus, 2009 column represents the percent change from the footprint area in 2008 to the footprint in 2009). Total annual footprints are given in Table 6.1. Target species codes are given in Table 3.

Target	% change from one year to the next			
code	2009	2010	2011	2012
BAR	-20.4	-5.0	-3.0	8.4
BCO	-85.8	1000.0	-80.3	411.7
BNS	-88.0	-100.0	0.0	-100.0
BYX	-61.8	-90.5	1682.6	-77.8
ELE	11.1	16.2	-20.2	12.3
EMA	12.2	-97.8	241.5	860.9
FLA	6.3	3.8	-15.9	9.4
GSH	162.1	31.5	22.0	-41.8
GUR	2.7	28.5	-5.5	11.5
HOK	45.2	-7.6	-29.2	10.1
HPB	-14.9	39.3	-0.2	-45.5
JDO	-12.2	10.1	-22.9	-10.6
JMA	-19.2	24.0	-22.7	12.0
LEA	28.0	150.8	-39.7	97.7
LIN	-10.7	15.7	-18.9	-46.9
MOK	4.6	-37.4	172.4	-45.0
PAD	-78.6	-41.7	174.2	-30.2
QSC	19.9	6.8	-71.8	80.7
RBT	196.2	-48.9	-71.2	333.7
RBY	-60.2	650.9	-82.6	365.8
RCO	-3.8	-7.4	7.8	-16.4
RSK	273.0	416.9	16.3	-48.3
SCH	38.7	-33.8	58.8	-1.7
SCI	11.5	34.6	-6.2	-74.7
SKI	235.9	-19.0	127.0	-73.6
SNA	0.6	-9.7	-4.7	1.2
SPD	50.0	0.5	-46.1	-30.7
SPE	42.2	305.8	54.5	-78.5
SPO	305.1	83.5	-2.5	35.7
SQU	-24.8	28.0	21.3	-19.9
STA	9.4	35.2	-1.1	-17.8
SWA	-23.9	-8.5	54.9	-37.0
TAR	11.5	-2.1	-1.1	-5.8
TRE	8.6	-12.2	10.9	-20.3
WAR	-15.0	5.5	10.1	10.8
All	0.4	4.9	-4.2	-2.1

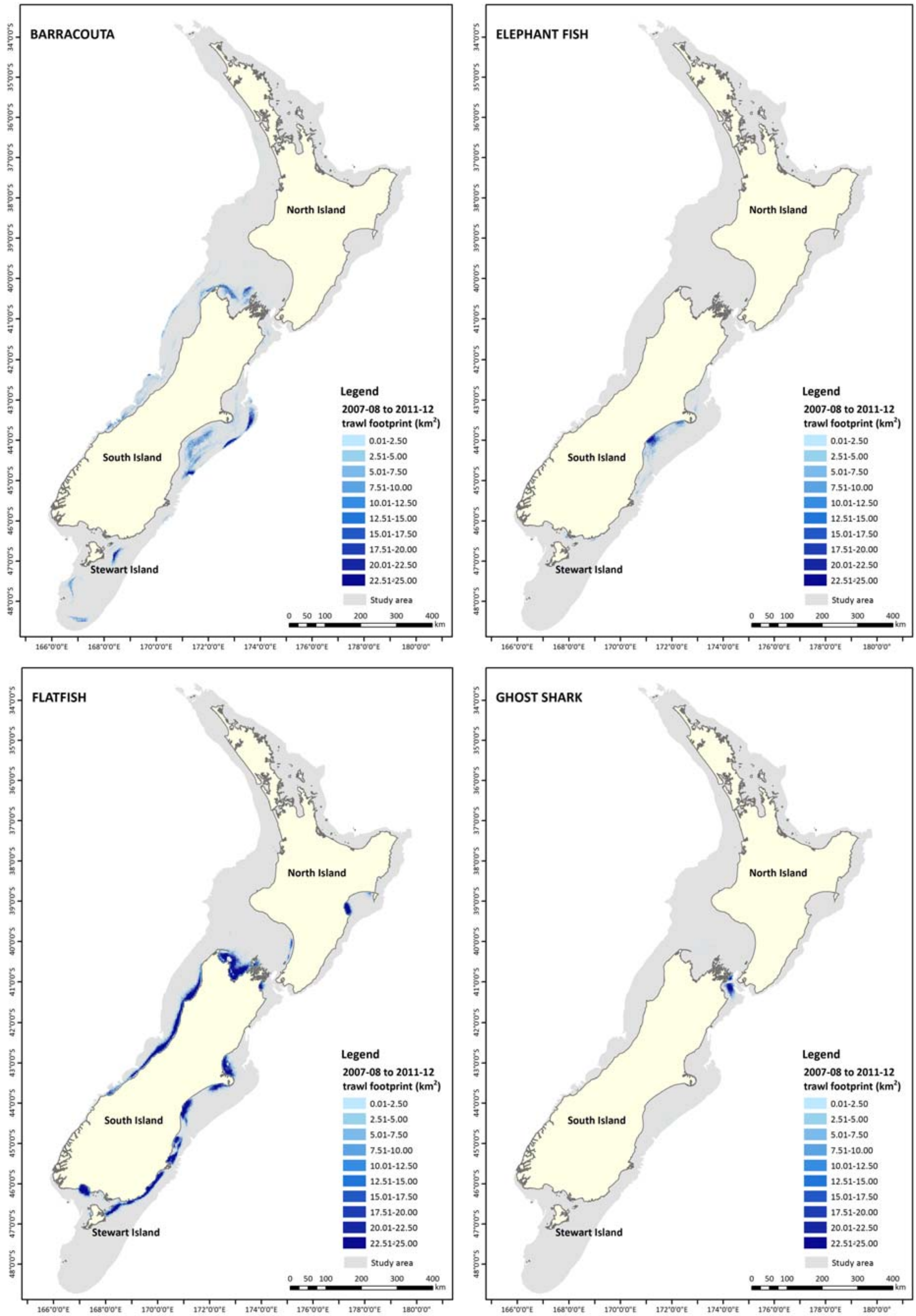

Figure 6.1: Cell-based trawl footprint for the five year data for the main target species.

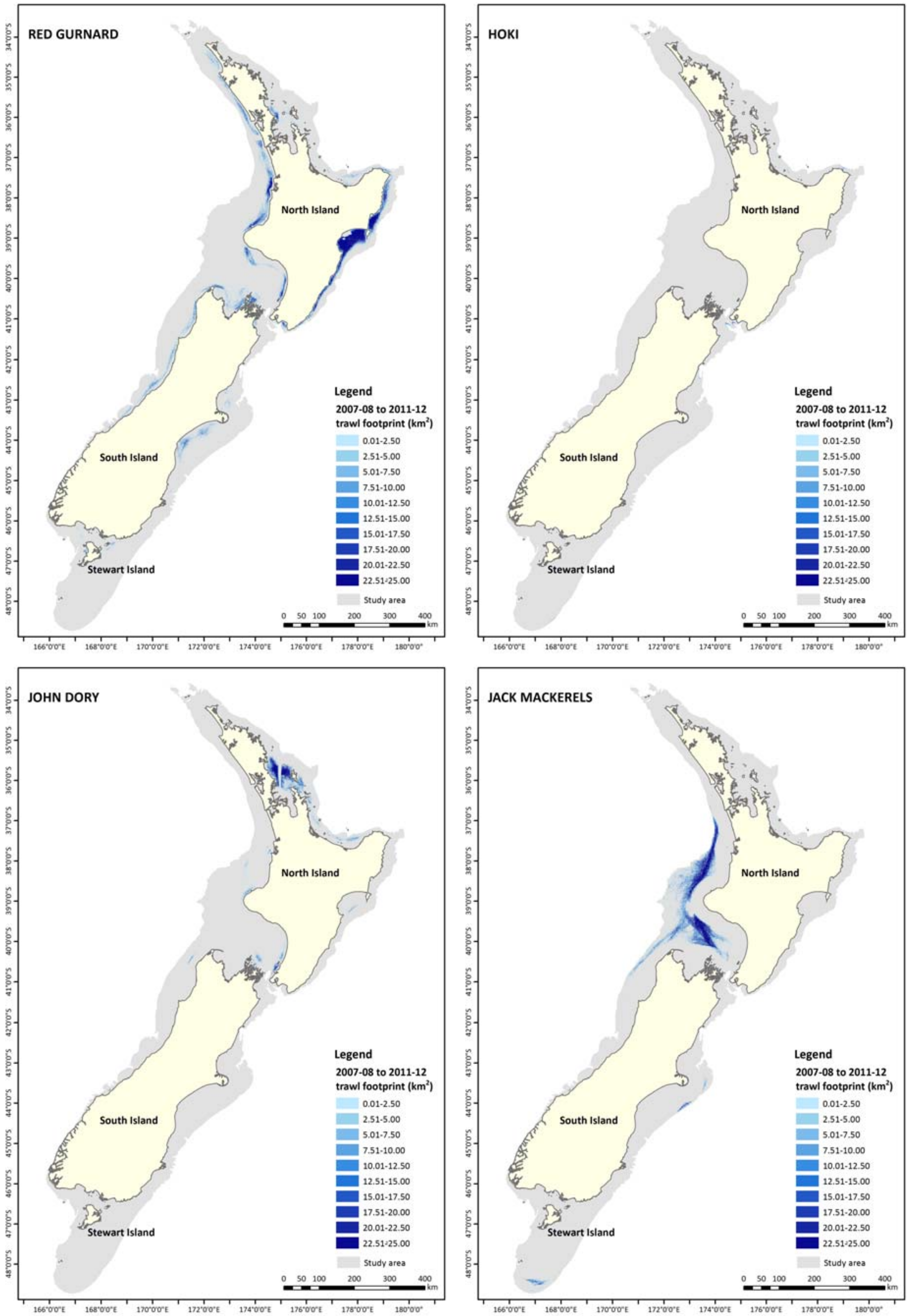

Figure 6.1 ***continued.***

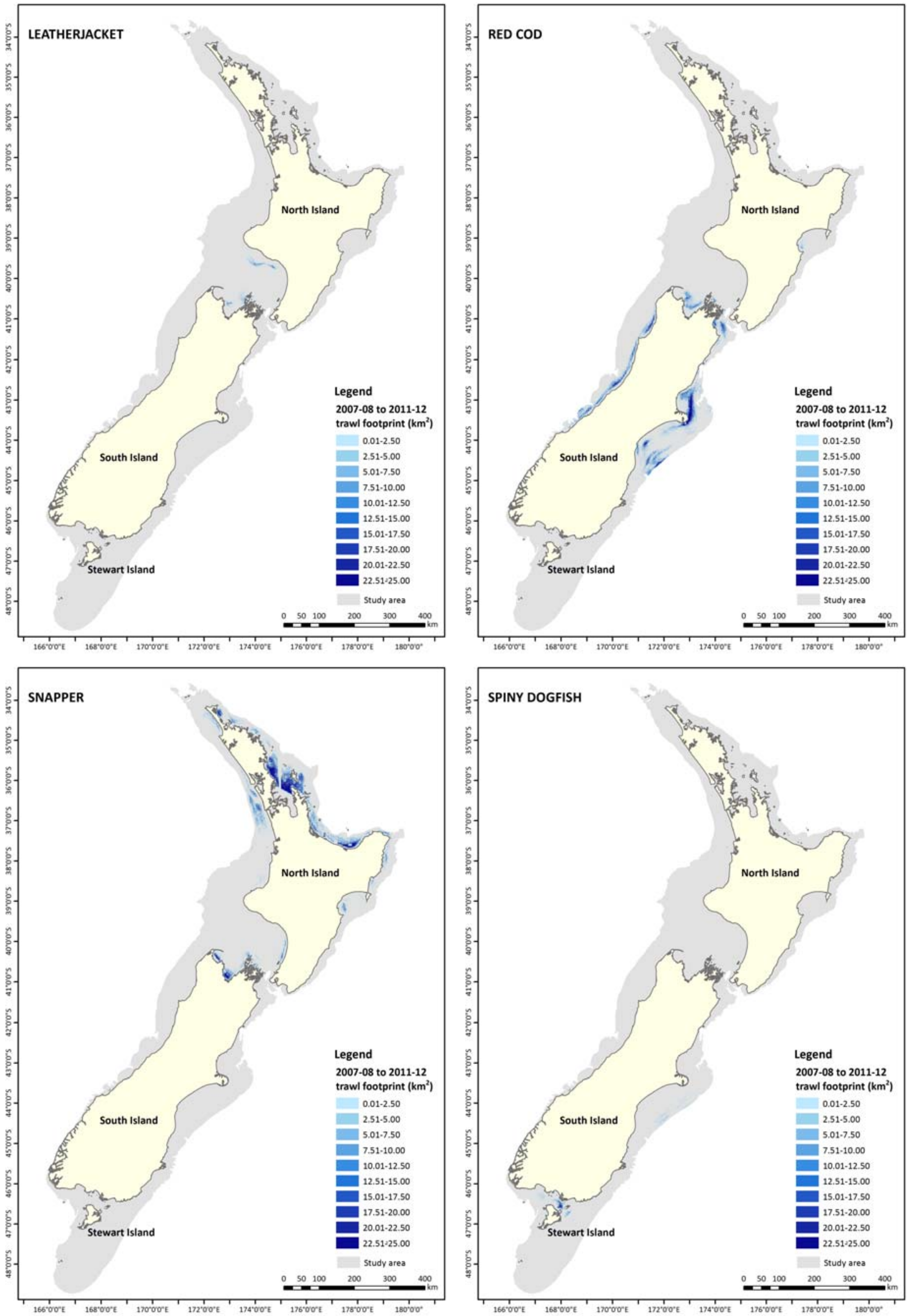

Figure 6.1 *continued.*

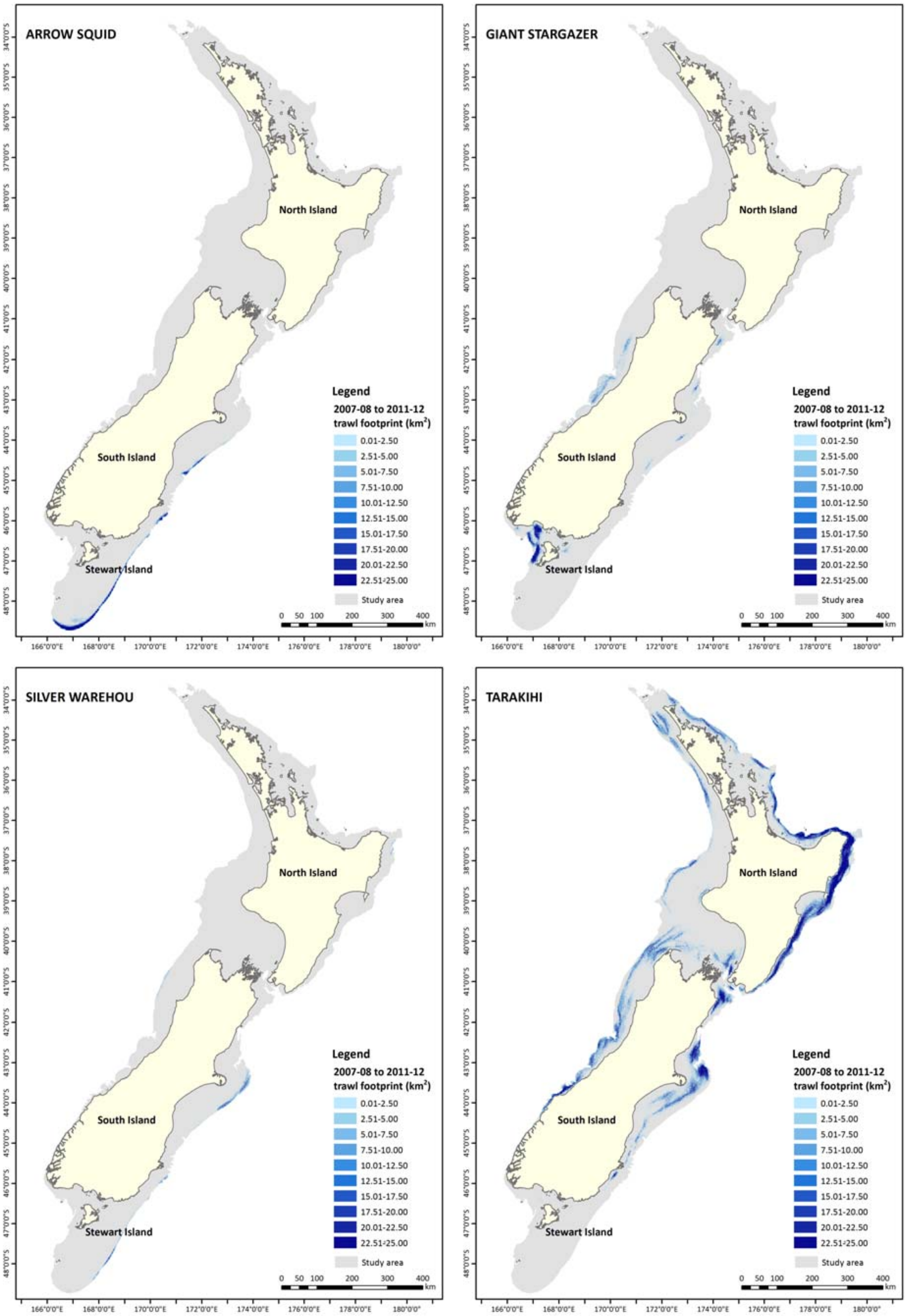

Figure 6.1 ***continued.***

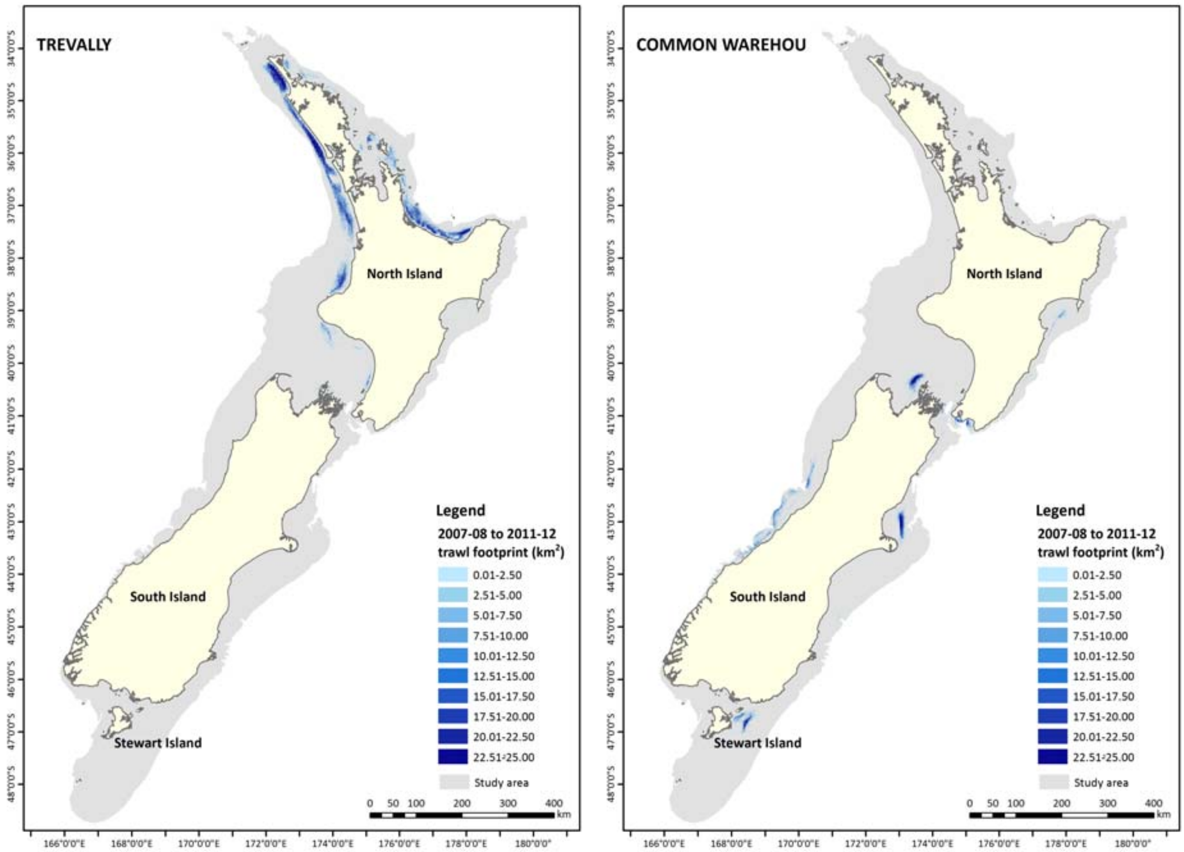

Figure 6.1 ***continued.***

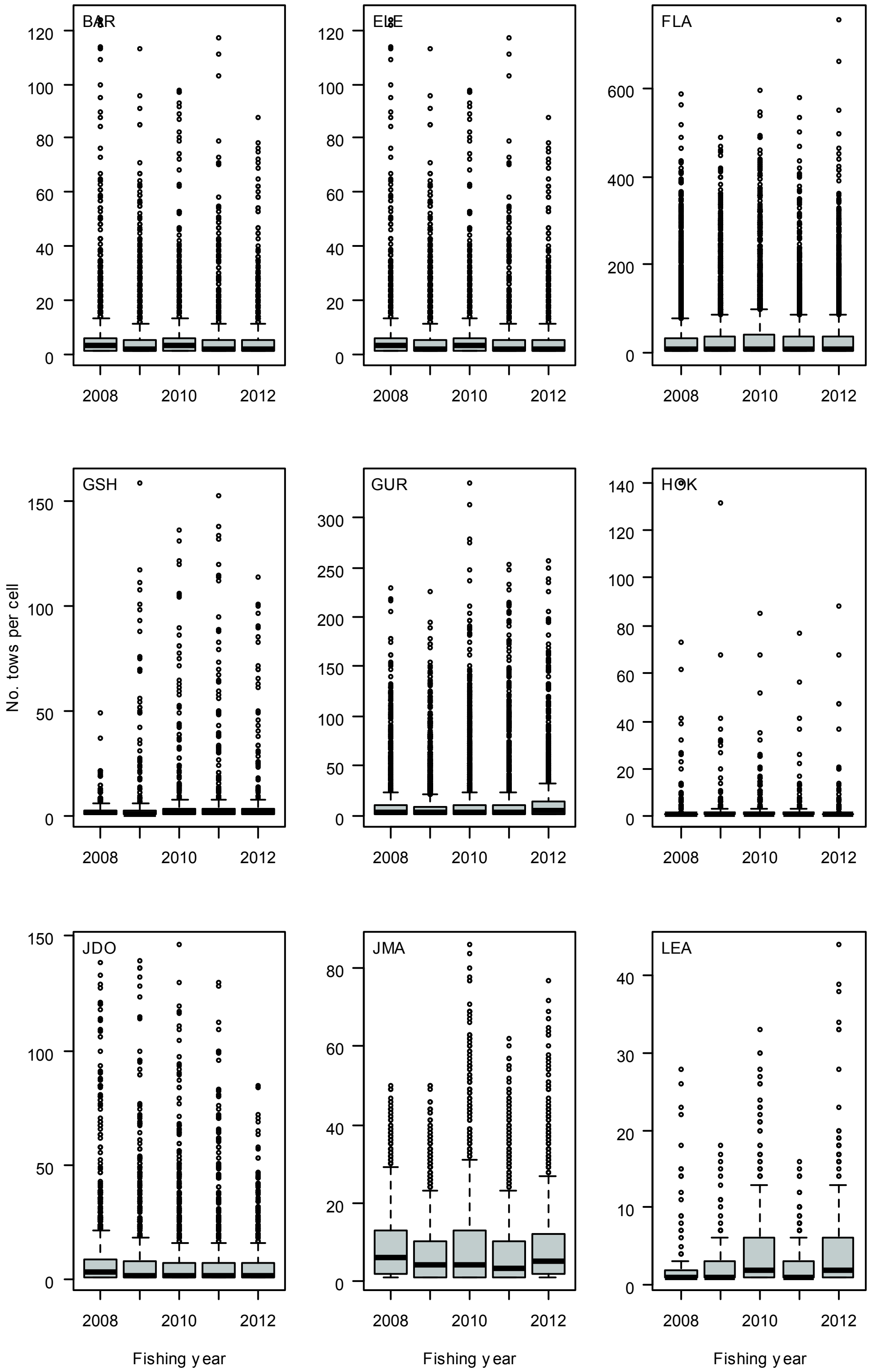

Figure 6.2: The distribution of the number of tows per cell and the cell footprint for the main target species by each fishing year, 2008–12. Target species codes are defined in Table 3.

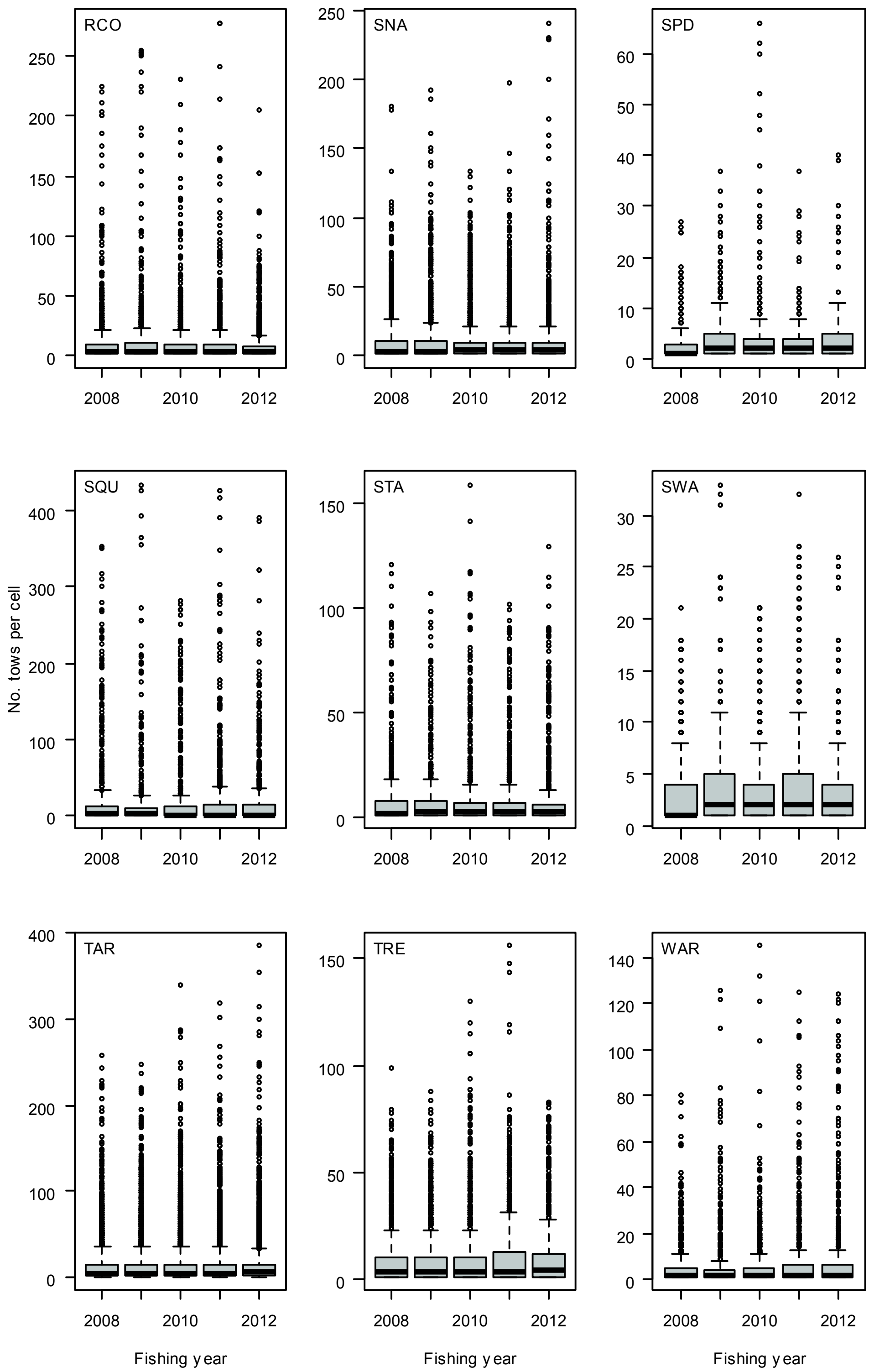

Figure 6.2 ***continued.***

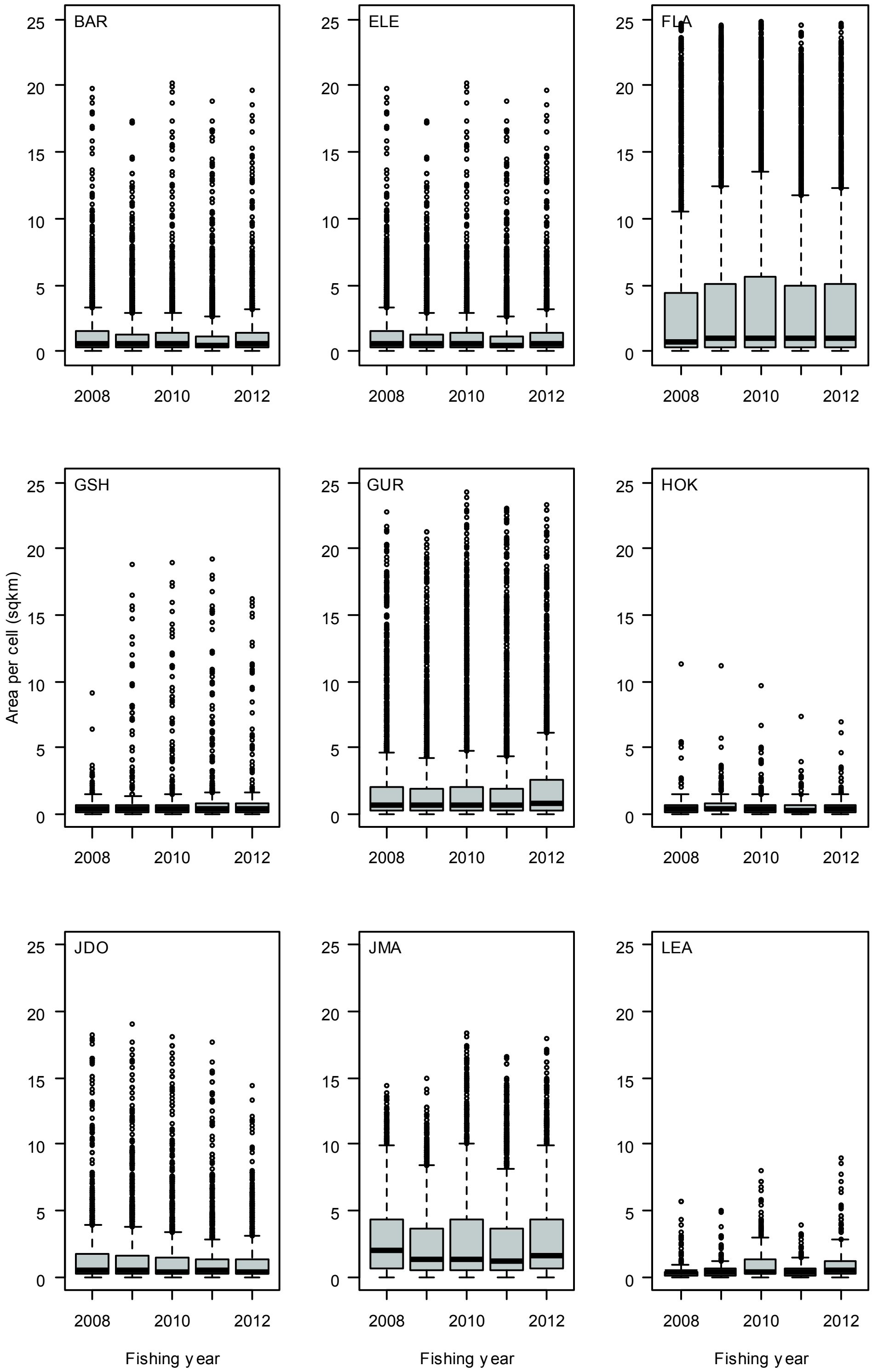

Figure 6.2 ***continued.***

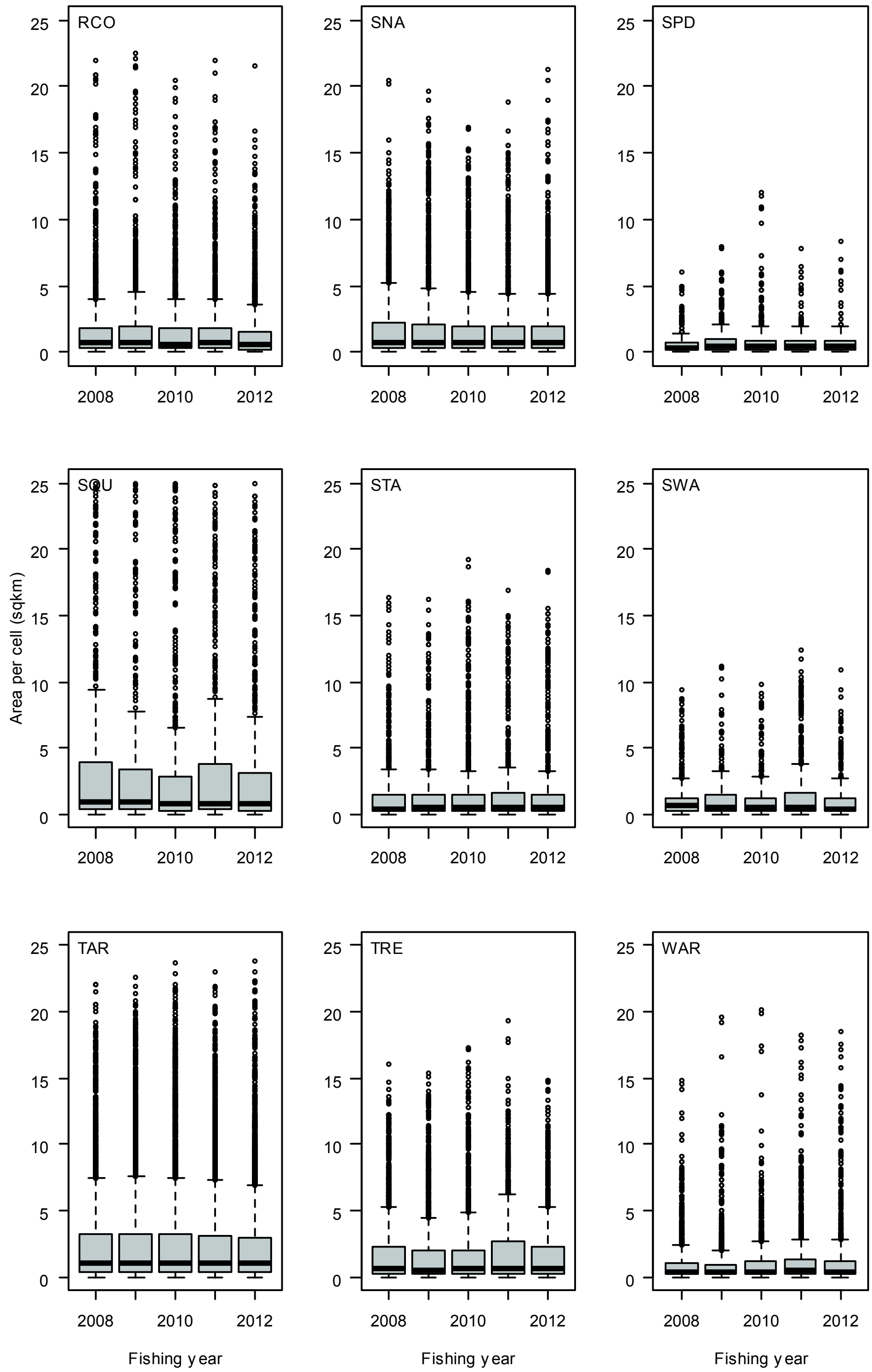

Figure 6.2 ***continued.***

APPENDIX 7: TRAWL FOOTPRINT– HABITAT OVERLAY

Table 7.1: Summary of the BOMEC class-depth zone-sediment habitat area and the amount of the trawl footprint in each habitat, by fishing year and for the five years combined.

Depth zone	Sediment type	Habitat area (km²)	Area of annual trawl footprint (km²) 2008	2009	2010	2011	2012	2008–12
BOMEC class A								
< 50 m	Mud	5 991.3	1 916.2	1 968.0	2 154.7	1 931.2	1 899.0	3 424.6
	Sand	10 756.0	2 205.2	2 243.7	2 124.7	2 117.4	2 213.1	5 038.2
	Gravel	6 760.5	1 373.3	1 360.3	1 429.6	1 328.9	1 500.5	2 896.1
	Calcareous gravel	557.8	30.1	31.9	55.4	28.1	35.4	116.3
	Calcareous sand	375.8	46.4	58.5	71.1	63.3	63.5	159.7
50–100 m	Mud	1 241.8	646.1	688.3	851.0	741.6	688.8	1 187.5
	Sand	1 262.3	447.6	438.4	375.2	409.2	419.4	954.3
	Gravel	359.4	95.3	92.0	95.5	91.1	113.8	237.4
	Calcareous gravel	36.8	4.2	5.0	5.8	4.4	2.7	13.1
	Calcareous sand	30.5	8.1	10.9	11.0	12.9	10.4	19.5
100–250 m	Mud	0.8	0.1	0.1	0.1	0.1	0.1	0.2
	Sand	0.3	0.1	0.1	–	0.1	–	0.2
	Calcareous gravel	1.9	–	–	–	–	–	–
		27 375.2	6 772.8	6 897.1	7 174.1	6 728.3	6 946.7	14 047.1
BOMEC class B								
< 50 m	Mud	2 898.4	1 457.9	1 416.4	1 661.7	1 411.1	1 516.4	2 370.7
	Sand	1 133.9	417.9	432.0	486.2	401.5	443.8	878.8
	Gravel	1 111.5	669.8	667.5	666.4	581.6	614.0	893.5
	Calcareous gravel	6.0	0.7	0.4	0.6	0.9	0.3	1.7
50–100 m	Mud	2 924.0	894.2	875.8	1 004.8	841.6	1 097.8	2 250.9
	Sand	894.1	240.8	321.9	393.2	402.3	422.0	752.3
	Gravel	286.4	117.0	130.1	123.2	96.6	112.1	223.5
	Calcareous gravel	39.0	8.3	5.2	9.8	8.3	5.8	25.4
100–250 m	Mud	2 892.5	585.6	603.5	636.1	647.6	666.3	1 804.6
	Sand	115.5	21.4	63.2	73.2	83.3	76.4	109.6
	Gravel	12.2	3.3	4.4	4.6	5.1	4.9	9.1
	Calcareous gravel	5.3	0.8	0.8	1.1	0.8	0.4	2.1
		12 318.8	4 417.7	4 521.2	5 061.2	4 480.8	4 960.2	9 322.3
BOMEC class C								
< 50 m	Mud	1 656.3	842.5	963.9	826.2	666.5	634.3	1 451.4
	Sand	1 681.4	473.6	562.8	525.7	479.2	451.4	1 168.1
	Gravel	403.7	85.9	68.3	71.3	72.6	66.8	166.7
	Calcareous gravel	72.2	24.0	32.8	24.7	27.0	22.9	59.5
	Calcareous sand	363.9	97.3	151.7	146.3	123.4	121.9	283.7
50–100 m	Mud	10 080.0	3 453.5	3 634.2	3 641.6	3 332.0	2 902.6	7271.9
	Sand	22 749.1	4 260.8	4 335.2	4 429.8	4 414.3	4 289.8	12 028.3
	Gravel	1 240.2	383.3	314.0	332.3	300.7	357.0	838.1
	Calcareous gravel	711.5	68.4	72.6	135.8	133.1	102.5	316.0
	Calcareous sand	1 583.5	84.8	115.4	170.5	143.8	146.2	406.2
100–250 m	Mud	26 049.3	4 769.2	4 054.2	3 905.0	3 694.5	3 652.5	11 737.5
	Sand	21 947.0	3 899.3	3 437.9	3 433.0	3 226.6	3 123.2	10 807.2
	Gravel	352.1	67.7	58.2	65.4	70.5	75.4	210.0
	Calcareous gravel	123.6	18.8	13.3	18.0	23.6	14.6	60.8
	Calcareous sand	546.6	102.6	102.8	106.4	86.3	102.1	314.6
		89 560.4	18 631.6	17 917.3	17 832.0	16 793.9	16 062.9	47 120.0

Table 7.1 *continued.*

Depth zone	Sediment type	Habitat area (km^2)	Area of annual trawl footprint (km^2) 2008	2009	2010	2011	2012	2008–12
BOMEC class D								
< 50 m	Mud	2 459.6	873.1	951.9	1 199.7	976.8	933.9	1 821.6
	Sand	7 063.6	2 338.7	2 677.5	2 924.4	2 720.2	2 649.5	5 303.8
	Gravel	5 341.6	1 102.0	1 213.2	1 232.8	1 249.2	1 300.9	2 688.2
	Calcareous gravel	1 261.5	269.3	312.2	334.0	326.3	354.5	571.1
	Calcareous sand	456.3	39.6	50.2	57.0	39.1	40.5	120.0
50–100 m	Mud	1 830.0	493.5	525.2	675.2	512.7	692.6	1 381.7
	Sand	5 336.4	1 238.9	1 492.2	1 373.3	1 300.9	1 208.1	3 544.4
	Gravel	534.6	135.0	146.7	172.6	157.8	172.6	297.1
	Calcareous gravel	156.1	3.7	4.4	3.1	3.8	4.2	13.4
	Calcareous sand	46.1	11.3	10.3	9.2	8.9	6.7	22.2
100–250 m	Mud	242.2	36.7	23.1	55.7	76.3	59.1	135.1
	Sand	476.7	124.3	92.8	148.6	189.3	173.7	383.1
	Gravel	22.9	6.0	12.8	12.1	15.7	9.3	21.2
	Calcareous gravel	285.6	5.8	3.4	6.9	16.1	19.4	41.9
		25 513.1	6 678.0	7 515.9	8 204.6	7 593.0	7 625.0	16 344.7
BOMEC class E								
< 50 m	Mud	1.7						
	Sand	79.7	15.7	20.6	14.4	19.4	23.3	42.4
	Gravel	15.6	0.0	0.9	0.3	0.3	0.9	2.2
	Calcareous gravel	95.9	0.3	2.0	1.3	1.2	1.6	4.6
	Calcareous sand	9.2	0.2	0.6	0.6	0.7	0.9	2.0
50–100 m	Mud	811.3	77.0	98.4	142.0	240.1	318.3	559.6
	Sand	8 115.1	1 174.6	1 366.9	1 680.3	1 745.9	1 409.9	4 274.5
	Gravel	1 021.8	130.3	110.5	126.2	157.8	148.3	396.9
	Calcareous gravel	1 054.6	16.3	12.9	13.7	6.7	17.2	55.8
	Calcareous sand	403.7	12.3	16.2	12.2	12.5	21.8	54.3
100–250 m	Mud	1 019.8	82.1	165.4	165.9	327.4	165.7	608.1
	Sand	8 864.6	1 352.6	1 308.5	1 603.7	1 855.4	1 625.8	3 869.0
	Gravel	189.5	24.3	25.1	43.7	49.3	40.5	67.9
	Calcareous gravel	22 930.5	1 353.8	1 250.4	1 462.3	1 545.3	1 504.5	3 219.3
	Calcareous sand	2 391.4	167.0	145.7	232.3	185.8	177.9	551.7
	Sandy Mud	182.2	175.3	171.6	173.9	178.5	166.3	182.3
		47 186.8	4 581.7	4 695.7	5 672.9	6 326.3	5 622.8	13 890.6
BOMEC class F								
< 50 m	Calcareous gravel	1.3	0.1	0.0				0.1
100–250 m	Calcareous gravel	380.4	35.4	7.3	22.2	46.1	17.8	73.1
		381.7	35.5	7.3	22.2	46.1	17.8	73.2

Table 7.1 *continued.*

Depth zone	Sediment type	Habitat area (km^2)	Area of annual trawl footprint (km^2) 2008	2009	2010	2011	2012	2008–12
BOMEC class G								
< 50 m	Mud	90.9	8.8	14.2	17.6	25.5	14.1	43.2
	Sand	67.9	6.7	2.4	3.6	5.2	5.1	15.0
	Gravel	28.3	0.6	0.6	0.4	2.1	1.4	4.4
	Calcareous gravel	17.2	0.4	0.5	0.3	0.8	0.7	1.6
50–100 m	Mud	329.3	41.9	46.5	64.6	71.1	64.0	139.9
	Sand	103.7	15.2	14.3	14.7	14.0	18.3	41.0
	Gravel	116.3	6.6	9.0	10.3	14.4	13.8	35.8
	Calcareous gravel	22.9	5.2	2.9	6.9	5.5	2.8	13.3
100–250 m	Mud	1 690.9	271.1	308.9	306.6	345.9	310.4	825.1
	Sand	676.3	139.2	167.5	171.4	197.3	211.7	429.5
	Gravel	721.0	111.6	146.0	150.6	153.0	150.8	342.7
	Calcareous gravel	33.6	3.9	3.3	3.5	5.0	5.4	11.4
		3 898.4	611.2	716.1	750.5	839.8	798.5	1 902.9
BOMEC class H								
< 50 m	Mud	0.004	–	–	–	–	–	0.0
	Sand	6.8	0.01	–	–	–	–	0.01
	Calcareous gravel	15.4	–	–	–	0.1	0.1	0.2
	Calcareous sand	0.2	–	–	–	–	–	–
50–100 m	Mud	2.5	0.4	0.8	0.7	0.7	0.7	1.2
	Sand	118.0	9.2	8.3	6.4	6.1	6.6	19.3
	Gravel	0.0	–	–	–	0.0	–	0.0
	Calcareous gravel	49.3	–	–	–	0.2	0.1	0.3
100–250 m	Mud	10 212.3	1 550.3	1 333.5	1 244.3	1 162.0	1 041.5	3 959.4
	Sand	13 014.8	1 761.2	1 638.0	1 451.0	1 426.3	1 426.1	4 994.2
	Gravel	12.4	4.8	2.9	2.2	3.3	2.4	8.6
	Calcareous gravel	1 217.6	25.1	20.9	32.8	26.5	25.2	98.8
	Calcareous sand	555.0	60.6	44.9	53.2	29.8	40.7	146.0
	Sandy Mud	0.1	–	–	–	–	–	–
		25 204.4	3 411.7	3 049.3	2 790.6	2 655.0	2 543.4	9 228.1
BOMEC class I								
50–100 m	Sand	0.01	–	–	0.001	–	–	0.001
100–250 m	Mud	1.0	0.1	–	–	–	–	0.1
	Sand	325.2	83.2	86.1	63.7	120.2	75.5	194.9
	Calcareous gravel	124.5	116.1	115.2	118.5	119.5	117.6	124.0
	Calcareous sand	1.4	0.4	0.2	0.2	0.4	0.4	0.7
	Sandy Mud	21.1	18.3	20.7	20.3	20.8	20.0	21.1
		473.2	218.2	222.2	202.7	260.8	213.5	340.8
BOMEC class J								
50–100 m	Mud	3.2	–	0.0001	–	0.05	–	0.05
	Sand	0.4	–	–	–	–	–	–
100–250 m	Mud	88.8	7.1	7.5	12.2	12.9	7.8	27.5
	Sand	41.4	1.7	0.5	1.0	0.7	0.4	3.8
	Calcareous gravel	0.09	–	–	–	–	–	–
	Calcareous sand	0.06	0.01	–	–	–	–	0.01
		133.9	8.8	7.9	13.3	13.8	8.2	31.3
BOMEC class L								
100–250 m	Calcareous gravel	188.9	81.8	72.2	97.0	92.9	84.5	121.5

APPENDIX 8: SUMMARY OF DREDGE OYSTER AND SCALLOP EFFORT DATA WITHIN 250 M, 1 OCTOBER 2007–30 SEPTEMBER 2012

Other bottom contact effort in waters shallower than 250 m included dredge effort that targeted the dredge oyster *Ostrea chilensis* and the scallop *Pecten novaezelandiae*. This dredge effort is reported under the primary method code of "D" on CELR forms. Thus, each record represents the daily number of dredge tows by a vessel within the individual target fishery statistical areas: the Northland scallop fishery, the Coromandel scallop fishery, the Challenger scallop and oyster fishery, and the Foveaux Strait oyster fishery. These areas are shown in Figures 8.1–8.3.

Dredge fishers are required to report the fishing duration as the total time the dredge is at the target depth for tows completed on the day; the total number of tows completed per day; and the width of the dredge used. It does appear that fishers complete the forms differently in the some of the fishery areas, and this is identified in the fishery sections below. Note that this summary does not attempt to estimate the area swept by the dredge gear used in these fisheries.

The primary data grooming on the daily CELR dredge records concentrated on the daily number of tows. Other variables that could contribute to measures of fishing effort, such as the effort width and fishing duration, were checked (and amended where obvious outliers or typographical errors were present) and summarised to describe the extent of the values reported. Fishing duration (hours fished) is likely to be reported differently by different fishers (Hartill & Williams 2014) and may represent a range of definitions from the hours spent away from port to the time that the gear was actually fishing. Summary distributions of these three effort variables are given in Figures 8.4–8.8. The data relating to vessels and Statistical Areas were used as reported by the fishers.

This summary provides data for the 2007–08 to 2011–12 fishing years. Similar data for 1989–90 to 2004–05 were summarised by Baird et al. (2011). Gear descriptions of the dredges used in these fisheries are described by Beentjes & Baird (2004).

Oyster dredge data

Dredge effort for oysters is primarily carried out in two major fisheries: Foveaux Strait and Challenger (Nelson-Marlborough). The fisheries operate under different rules and use different gear (Ministry for Primary Industries 2013). The Foveaux Strait fishery is reported by calendar year (with the season from 1 March to 31 August), but the Challenger fishery is reported by the 1 October to 30 September fishing year. For the summary purposes of this study, for which the data extract was from 1 October 2007 to 30 September 2012, all oyster data are summarised by the October–September fishing year.

Foveaux Strait dredge oyster data

The Foveaux fishery is divided into 18 areas (Figure 8.1). Fourteen vessels were in the original five year dataset. However, 11 vessels operate each year in this fishery and the small number of records for two vessels (n = 1, n = 6) have been treated as errors and ignored here, to give a final total of 3341 daily CELR records. The total of 12 vessels occurs because one vessel was replaced by another during the 2007–08 to 2011–12 time period. The density of vessels fishing in each area varied by year, and areas E7, G8, and S7 had consistently higher number of vessels each year during 2007–08 to 2011–12 (Table 8.1).

Fishers in this fishery use two heavy double bit, double ring-bag dredges of up to 3.35 m width per fishing event in the Foveaux Strait fishery (Ministry for Primary Industries 2013). Fishers undertake 4–5 fishing events per hour, and each event is recorded as two 'tows' to represent the use of two dredges (Keith Michael, NIWA, pers. comm.). The effort width data give the width of one dredge (up to 3.35 m). The number of hours fished as recorded on the CELRs are likely to represent the actual fishing time. Investigation of the effort width data and the effort number data relative to the fishing duration data, for each of the 12 vessels, indicated that effort number and effort width data were swapped for two vessels. These data were amended, and no further grooming was done on the effort number data. The spread of the number of tows relative to the fishing duration is shown in Figure 8.6.

The total number of tows by fishing year and month are given in Table 8.2. The annual totals (18 700–21 311 tows) represent about 75% (range 70–82%) of the tows reported in industry data for the same years (Keith Michael, NIWA, pers. comm.). Over all the data, the median number of tows reported per day was 26 (range 1–96), but the median by year indicates less daily activity in the later years of the five year dataset (see Figure 8.4).

The dredge oyster season in this area is from 1 March to 31 August. Over the five fishing years, 28.4% of the total effort was during March, 23.4% in April, 20.8% in May, 15.2% on June and another 10% in July and August (Table 8.2).

Between about 9000–10 000 dredge tows were made each year in the main fishery area (G8), which accounted for about 50% of the total dredge tows over the five year period (Table 8.3). Other important areas were E7 and S7, and to a lesser extent, E6, G9, D7, and A. The spread of this effort throughout the season is given in Table 8.4.

Challenger dredge oyster data

Dredge oysters in the Challenger fishery area are treated as two different stocks: fishery areas 7AA–7LL comprise the OYS7 fish stock and 7MM is the OYS 7C fish stock (see Figure 8.2). Vessels in this fishery use the same gear to target both dredge oysters and scallops, as well as green-lipped mussels (*Perna canaliculus*) – generally two ring bag dredges for each fishing event, that are (by legislation) no more than 2.4 m wide (per dredge). All but two of the fishers reported the total dredge width (that is, of the two dredges) on the CELR (median 4.4 m from range of 2.4 m to 4.8 m), which is contrary to the reporting in the Foveaux Strait fishery. The spread of the effort data suggests that these fishers report each fishing event as one tow, also in contrast to the fishers in the Foveaux fishery (see Figures 8.4–8.6). The only changes were made to the Challenger oyster data were to tidy up typographical errors and NAs in the effort width data.

Of the 406 dredge oyster records, 1.2% were ignored because they were reported using the larger General Statistical Area 017 which includes the fishery specific areas 7JJ, 7KK, 7LL, and 7MM. Two records in 7MM by a vessel targeting oysters were reported as 'SCA' in 2009; these records were changed to OYS target species code. It may be that some other effort is reported as scallop when in fact it was for oyster, and vice versa.

The number of vessels fishing in the area has varied from year to year (Table 8.5). For 2007–08 to 2011–12, 12 vessels reported dredge oyster fishing activity in this area; however, 74% of the effort was reported from two vessels that fished each year. The remaining 10 vessels fished in either one year (7 vessels) or in two years (3 vessels).

About 32% of the 7154 tows were from 2008, and since then the annual effort has varied between 695 (in 2009) and 1964 (in 2011) (Table 8.6). About 68% of the effort reported during the five year period came from the most eastern areas, 7LL and 7MM (Table 8.7). In 2008 the effort was distributed in seven areas, but in 2009, 2010, and 2012, effort was restricted to one or two areas (7LL and/or 7MM).

Currently, there is no seasonal restriction on the commercial take of oysters from this area (Ministry for Primary Industries 2013). The data indicate that in the 2008–2010 fishing years, the fishing was mainly in the summer months, but in 2011 and 2012, the effort was spread throughout most of the year, with the winter months, especially August, having relatively high effort (see Table 8.6). Area 7LL had effort in each month, 7MM had effort in most months, but the other areas tended to operate in the summer months, apart from the August effort in 7FF, 7GG, and 7II (Table 8.8).

Scallop dredge data

Dredge effort for scallops was reported from three fisheries: Challenger (Nelson-Marlborough), Coromandel, and Northland (see Figures 8.2 and 8.3). The fisheries operate under spatial and temporal management regimes (Cryer & Parkinson 2006, Williams et al. 2014) and the northern and southern fisheries use different gear. Williams et al. (2014) provide a comprehensive review of the SCA 7 fishery, and Hartill & Williams (2014) provide a characterisation of the Northland scallop fishery (SCA 1).

Note: the fishing year for these scallop fisheries is from 1 April to 31 March, and the scallop data presented here are summarised by the scallop fishing years. However, the full data extract was for 1 October 2007 to 30 September 2012, so data in both the 1 April 2007–31 March 2008 (2008) and 1 April 2012–31 March 2013 (2013) fishing years will be incomplete.

Challenger Scallop dredge data

Commercial fishing usually occurs in the SCA 7 fishery from August to December, although management regimes may change these dates (Ministry for Primary Industries 2013). Two ring-bag dredges of 2.0–2.4 m width are used per fishing event in the Challenger fishery (Williams et al. 2014). These dredges use tickler chains and have a maximum width limit of 2.5 m under the MPI (Challenger Area Commercial Fishing) Regulations 1986 (see Beentjes & Baird 2004). This is evident in the distribution of the effort width data shown in Figure 8.7. Fishers in this fishery report the summed width of the dredges used in the effort width column on the CELR, though it also appears that some vessels either used one dredge occasionally or the fisher recorded the width of one dredge only. A fishing day is rarely longer than 12 hours and fishers report the fishing duration as the time between the start of the first tow and the end of the last tow, in a day (James Williams, NIWA, pers. comm.). The median number of daily tows for any one year has varied between about 16 and 24 for the complete fishing years (2009–2012), and the median time spent fishing varied between about 6.5 and 10 h (Figures 8.4 and 8.5). The data suggest that tows are generally about 25 minutes long (see Figure 8.8).

There were 2401 daily CELR records assigned to this fishery area for the time period. Of the 41 vessels that reported scallop effort in the Challenger fishery, 10 fished in every fishing year, 4 in five fishing years, 8 in four fishing years, 3 in three fishing years, 7 in two fishing years, and 9 in one fishing year. During this period, there was no effort in three of the fishery areas important in earlier years of the SCA 7 fishery (see Williams et al. 2014), and most vessels operated in 7BB, 7CC, 7KK, and 7LL (Table 8.9).

The number of tows reported per fishing year was greatest in 2009, at about 43% of the total of 48 740 tows, with most effort in September, October, and November (Table 8.10) in 7KK and 7BB (Tables 8.11 and 8.12). Effort was distributed in different areas over time, especially in areas 7CC and 7LL.

Coromandel scallop dredge data

The commercial Coromandel scallop fishing season is from 15 July to 21 December each year (Ministry for Primary Industries 2013), and the areas are shown in Figure 8.3. Fishers in the Northland and Coromandel scallop fisheries prefer the self-tipping “box” dredges to fish discrete beds within the fishery areas (Cryer & Parkinson 2006). The legislation allows fishers to use either one dredge of up to 2.5 m width or two dredges which should not exceed 1.4 m in width each specified by MPI (Auckland and Kermadec Areas Commercial Fishing) Regulations 1986. Unlike the dredges used in the Challenger fishery, these dredges are fitted with rigid tines on the leading bottom edge. The effort width data suggest that a variety of dredge widths are used (Figure 8.7), though most are reported at about 2 m width. The data suggest tows are about 15 minutes long (see Figure 8.8). The daily effort in terms of the number of dredge tows and the fishing duration has halved over the five year period, from median values of 29 tows in 2009 (7.5 h duration) to 15 tows in 2012 (3.25 h in 2012) (Figures 8.4 and 8.5).

The 2463 daily CELR records represented the effort of 12 vessels, with about 8 vessels fishing regularly in 2L, 2R, and 2W (Table 8.13). Seven vessels fished consistently in this fishery and accounted for 96% of the reported effort in the dataset. Four of these vessels also fished in the Northland scallop fishery, but only one fished consistently in the Northland fishery.

Although the effort reported was maintained at about 8 000–11 000 tows per year for fishing years 2010–2012, the number reported in 2012 was about half that reported for 2009 (Table 8.14). Fishing mainly took place during August–November in areas 2L, 2R, and 2W (Tables 8.15 and 8.16).

Northland scallop dredge data

The fishing season in this fishery is from 15 July to 14 February each year (Ministry for Primary Industries 2013), and the fishery areas are shown in Figure 8.3. The data indicate that the box dredges used (see above Coromandel fishery description) are generally between 1.8 and 2.5 m wide (Figure 8.7), with one dredge used each tow. The data suggest that tows are generally between 15 and 30 minutes long. The median number of daily tows was around 20 tows per season; and the median time spent fishing has remained close to 10 h (Figures 8.4 and 8.5).

There were 1277 daily CELR records in this fishery area. Of the 17 vessels that reported scallop effort, 8 fished during three to five fishing years, with the remaining vessels reporting effort only in one or two years. There has been a large drop in the number reporting effort in recent years, with 4 or 5 vessels in 2011 and 2012 (Table 8.17). Overall, 24% of the tows were from one vessel; and 7 vessels accounted for 88% of the effort in the dataset. From a total of almost 25 000 tows, about 90% were from the 2008–2010 fishing years (Table 8.18). Substantial drops in effort occurred in subsequent years, to about 1000 tows each in 2011 and 2012. Fishery area 1D was consistently fished and accounted for about 90% of the total effort in the dataset.

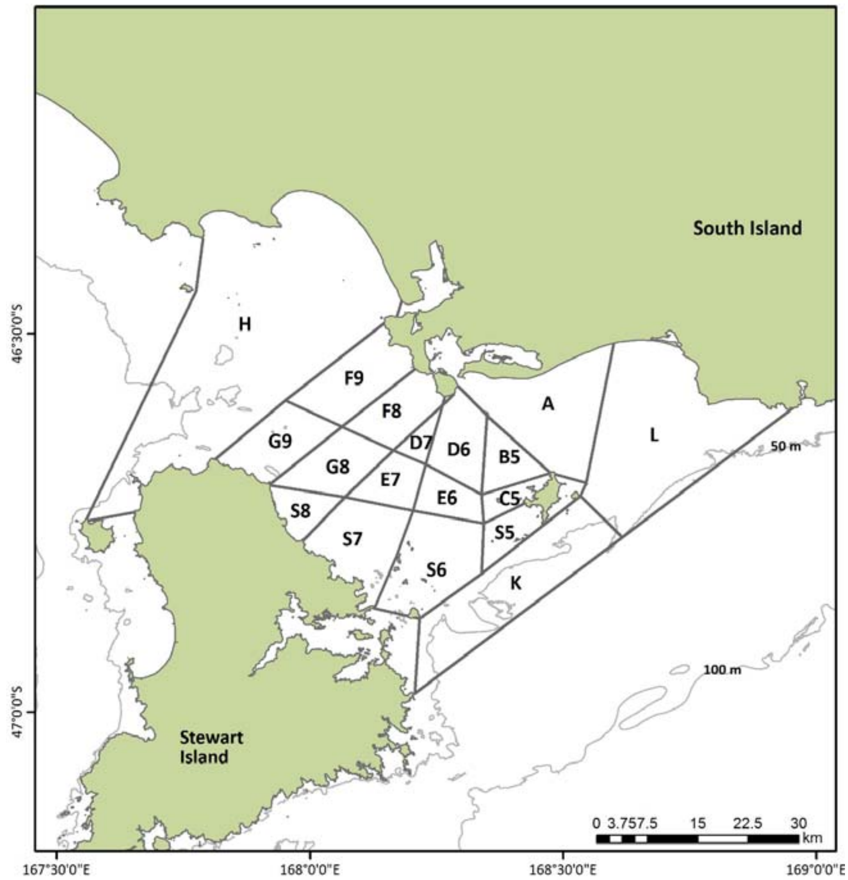

Figure 8.1: Fishery reporting areas in the Foveaux Strait dredge oyster fishery.

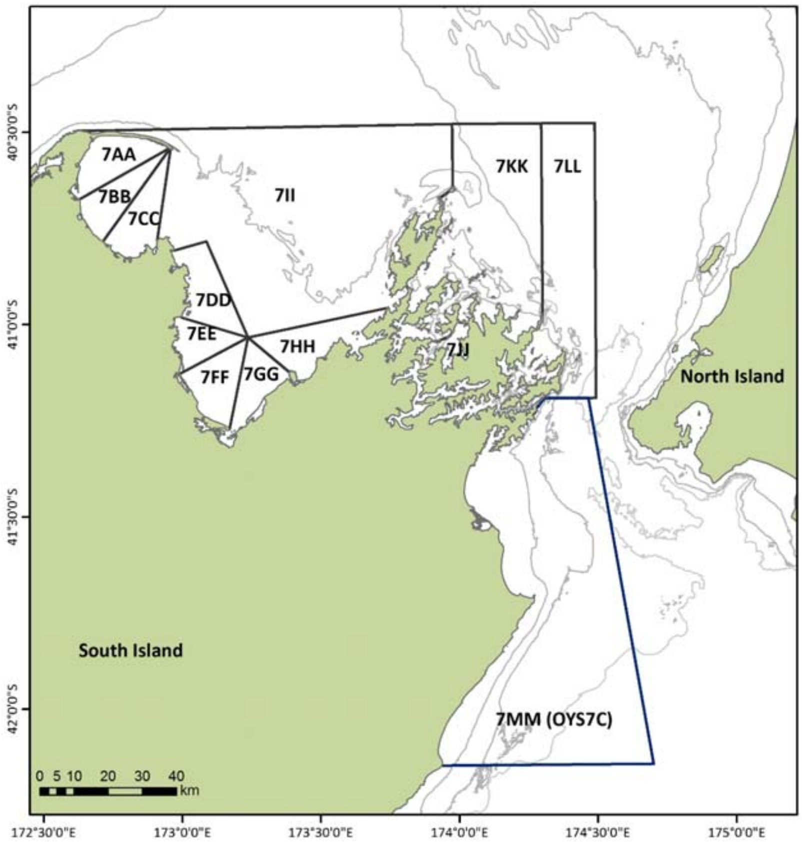

Figure 8.2: Fishery reporting areas in the Challenger scallop fishery (7AA–7LL) and the Challenger oyster fishery (7AA–7MM). The contours shown represent 50 m, 100 m, and 250 m.

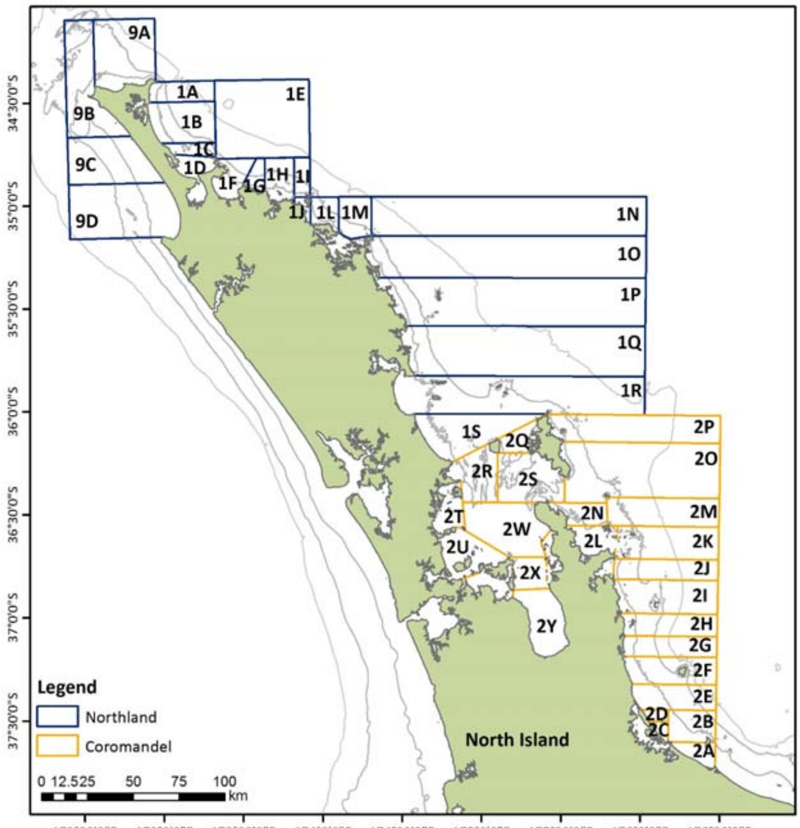

Figure 8.3: Fishery reporting areas in the Northland (9A–9D and 1A–1S) and the Coromandel (2A–2Y) scallop fisheries. The contours shown represent 50 m, 100 m, and 250 m.

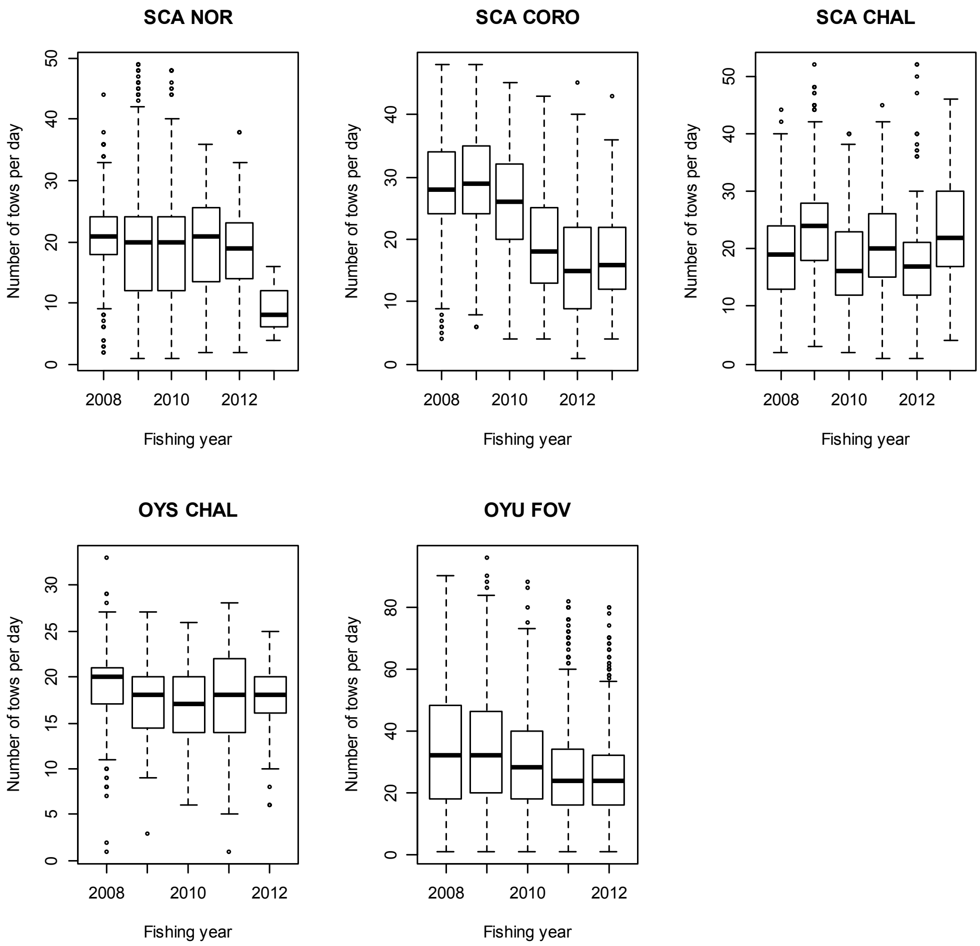

Figure 8.4: The distribution of the reported number of daily dredge tows in the main fishery areas, by fishing year, where SCA is scallop in the NOR (Northland), CORO (Coromandel), and CHAL (Challenger) fisheries, and OYS is dredge oyster in the Challenger fishery, and OYU is the dredge oyster in the FOV (Foveaux Strait) fishery. Scallop fishing years (1 April to 31 March) are used for the scallop data and the 1 October to 30 September fishing year is used for the oyster data.

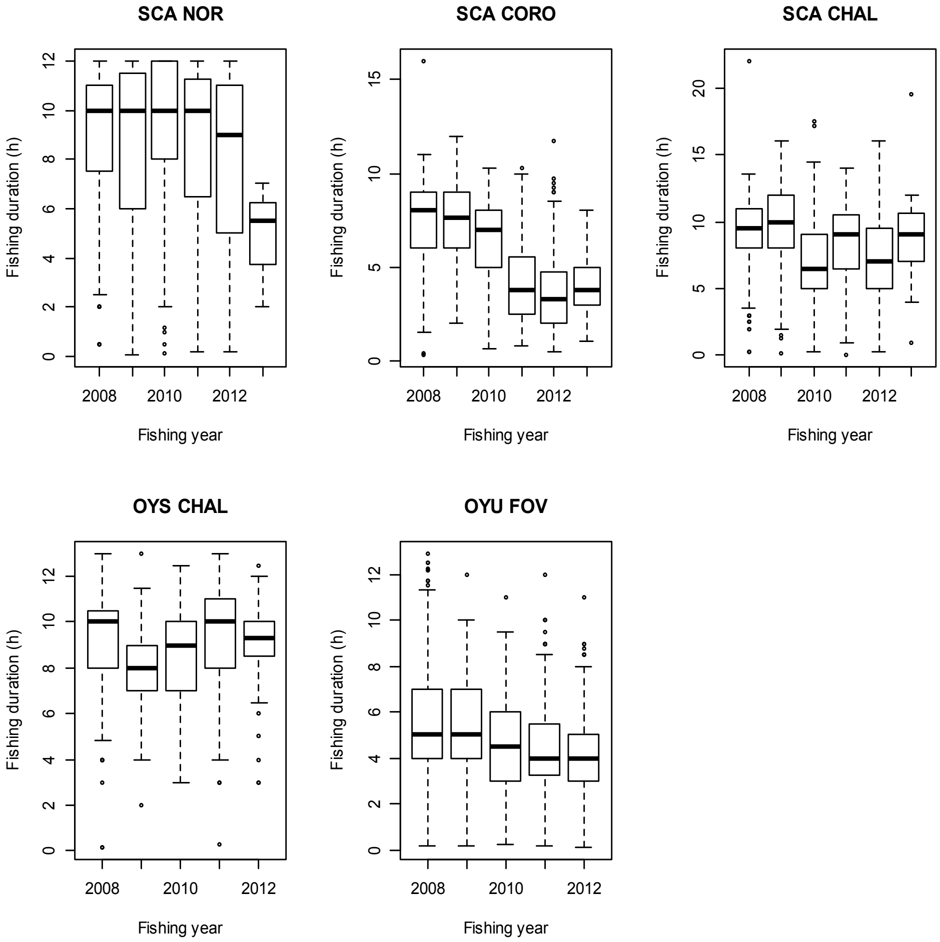

Figure 8.5: The distribution of the reported daily fishing duration in the main fishery areas, by fishing year, where SCA is scallop in the NOR (Northland), CORO (Coromandel), and CHAL (Challenger) fisheries, and OYS is dredge oyster in the Challenger fishery, and OYU is the dredge oyster in the FOV (Foveaux Strait) fishery. Scallop fishing years (1 April to 31 March) are used for the scallop data and the 1 October to 30 September fishing year is used for the oyster data.

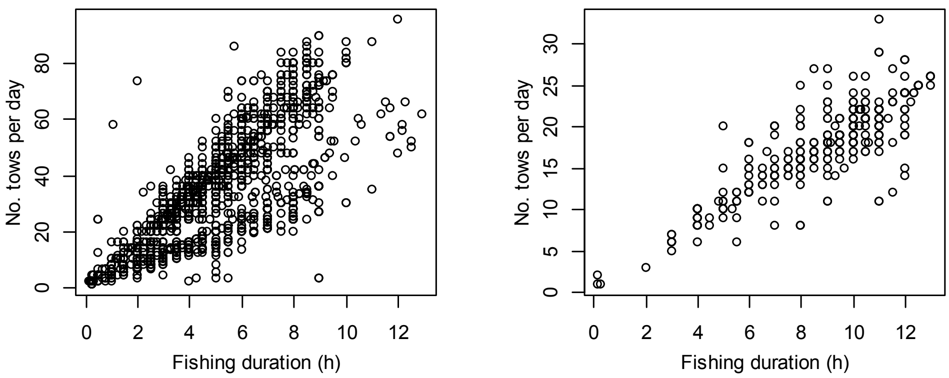

Figure 8.6: Relationship between effort number and fishing duration for data from the Foveaux Strait oyster fishery (left) and the Challenger oyster fishery (right).

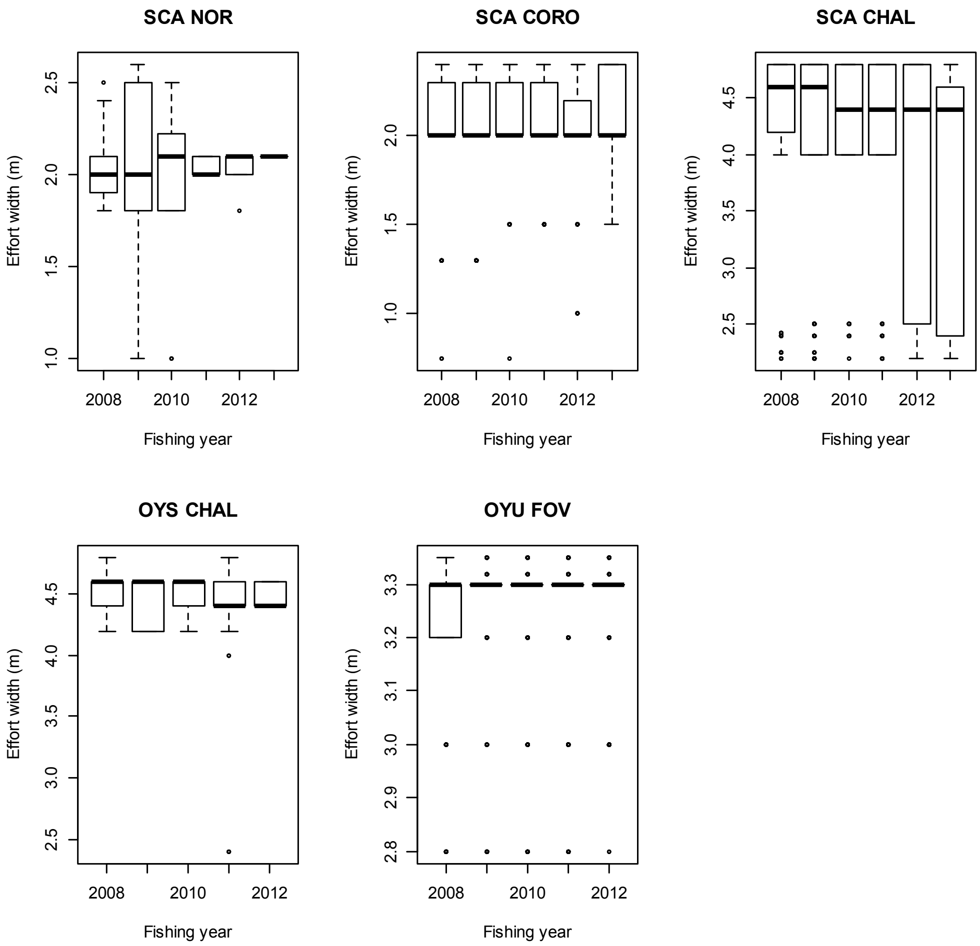

Figure 8.7: The distribution of the effort width data from the main fishery areas, by fishing year, where SCA is scallop in the NOR (Northland), CORO (Coromandel), and CHAL (Challenger) fisheries, and OYS is dredge oyster in the Challenger fishery, and OYU is the dredge oyster in the FOV (Foveaux Strait) fishery. Scallop fishing years (1 April to 31 March) are used for the scallop data and the 1 October to 30 September fishing year is used for the oyster data.

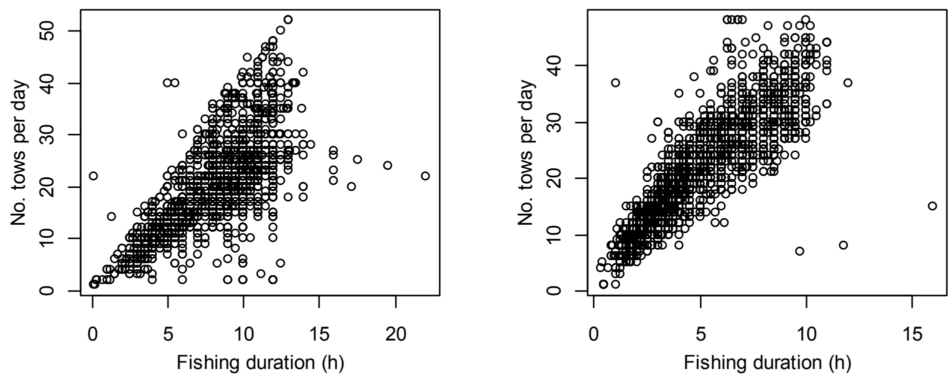

Figure 8.8: Relationship between effort number and fishing duration for data from the Challenger scallop fishery (left) and the Coromandel scallop fishery (right).

Table 8.1: Number of vessels targeting dredge oysters in Foveaux Strait fishery, by fishing year 2007–08 (2008) to 2011–12 (2012). Areas are shown in Figure 8.1.

Statistical Area	2008	2009	2010	2011	2012	All years
A	1	2	2	6	7	7
B5	0	2	5	3	3	8
C5	2	2	3	2	3	7
D6	0	1	0	0	1	2
D7	2	0	0	1	3	5
E6	3	4	4	1	3	6
E7	7	6	6	5	5	10
F8	1	2	0	0	0	4
F9	0	0	0	0	1	1
G8	9	10	9	9	8	12
G9	3	4	2	2	1	6
H	0	1	0	0	0	1
S5	2	1	2	2	2	4
S6	2	6	2	4	4	7
S7	6	7	5	9	9	11
S8	1	1	2	3	0	3
All areas	11	11	11	11	11	11

Table 8.2: Number of dredge oyster tows reported from the Foveaux Strait fishery, by month for each fishing year 2007–08 (2008) to 2011–12 (2012). The oyster season is from 1 March to 31 August (grey highlight). Note the effort in September and October represents special permit effort to provide catch for the 2011 Rugby World Cup (Ministry for Primary Industries 2013).

Month	2008	2009	2010	2011	2012	All
Oct	0	0	0	0	480	480
Nov	0	11	0	0	2	13
Dec	0	0	0	0	0	0
Jan	0	0	0	0	0	0
Feb	0	3	5	3	0	11
Mar	6 270	6 923	4 610	4 752	5 766	28 321
Apr	6 038	5 605	3 538	4 012	4 133	23 326
May	4 175	4 543	4 352	3 204	4 498	20 772
Jun	2 047	3 792	3 608	2 988	2 752	15 187
Jul	144	418	2 199	1 485	3 022	7 268
Aug	16	16	408	823	1 332	2 595
Sep	0	0	0	1 754	0	1 754
All	18 690	21 311	18 720	19 021	21 985	99 727

Table 8.3: Number of dredge oyster tows in Foveaux Strait fishery, by fishery area for each fishing year 2007–08 (2008) to 2011–12 (2012). Areas are shown in Figure 8.1.

Area	2008	2009	2010	2011	2012	All
A	32	142	110	1 921	418	2 623
B5	0	90	292	18	246	646
C5	215	86	168	64	261	794
D6	0	140	0	0	170	310
D7	1 912	0	0	66	724	2 702
E6	906	2 337	2 295	450	509	6 497
E7	2 523	4 731	3 270	2 390	2 842	15 756
F8	4	72	0	44	0	120
F9	0	0	0	0	312	312
G8	10 001	9 421	10 210	9 281	8 678	47 591
G9	1 436	898	276	263	26	2 899
H	0	6	0	0	0	6
S5	210	52	133	116	433	944
S6	310	587	169	202	330	1 598
S7	1 107	2 565	1 697	4 138	7 036	16 543
S8	34	184	100	68	0	386
All	18 690	21 311	18 720	19 021	21 985	99 727

Table 8.4: Number of dredge oyster tows in Foveaux Strait fishery, by fishery area for each month with effort, for all years combined (2007–08 to 2011–12). Areas are shown in Figure 8.1.

Area	Oct	Nov	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	All
A	104	0	0	249	338	376	160	237	430	729	2 623
B5	0	0	5	0	8	80	231	194	120	8	646
C5	0	0	0	6	36	154	361	156	81	0	794
D6	0	0	0	0	26	144	140	0	0	0	310
D7	0	0	0	898	724	486	294	282	2	16	2 702
E6	29	0	0	3 116	1 290	1 051	527	333	151	0	6 497
E7	22	13	6	6 223	4 054	2 800	1 967	477	65	129	15 756
F8	0	0	0	4	20	0	52	0	44	0	120
F9	0	0	0	0	58	254	0	0	0	0	312
G8	295	0	0	11 369	10 526	10 485	8 652	4 539	1 024	701	47 591
G9	0	0	0	254	1 606	649	355	35	0	0	2 899
H	0	0	0	0	0	6	0	0	0	0	6
S5	0	0	0	120	187	116	250	94	177	0	944
S6	10	0	0	428	72	533	279	224	18	34	1 598
S7	20	0	0	5 528	4 381	3 402	1 895	697	483	137	16 543
S8	0	0	0	126	0	236	24	0	0	0	386
All	480	13	11	28 321	23 326	20 772	15 187	7 268	2 595	1 754	99 727

Table 8.5: Number of vessels targeting dredge oysters in the Challenger fishery, by fishing year 2007–08 (2008) to 2011–12 (2012). Areas are shown in Figure 8.3. Note: no effort was reported from areas 7AA–7CC.

Area	2008	2009	2010	2011	2012	All
7DD	3	1	0	0	0	4
7EE	4	0	0	0	0	4
7FF	4	0	0	7	0	8
7GG	4	0	0	1	0	5
7HH	3	0	0	0	0	3
7II	1	0	0	1	0	1
7KK	0	0	2	0	0	2
7LL	0	0	1	3	2	3
7MM	2	2	2	0	0	4
All	7	2	3	9	2	12

Table 8.6: Number of dredge oyster tows in Challenger fishery, by month for each fishing year 2007–08 (2008) to 2011–12 (2012). Areas are shown in Figure 8.3.

Month	2008	2009	2010	2011	2012	All
Oct	0	0	0	140	0	140
Nov	0	0	173	201	91	465
Dec	75	0	192	206	118	591
Jan	349	264	296	166	100	1 175
Feb	431	230	257	165	156	1 239
Mar	804	131	236	182	16	1 369
Apr	651	67	77	85	87	967
May	18	3	0	96	30	147
Jun	1	0	0	178	48	227
Jul	0	0	0	134	50	184
Aug	0	0	0	411	182	593
Sep	0	0	0	0	57	57
All	2 329	695	1 231	1 964	935	7 154

Table 8.7: Number of dredge oyster tows in Challenger fishery, by fishery area for each fishing year 2007–08 (2008) to 2011–12 (2012). Areas are shown in Figure 8.3. Note: no effort was reported for areas 7AA–7CC.

Area	2008	2009	2010	2011	2012	All
7DD	194	3	0	0	0	197
7EE	760	0	0	0	0	760
7FF	443	0	0	366	0	809
7GG	198	0	0	24	0	222
7HH	114	0	0	0	0	114
7II	21	0	0	21	0	42
7KK	0	0	129	0	0	129
7LL	0	0	470	1 553	935	2 958
7MM	599	692	632	0	0	1 923
All	2 329	695	1 231	1 964	935	7 154

Table 8.8: Number of dredge oyster tows in the Challenger fishery, by month for each fishery area. Areas are shown in Figure 8.3. Note: no effort was reported for areas 7AA–7CC.

Month	7DD	7EE	7FF	7GG	7HH	7II	7KK	7LL	7MM	All
Oct	0	0	0	0	0	0	0	140	0	140
Nov	0	0	0	0	0	0	13	337	115	465
Dec	0	0	0	0	0	0	60	324	207	591
Jan	0	0	0	0	0	0	0	380	795	1 175
Feb	0	128	88	43	0	0	0	442	538	1 239
Mar	115	382	208	99	0	0	31	336	198	1 369
Apr	79	250	147	56	98	21	25	224	67	967
May	3	0	0	0	16	0	0	126	2	147
Jun	0	0	0	0	0	0	0	226	1	227
Jul	0	0	0	0	0	0	0	184	0	184
Aug	0	0	366	24	0	21	0	182	0	593
Sep	0	0	0	0	0	0	0	57	0	57
All	197	760	809	222	114	42	129	2 958	1 923	7 154

Table 8.9: Number of vessels targeting scallops in the Challenger fishery, by fishery area for each scallop fishing year, 1 April 2007–31 March 2008 (2008) to 2012–13 (2013). Note: data for the 2008 and the 2013 fishing years will not be complete because the data extract was from 1 October 2007 to 30 September 2012. Areas are shown in Figure 8.2. Note: no effort was reported from areas 7EE, 7HH, or 7JJ.

Area	2008	2009	2010	2011	2012	2013	All
7AA	0	0	8	0	0	0	8
7BB	0	31	13	5	1	0	32
7CC	30	6	7	0	1	0	30
7DD	0	0	1	1	0	0	2
7FF	1	1	0	0	0	0	2
7GG	0	1	0	0	0	0	1
7II	0	0	1	1	1	0	3
7KK	0	20	23	22	17	10	34
7LL	5	2	9	13	16	11	25
All	32	32	26	22	18	14	41

Table 8.10: Number of scallop tows in the Challenger fishery, by month for each scallop fishing year. Note: see Table 8.9 caption for fishing year comments on data completeness for 2008 and 2013. The fishing season is generally from August to December.

Month	2008	2009	2010	2011	2012	2013	All
Aug	0	0	95	0	0	0	95
Sep	0	0	4 882	4 037	643	2 263	11 825
Oct	5 857	6 202	5 179	3 511	4 988	0	25 737
Nov	479	7 707	172	0	488	0	8 846
Dec	0	1 532	0	0	0	0	1 532
Jan	6	615	3	0	0	0	624
Feb	0	72	10	0	0	0	82
All	6 342	16 128	10 341	7 548	6 119	2 263	48 741

Table 8.11: Number of scallop tows in the Challenger fishery, by fishery area for each scallop fishing year. Note: see Table 8.9 caption for fishing year comments on data completeness for 2008 and 2013. Areas are shown in Figure 8.2. Note: no effort was reported from areas 7EE, 7HH, or 7JJ.

Area	2008	2009	2010	2011	2012	2013	All
7AA	0	0	385	0	0	0	385
7BB	0	10 939	1 666	1 288	96	0	13 989
7CC	5 293	138	469	0	76	0	5 976
7DD	0	0	10	22	0	0	32
7FF	6	20	0	0	0	0	26
7GG	0	37	0	0	0	0	37
7II	0	0	4	54	16	0	74
7KK	0	4 964	7 467	5 449	3 857	940	22 677
7LL	1 043	30	340	735	2 074	1 323	5 545
All	6 342	16 128	10 341	7 548	6 119	2 263	48 741

Table 8.12: Number of scallop tows in the Challenger fishery, by month for each month of the data extract (1 October 2007 to 30 September 2012). The fishing season is generally from August to December. Areas are shown in Figure 8.2. Note: no effort was reported for March–July inclusive or for 7EE, 7HH, or 7JJ.

Month	7AA	7BB	7CC	7DD	7FF	7GG	7II	7KK	7LL	All
Aug	0	91	0	0	0	0	4	0	0	95
Sep	88	610	74	22	0	0	16	8 445	2 570	11 825
Oct	297	6 665	5 299	0	20	37	54	10 415	2 950	25 737
Nov	0	5 128	566	0	0	0	0	3 130	22	8 846
Dec	0	1 495	37	0	0	0	0	0	0	1 532
Jan	0	0	0	0	6	0	0	615	3	624
Feb	0	0	0	10	0	0	0	72	0	82
All	385	13 989	5 976	32	26	37	74	22 677	5 545	48 741

Table 8.13: Number of vessels targeting scallops in the Coromandel fishery, by fishery area for each scallop fishing year, 1 April 2007–31 March 2008 (2008) to 2012–13 (2013). Note: data for the 2008 and the 2013 fishing years will not be complete because the data extract was from 1 October 2007 to 30 September 2012. Areas are shown in Figure 8.3. Note: no effort was reported from areas 2B, 2D, 2G, 2I, 2J, 2M–2P, 2T–2V, or 2Y.

Area	2008	2009	2010	2011	2012	2013	All
2A	1	0	0	1	0	0	2
2C	0	1	0	0	0	0	1
2E	1	0	0	0	0	0	1
2F	0	1	0	0	0	0	1
2H	1	0	0	0	0	0	1
2K	5	0	3	2	0	0	6
2L	8	7	7	7	7	0	9
2Q	0	0	0	0	1	0	1
2R	5	6	7	7	8	0	9
2S	2	1	0	2	1	0	4
2W	4	3	8	3	7	7	10
2X	2	0	0	0	1	0	2
All	8	7	8	7	8	7	12

Table 8.14: Number of scallop tows in the Coromandel fishery, by month for each scallop fishing year. Note: see Table 8.13 caption for fishing year comments on data completeness for 2008 and 2013. The fishing season is 15 July–21 December.

Month	2008	2009	2010	2011	2012	2013	All
Jul	0	1 472	0	0	449	788	2 709
Aug	0	3 613	1 925	1 703	3 461	2 622	13 324
Sep	0	4 179	3 311	2 361	2 782	2 276	14 909
Oct	3 548	3 889	3 584	1 991	1 396	0	14 408
Nov	2 767	2 722	2 247	2 038	372	0	10 146
Dec	9	0	0	0	0	0	9
Jan	0	0	0	0	5	0	5
Feb	0	0	0	0	9	0	9
All	6 324	15 875	11 067	8 093	8 474	5 686	55 519

Table 8.15: Number of scallop tows in the Coromandel fishery, by fishery area for each scallop fishing year. Note: see Table 8.13 caption for fishing year comments on data completeness for 2008 and 2013. Areas are shown in Figure 8.3. Note: no effort was reported from areas 2B, 2D, 2G, 2I, 2J, 2M–2P, 2T–2V, or 2Y.

Area	2008	2009	2010	2011	2012	2013	All
2A	38	0	0	32	0	0	70
2C	0	897	0	0	0	0	897
2E	6	0	0	0	0	0	6
2F	0	48	0	0	0	0	48
2H	7	0	0	0	0	0	7
2K	1 056	0	319	143	0	0	1 518
2L	3 452	14 203	8 529	4 304	5 290	0	35 778
2Q	0	0	0	0	21	0	21
2R	585	372	1 767	3 219	640	0	6 583
2S	36	25	0	58	14	0	133
2W	1 098	330	452	337	2 493	5 686	10 396
2X	46	0	0	0	16	0	62
All	6 324	15 875	11 067	8 093	8 474	5 686	55 519

Table 8.16: Number of scallop tows in the Coromandel fishery, by month for each month of the data extract (1 October 2007 to 30 September 2012). The fishing season is from 15 July to 21 December. Note: no effort was reported from areas 2B, 2D, 2G, 2I, 2J, 2M–2P, 2T–2V, or 2Y.

Month	2A	2C	2E	2F	2H	2K	2L	2Q	2R	2S	2W	2X	All
Jul	0	224	0	0	0	0	1 697	0	0	0	788	0	2 709
Aug	0	0	0	0	0	12	9 389	0	1 301	0	2 622	0	13 324
Sep	0	0	0	0	0	0	9 084	0	2 552	0	3 257	16	14 909
Oct	0	673	6	48	7	133	10 022	21	1 340	25	2 133	0	14 408
Nov	70	0	0	0	0	1 373	5 577	0	1 376	108	1 596	46	10 146
Dec	0	0	0	0	0	0	9	0	0	0	0	0	9
Jan	0	0	0	0	0	0	0	0	5	0	0	0	5
Feb	0	0	0	0	0	0	0	0	9	0	0	0	9
All	70	897	6	48	7	1 518	35 778	21	6 583	133	10 396	62	55 519

Table 8.17: Number of vessels targeting scallops in the Northland fishery, by fishery area for each scallop fishing year 1 April 2007–31 March 2008 (2008) to 2012–13 (2013). Note: data for the 2008 and the 2013 fishing years will not be complete because the data extract was from 1 October 2007 to 30 September 2012. Areas are shown in Figure 8.3. Note: no effort was reported from areas 1B, 1C, 1E–1H, 1J, 1L–1P, 9B–9D.

Area	2008	2009	2010	2011	2012	2013	All
1A	0	1	0	0	0	0	1
1D	8	8	9	4	4	0	11
1I	1	1	0	0	0	0	1
1Q	1	0	0	0	0	0	1
1R	3	0	0	1	1	1	5
1S	0	0	0	1	0	0	1
9A	5	6	1	0	0	0	7
All	13	9	9	5	4	1	17

Table 8.18: Number of scallop tows in the Northland fishery, by month for each scallop fishing year. The fishing season is from 15 July to 14 February each year. Note: see Table 8.17 caption for fishing year comments on data completeness for 2008 and 2013.

	2008	2009	2010	2011	2012	2013	All
Jul	0	327	1 034	158	0	0	1 519
Aug	0	685	1 402	127	51	0	2 265
Sep	0	1 514	1 196	22	80	28	2 840
Oct	1 122	1 783	905	124	88	0	4 022
Nov	1 441	1 728	1 475	235	263	0	5 142
Dec	924	1 200	808	217	109	0	3 258
Jan	1 651	1 573	724	195	339	0	4 482
Feb	808	394	244	0	20	0	1 466
Mar	0	4	0	0	0	0	4
All	5 946	9 208	7 788	1 078	950	28	24 998

Table 8.19: Number of scallop tows in the Northland fishery, by fishery area for each scallop fishing year. Note: see Table 8.17 caption for fishing year comments on data completeness for 2008 and 2013. See Figure 8.3 for areas. There was no effort reported from areas 1B, 1C, 1E–1H, 1J, 1L–1P, 9B–9D.

Area	2008	2009	2010	2011	2012	2013	All
1A	0	21	0	0	0	0	21
1D	4 894	8 312	7 786	1 004	948	0	22 944
1I	13	10	0	0	0	0	23
1Q	63	0	0	0	0	0	63
1R	152	0	0	31	2	28	213
1S	0	0	0	43	0	0	43
9A	824	865	2	0	0	0	1 691
All	5 946	9 208	7 788	1 078	950	28	24 998

Table 8.20: Number of scallop tows in the Northland fishery, by fishery area for each month of the data extract (1 October 2007 to 30 September 2012). Areas are shown in Figure 8.3. No effort was reported from areas 1B, 1C, 1E–1H, 1J, 1L–1P, 9B–9D.

Month	1A	1D	1I	1Q	1R	1S	9A	All
Jul	0	1 519	0	0	0	0	0	1 519
Aug	0	2 252	0	0	13	0	0	2 265
Sep	0	2 798	2	0	40	0	0	2 840
Oct	0	3 873	0	0	0	43	106	4 022
Nov	21	4 673	3	63	156	0	226	5 142
Dec	0	2 453	3	0	0	0	802	3 258
Jan	0	4 086	4	0	4	0	388	4 482
Feb	0	1 290	7	0	0	0	169	1 466
Mar	0	0	4	0	0	0	0	4
All	21	22 944	23	63	213	43	1 691	24 998

APPENDIX 9: SUMMARY OF DANISH SEINE EFFORT

A Danish seine net is defined as "any net or part of a net (including any warp, rope, chain, material, or device used in conjunction with or attached to the net) that — (a) has a buoyancy system on the top edge; and (b) is weighted on the bottom edge; and (c) is operated, without the use of any horizontal net opening device, by surrounding any fish and being drawn over the bed of any waters, or through any waters, to 1 or more vessels" (Fisheries (Auckland and Kermadec Areas Commercial Fishing) Regulations 1986).

A total of 11 053 daily records from CELR data for 2007–08 to 2011–12 equated to 26 768 Danish seine sets reported from a total of 36 vessels. Twenty-one vessels made at least 500 sets over the five year period, which equates to about 90% of the total Danish seine effort. Minimal grooming has been carried out on these data, other than to check target species and amend a very small percentage of the fishing duration data.

The median number of daily sets was 2 (range of 1–10 sets per day). For the records where fishing duration was reported (as the number of hours fished per day), the data suggest that each set was generally between 2 and 4 hours long: note, almost 37% of records had no fishing duration data.

The number of sets per fishing year has been relatively steady over the five year period (Table 9.1). At least 31 different target species were reported for Danish seine effort, seven of which accounted for 98% of the total effort. The main targets were: snapper (36.2% of the sets), red gurnard (20.8%), flatfish species (19.2%), tarakihi (7.6%), red cod (6.2%), John dory (5.8%), and rig (2.2%). The annual effort has been reasonably steady from year to year for snapper and red gurnard, whereas relatively large fluctuations are evident in effort targeted at flatfish species and John dory. Tarakihi and rig effort has increased over the five year period, whereas red cod effort has steadily declined.

Effort for the main targets was primarily in Statistical Area 047 off the northern west coast North Island; 003 off the Bay of Islands; 006, 008, and 009 in the Hauraki Gulf and Bay of Plenty; 038 in Nelson-Marlborough waters; and 020 and 022 off the east coast South Island (Tables 9.2 and 9.3). Snapper was targeted consistently in 006 (38% of all snapper sets) and in 008 and 009 (37% of snapper sets), with lesser effort in 003, 010, and 005. Red gurnard was targeted mainly in waters around the northern North Island, in 003, 005, 008, 009, 010, 012, and 013 off the east coast and in 039,041,042, 045, 046, and 047 off the west coast. Area 047 accounted for 23% of all red gurnard sets.

Almost 77% of the flatfish effort was in 038, though there was large interannual variation (range: 422 in 2011 to 1128 sets in 2010). The remainder of the flatfish effort was mainly in 020 and 022. Statistical Areas 020 and 022 were also important for tarakihi, accounting for 56% of the Danish seine sets. Areas 009 (22%) was the next most important area, with 003 and 008 accounting for another 13% of sets. Effort for the remaining species was less widespread. Red cod was almost exclusively targeted in 020 and 022; John dory in 006; and rig in 020 and 022.

Table 9.1: Target species reported for Danish seine effort on CELR forms, 2007–08 (2008) to 2011–12 (2012).

Target species	2008	2009	2010	2011	2012	All
Barracouta	0	0	0	0	1	1
Elephant fish	79	16	9	67	36	207
Blue mackerel	0	0	0	5	5	10
Flatfish	1 218	972	1 262	613	1 093	5 158
Garfish	0	0	5	0	0	5
Grey mullet	0	0	2	0	2	4
Ghost shark	2	9	0	0	3	14
Red gurnard	915	1 163	1 182	1 210	1090	5 560
Hoki	0	0	4	45	4	53
John dory	435	262	202	329	335	1 563
Spotted gurnard	0	0	0	0	1	1
Jack mackerel	0	0	0	0	2	2
Kahawai	0	1	0	0	5	6
Mirror dory	0	0	0	1	0	1
Parore	0	0	1	0	0	1
Pilchard	3	0	0	0	0	3
Red cod	435	390	328	308	190	1 651
School shark	0	0	0	3	12	15
Gemfish	0	0	1	0	0	1
Skipjack	0	0	0	1	0	1
Snapper	2 035	1 871	1 859	1 810	2 120	9 695
Spiny dogfish	0	0	38	4	0	42
Sea perch	0	3	0	0	0	3
Rig	19	25	113	194	248	599
Arrow squid	0	0	0	0	2	2
Tarakihi	207	417	441	425	539	2 029
Trevally	2	0	9	49	81	141
All	5 350	5 129	5 456	5 064	5 769	26 768

Table 9.2: Number of Danish seine sets for the main species (snapper, red gurnard, flatfish, tarakihi, red cod, John dory, and rig) in each statistical area, by fishing years 2007–08 (2008) to 2011–12 (2012). These species account for 95% of the total number of sets.

Statistical Area	2008	2009	2010	2011	2012	All
001	0	3	0	0	1	4
002	38	28	33	20	7	126
003	338	233	338	227	313	1 449
004	2	0	12	2	14	30
005	152	245	331	143	246	1 117
006	1 288	869	851	828	1 234	5 070
007	8	3	9	0	0	20
008	414	417	379	388	374	1 972
009	395	648	809	777	536	3 165
010	97	107	168	442	314	1 128
011	4	1	3	31	11	50
012	10	0	69	131	187	397
013	24	0	13	47	220	304
015	0	1	0	0	0	1
016	0	15	0	0	0	15
017	20	15	7	5	28	75
018	4	14	3	20	27	68
020	510	499	441	574	591	2 615
021	6	0	0	0	0	6
022	377	323	296	294	461	1 751
023	0	0	0	5	0	5
024	0	0	0	3	4	7
030	0	3	0	0	0	3
033	0	0	0	0	2	2
035	0	21	8	36	3	68
036	0	0	1	1	0	2
037	5	6	8	3	11	33
038	922	778	1 141	448	740	4 029
039	79	61	16	55	44	255
040	4	25	0	1	0	30
041	39	88	2	2	24	155
042	77	139	8	116	44	384
045	59	95	34	101	89	378
046	24	89	23	25	0	161
047	353	361	374	159	87	1 334
101	2	0	0	0	0	2
106	2	0	3	0	0	5
107	0	4	0	0	0	4
608	0	0	0	3	0	3
All	5 253	5 091	5 380	4 887	5 612	26 223

Table 9.3: Number of Danish seine sets for the main target species in each Statistical Area, for 2007–08 to 2011–2102 combined. FLA is flatfish, GUR is red gurnard, JDO is John dory, RCO is red cod, SNA is snapper, SPO is rig, TAR is tarakihi.

Statistical Area	FLA	GUR	JDO	RCO	SNA	SPO	TAR	All
001	0	1	0	0	3	0	0	4
002	0	57	0	0	29	0	40	126
003	7	509	32	0	753	0	148	1 449
004	0	9	0	0	2	0	19	30
005	4	499	51	0	535	0	28	1 117
006	1	46	1 374	0	3 640	9	0	5 070
007	8	0	1	0	11	0	0	20
008	0	493	18	0	1 341	2	118	1 972
009	0	445	27	0	2 253	0	440	3 165
010	0	271	48	0	766	1	42	1 128
011	0	22	0	0	24	0	4	50
012	0	252	0	0	134	0	11	397
013	3	282	0	0	19	0	0	304
015	0	0	0	0	1	0	0	1
016	15	0	0	0	0	0	0	15
017	11	51	0	13	0	0	0	75
018	0	29	0	8	0	5	26	68
020	760	7	0	987	0	424	437	2 615
021	0	0	0	6	0	0	0	6
022	270	5	0	633	0	144	699	1 751
023	0	0	0	0	0	5	0	5
024	4	0	0	3	0	0	0	7
030	3	0	0	0	0	0	0	3
033	0	2	0	0	0	0	0	2
035	65	3	0	0	0	0	0	68
036	0	0	1	0	1	0	0	2
037	1	32	0	0	0	0	0	33
038	3 948	10	2	1	65	3	0	4 029
039	44	200	1	0	0	6	4	255
040	0	30	0	0	0	0	0	30
041	8	145	0	0	2	0	0	155
042	6	372	0	0	6	0	0	384
045	0	357	0	0	17	0	4	378
046	0	161	0	0	0	0	0	161
047	0	1 266	0	0	60	0	8	1 334
101	0	0	0	0	2	0	0	2
106	0	0	5	0	0	0	0	5
107	0	0	0	0	4	0	0	4
608	0	3	0	0	0	0	0	3
All	5 158	5 559	1 560	1 651	9 668	599	2 028	26 223