Fisheries New Zealand

Tini a Tangaroa

Non-target fish and invertebrate catch and discards in New Zealand hoki, hake, ling, silver warehou, and white warehou trawl fisheries from 1990–91 to 2016–17

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Commercial catch-effort data and fisheries observer records of catch and discards by species, provided by Fisheries New Zealand, were used to estimate the rate and level of non-target fish and invertebrate catch and discards in the hoki, hake, ling, silver warehou and white warehou target trawl fisheries for the fishing years from 1990–91 to 2016–17. Separate estimates were made for broad categories of catch and discards including; all QMS species combined, all non-QMS fish species combined, and all non-QMS invertebrate species combined, as well as discards of the target species. The species composition of these groups were adjusted, where necessary, for each year to match the year-of-entry of individual species into the QMS system. In addition, separate estimates of annual catch were made for a range of the major individual bycatch species and species groups.

For the first time in this fishery the calculation of non-target catch and discards estimates from observer data was based on a statistical model, using Bayesian estimation and incorporating fishing year, standardised areas, net type, and vessel class as model covariates. The basic model was extended in one example area (the Chatham Rise) to include spatially correlated random effects to explore the influence on the estimates from spatial autocorrelation in the observer data.

Hoki accounted for about 73% of the total estimated catch from the observed tows in the target fishery for the five species since 2002–03. The remainder of the observed catch comprised hake (6.7%), ling (5.2%), silver warehou (3.9%), javelinfish (1.9%), other (unspecified) rattails (1.6%), spiny dogfish (1.4%), and white warehou (1.3%), plus a range of other (mainly non-QMS) species including various species of sharks, skates and dogfishes, rattails and other bony fishes. Arrow squid was the ninth most common bycatch species by weight (0.5% of the catch) and the only invertebrate in the top 30 bycatch taxa. Other invertebrate groups frequently observed included warty squid and a range of sponges, echinoderms, crustaceans, and molluscs.

The total annual bycatch estimated by the observer-based model was 17 500–49 000 t between 1990–91 and 2016–17, varying over time approximately in proportion to total fishing effort throughout the period. Annual bycatch was an approximately even mixture of QMS species (5000–25 000 t) and non-QMS fish species (8000–36 000), although QMS species catch increased over time while non-QMS fish species catch decreased. Annual bycatch of non-QMS invertebrates increased significantly over time, from 400–700 t in the early 1990s to over 1100 t after 2014–15.

Discard estimates were calculated only for the 2002–03 to 2016–17 period for the primary target species (hoki, hake, ling) and were low but highly variable, 76–2300 t. Discards of QMS species and non-QMS fish species followed a similar pattern to bycatch (for the years in common), with increased QMS discards (240–3500 t) and a significant decline in non-QMS fish discards (2000–19 000 t). Discards of non-QMS invertebrates declined over time despite increased bycatch over the same period, most likely due to the increased use of meal plants for catch species previously discarded. Total discards were 5000–25 000 t per year and decreased significantly between 2002–03 and 2016–17.

The discard fraction (kg of total discards/kg of target species catch) varied from 0.03 in 2015–16 to 0.17 in 2008–09 with an overall value for the 27-year period of 0.06 and showed little trend over time. This is similar to previous estimates for this fishery, and relatively low compared with most other fisheries that are monitored, which ranged between 0.005 (southern blue whiting trawl fishery) and 3.6 (scampi trawl fishery).

The extended estimation model (incorporating methods to deal with the bias introduced from spatially correlated input data) was successful in estimating bycatch and discards for the Chatham Rise, with model

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convergence in all test applications, and there was no discernible improvement in the fits to the data compared with the standard model. Further exploration of the model, possibly in other areas with a less uniform habitat than the Chatham Rise, may be necessary to determine its ultimate usefulness for refining estimates.

1   INTRODUCTION

The Ministry for Primary Industries (now referred to as Fisheries New Zealand) National Deepwater Plan includes the following Environment Outcome related management objective: MO2.4. "Identify and avoid or minimise adverse effects of deepwater and middle-depth fisheries on incidental bycatch species". This report partially addresses that objective by providing estimates of the level of bycatch of species or groups of species not managed separately in the Quota Management System (QMS). Summary reports of bycatch and discards have been regularly produced for each of the major offshore fisheries since 2000 (Clark et al. 2000). The most recent assessments addressed the scampi (*Metanephrops challengeri*), arrow squid (*Nototodarus* spp.), hoki (*Macruronus novaezelandiae*)/hake (*Merluccius australis*)/ling (*Genypterus blacodes*), jack mackerel (*Trachurus* spp.), orange roughy (*Hoplostethus atlanticus*), and oreos (Oreosomatidae) trawl fisheries (Anderson 2012, 2013, Ballara & O'Driscoll 2015, Anderson et al. 2017a, Anderson et al. 2017b, Anderson & Edwards 2018), and the ling bottom longline fishery (Anderson 2014). This report updates bycatch and discards in the hoki, hake, and ling trawl fisheries using similar methods to past studies but expands the definition of the target fishery to include silver warehou (*Seriolella punctata*) and white warehou (*Seriolella caerulea*) to better align with Marine Stewardship Council (MSC) definitions for its certification of this fishery.

The hoki fishery has been New Zealand's largest by volume, with total reported catches of 88 000–269 000 t per year for the fishing years 1990–91 to 2015–16 (Ballara & O'Driscoll 2017). The hake, ling, silver warehou, and white warehou trawl fisheries are considerably smaller, but together accounted for 30 000–40 000 t of landed fish per year. Total reported catches in 2016–17 were 141 500 t of hoki, 6 144 t of hake, 15 056 t of ling, 8 670 t of silver warehou, and 1 069 t of white warehou (data from Fisheries New Zealand 2018). Trawl fisheries for silver warehou and white warehou operate in similar areas to the hoki, hake, and ling fisheries and use the same vessel fleet and similar gear types, and so in this report the target fishery definition was expanded to include all five species. Since 1990 there have been 13 000–36 000 trawls targeting these five species each year in the New Zealand Exclusive Economic Zone (EEZ) and Territorial Sea.

Hoki are widely distributed throughout the EEZ, mainly between 200 and 800 metres deep (Fisheries New Zealand 2018). However, the commercial fisheries operate in four main areas: two spawning fisheries, which are centred on the west coast of the South Island (WCSI) and in Cook Strait during the winter months (July–early September); and two non-spawning fisheries, on the Chatham Rise and on the Sub-Antarctic during the remainder of the year when hoki are in their dispersed phase (Ballara & O'Driscoll 2017). Smaller spawning fisheries occur in the Puysegur area and off the east coast of the South Island. The hoki fishery operates throughout the year using a mixture of head-and-gut vessels, fillet vessels, and whole fish ice vessels. An increasing number of vessels also have meal plants. Other operational advances in recent years include twin-trawl rigs on some vessels since 1998, increased use of low-drag ultra-high molecular weight polyethylene netting (Spectra/Dyneema) trawls since 2007, and the introduction of the Modular Harvest System (MHS) technology in 2012. MHS is a prototype trawl system (approved for general use in 2018) designed to enable fish to be landed in much better condition than traditional trawls. There are also management controls that may contribute to spatial variability in bycatch and discards. These include restrictions limiting the fishing grounds accessible to vessels longer than 46 m and Operational Procedures for Hoki Fisheries, implemented by the Deepwater Group (who represent industry shareholders) from 1 October 2009. The Operational Procedures aim to manage and monitor fishing effort within four industry management areas, where there is thought to be high abundance of juvenile hoki (Narrows Basin of Cook Strait, Canterbury Banks, Mernoo Bank, and Puysegur Bank). These areas are closed to hoki target trawling by vessels larger than 28 m, with increased monitoring when targeting species other than hoki. There is also a general recommendation that vessels move from areas where catches of juvenile hoki (defined as less than 55 cm total length) comprise more than 20% of the hoki catch by number.

Hake are widely distributed throughout the middle depths of the New Zealand EEZ, mostly south of 40° S. The main fisheries are on the WCSI, the Chatham Rise, and the Sub-Antarctic, where hake are taken by large trawlers, often as bycatch in hoki target fisheries, although target fisheries exist in each of these areas (Horn & Dunn 2007). The largest hake fishery is off the WCSI and where the catch is a mixture of direct targeting and bycatch from the hoki fishery, and catches have been variable due to management changes over time (Devine 2009) including changes to the hake and hoki TACC, changes in fishing practices such as gear used, tow duration, and strategies to limit hake bycatch in the hoki target fishery. In some years, particularly earlier in 1990–91 to 2016–17 period, there was a hake target fishery on the WCSI in September after the peak of the hoki fishery, and bycatch levels of hake early in the fishing season in some years were relatively high (Ballara 2015). In the Sub-Antarctic and the Chatham Rise, hake were caught mainly as bycatch by trawlers targeting hoki, although targeting for hake does occur, particularly in Statistical Area 404 in HAK 4 (Mackay et al. 2005), a known spawning area for hake northwest of the Chatham Islands, and between the Snares and Auckland Islands in the Sub-Antarctic (Devine 2009).

Ling are also widely distributed throughout the middle depths of the New Zealand EEZ, mostly south of 40° S, and like hoki and hake, are also fished mainly on the WCSI, the Chatham Rise, and the Sub-Antarctic. There are at least five ling stocks: WCSI, Chatham Rise, Cook Strait, Bounty Plateau, and the Campbell Plateau (including the Stewart-Snares shelf, and Puysegur Bank) (Horn 2005). Timing of spawning varies between areas: July to November on the Chatham Rise; September to December on the Campbell Plateau and Puysegur Bank; September to February on the Bounty Plateau; July to September off west coast South Island and in the Cook Strait. Ling appear to be mainly bottom dwellers (Horn 2005), although they may at times be caught well above the bottom, for example when feeding on hoki during the hoki spawning season. Until 2000, up to a third of ling landings were taken by bottom longliners, but longline catch then declined in most areas, offset, to some extent, by increased trawl landings (Horn et al. 2013). Ling are mainly caught by large trawlers at Puysegur Bank, on the slope of the Stewart-Snares shelf, and in the Auckland Islands area. Small domestic vessels tend to fish for ling on the WCSI and the east coast of both main islands south of East Cape (Horn et al. 2013).

Silver warehou are most common around the South Island at depths of 200–800 m. Most of the commercial catch is taken from the Chatham Rise, Canterbury Bight, southeast of Stewart Island and WCSI. The total catch is taken partly as bycatch of the hoki and squid, and jack mackerel trawl fisheries, and partly by direct targeting, mainly on the Mernoo Bank and along the Stewart-Snares shelf.

White warehou are mainly restricted to waters around the South Island, at depths of 300–700 m. Most of the commercial catch is from bottom trawls targeting hoki, squid, ling and silver warehou (Ballara & Baird 2012), with a smaller amount by midwater trawl. Some target fishing for white warehou occurs around Mernoo Bank, the Stewart-Snares shelf, Puysegur Bank and WCSI, with higher catch rates recorded in the more southern areas.

Since the first estimates of annual bycatch and discards in the hoki trawl fishery (Clark et al. 2000), the methodology has been progressively refined and estimates regularly updated (Anderson et al. 2001, Anderson & Smith 2005, Ballara et al. 2010, Ballara & O'Driscoll 2015). The most recent analysis of bycatch and discards in the trawl fisheries for hoki, hake, and ling combined, (Ballara & O'Driscoll 2015) used a ratio-method with a number-of-tows based estimator and covered the period 1990–91 to 2012–13. That report estimated that total annual bycatch in the target hoki, hake, and ling fishery for the period ranged from 12 020 t to 37 730 t and total annual discards from about 3699 t to 16 633 t per year, peaking in about 2000. The principal bycatch species were silver warehou, javelinfish (*Lepidorhynchus denticulatus*), unspecified rattails (Macrouridae), and spiny dogfish (*Squalus acanthias*). The main species discarded were spiny dogfish, unspecified rattails, javelinfish, hoki, and shovelnose dogfish (*Deania calcea*). Discards of hoki, hake, and ling accounted for 0.7% of the total observed discards. For the whole fishery, there was an estimated average of 0.05 kg of total discards for each kilogram of hoki, hake, and ling caught.

This report presents revised and updated estimates of annual bycatch for 1990–91 to 2016–17 and discards for 2002–03 to 2016–17 in this multi-species fishery, using a statistical model-based estimator.

1.1 Objectives

This report was prepared as an output from the Fisheries New Zealand project DAE201701 "Bycatch monitoring and quantification in deepwater fisheries (HOK/HAK/LIN)" which has the following objectives.

Overall objective:

To estimate the composition of catch (including non-target fish catch and discards of target and non-target fish species) in hoki, hake, and ling trawl fisheries.

Specific objectives

1.   To estimate the catch composition in the target fisheries for hoki, hake, and ling. This should include the quantity of non-target fish species caught, and the target and non-target fish species discarded, using data from Fisheries New Zealand Observers to the end of the most recent complete fishing year in a format that meets management needs.
2.   To compare estimated rates, amounts, and trends of bycatch and discards over time in the hoki, hake, and ling trawl fisheries.
3.   To update any relevant sections of the Aquatic Environment and Biodiversity Annual Review and Environmental and Ecosystem considerations sections of the Fisheries Assessment Plenary documents with new results from this work.
4.   To undertake a preliminary investigation of the use of spatio-temporal distributional modelling approaches for the estimation of bycatch in an example stratum (i.e., the Chatham Rise).

This report addresses Objectives 1, 2, and 4 only.

After subsequent discussions between project and Fisheries New Zealand staff, the following agreements were made:

- The specification of the target fishery shall be amended to include silver warehou (SWA) and white warehou (WWA) to align with Marine Stewardship Council (MSC) recertification requirements for the hoki fishery, and to acknowledge the substantial targeting of these species by the fleet on the Chatham Rise (SWA) and the sub-Antarctic (WWA).
- Estimates of bycatch shall be made for all fishing years since 1990–91 but estimates of discards shall be made for only the fishing years since 2002–03. This date is after the introduction of observer logbooks (with consistent assignation of discard information to individual tows).
- In addition to the (year-of-entry adjusted) QMS, non-QMS fish, and non-QMS invertebrate species categories, annual estimates of bycatch shall be made for the following species groups: morid cods (Moridae), Schedule 6 species[1], rattails (all species combined), slickheads (Alepocephalidae), sharks (all cartilaginous fishes, Chondrichthyes); and the following species: barracouta, black oreo (*Allocyttus niger*), alfonsino (*Beryx* spp.), giant stargazer (*Kathetostoma giganteum*), dark ghost shark (*Hydrolagus novaezealandiae*), pale ghost shark (*Hydrolagus bemisi*), javelinfish, jack mackerels, lookdown dory (*Cyttus traversi*), orange roughy, red cod (*Pseudophycis bachus*), ribaldo (*Mora moro*), gemfish (*Rexea solandri*), southern blue whiting (*Micromesistius australis*), shovelnose dogfish, spiny dogfish, sea perch (*Helicolenus* spp.), frostfish (*Lepidopus caudatus*), and arrow squids.
- The area breakdown for presentation of results will follow the standard (protected species) divisions used in recent reports (e.g., Anderson & Edwards 2018), but estimates for individual sub-Antarctic areas will be based on observer data from combined areas to better align with the distribution of the hoki fishery in that region.

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[1] QMS species that can be legally returned to the sea under certain conditions. See relevant sections of the Fisheries Act 1996 for more details.

- Stratification of the analyses will include gear type (midwater and bottom trawl) to reflect the high use of midwater trawl gear that is particular to this fishery in some regions – especially the west coast South Island.
- An investigation into correlation between observer coverage levels and uncertainty of the estimates will be undertaken.
- Changes over time in the distribution of observer coverage with respect to vessel type will be examined in light of higher observer coverage on foreign owned vessels and lower coverage on domestic vessels in recent years, with this factor included as a model covariate in the estimation of discards if deemed necessary.
- The use of MHS gear (catch and effort levels) will be documented for each fishery.

1.2 Definitions

For this study *non-target catch* is equivalent to *bycatch* and includes all fish and invertebrates caught that were not either hoki, hake, ling, silver warehou or white warehou whether or not they were discarded (McCaughran 1992). McCaughran's definition of *discarded catch* (or *discards*) as "all the fish, both target and non-target species, which are returned to the sea whole as a result of economic, legal, or personal considerations", is also adopted. *Discarded catch* in this report is defined to also include invertebrate discards and fish lost from the net at the surface, but excludes fish returned to the sea alive. The *target fisheries for hoki, hake, ling* (expanded by agreement to include silver warehou and white warehou) are defined as all fishing using trawling methods where the target species was recorded as the Fisheries New Zealand reporting codes HOK, HAK, LIN, SWA, and WWA. Data were analysed by fishing year (1 October to 30 September), for convenience occasionally referred to in figures as, for example, 1991 for the 1990–91 fishing year.

2 METHODS

2.1 Observer data

Fisheries New Zealand observers have recorded details of catch and discards by species or species groups for the fleet of vessels involved in this fishery in every fishing year since 1990–91. Only a minority of the fishing effort was covered, however, and the allocation of observers on commercial vessels considers a range of data collection requirements and compliance issues for multiple fisheries, as well as the capacity of vessels to accommodate additional personnel. Although it is not possible to achieve a perfectly representative or random spread of observer effort across the fishery, the analyses used here assume that the bias from such non-representativeness is sufficiently low that that results are not substantially biased. Various summaries and figures are presented in Section 3.1 to characterise the representativeness across a range of parameters. A further assumption required for the estimation of QMS species discards is that discarding of these species is unaffected by the presence of an observer on the vessel.

There is a considerable amount of observer data available for this analysis, with about 1250–5800 observed trawls annually. Some changes in recording and database storage of observer data occurred in the early 2000s so that discard information could more readily be assigned to individual tows, and improvements in taxonomic identification became possible with the introduction of a range of more specific 3-letter Fisheries New Zealand codes. For these reasons it was agreed to restrict the calculation of discards to the 2002–03 to 2016–17 period, as this corresponds to a period of greater consistency in the observer data.

2.1.1 Data preparation and grooming

A dataset was prepared from the Fisheries New Zealand observer database *cod* based on all observed trawls that targeted hoki, hake, ling, silver warehou, and white warehou for the period from 1990–91 to 2016–17.

This dataset contained a complete set of catch-by-species for all relevant trawls. Catches in various categories not considered in this analysis were removed from the initial extract; e.g., seaweed, birds, marine mammals, reptiles, and rubbish. Records in these categories comprised about 0.5% of the total.

All records in the observer dataset were run through a set of checks to ensure consistency, to correct or aid correction of erroneous values where possible, to remove records with missing values in critical fields, and to derive additional variables with the potential to describe patterns in variability of bycatch and discards.

Trawl distance was calculated from the recorded start and finish positions. Records in which a start or finish position was missing were identified and groomed using median imputation. This process substituted the missing value with an approximate one calculated from the median latitude or longitude for other trawls by the same vessel on the same day, if any existed. Long tows (over 100 km, approximately the 98th percentile of the distribution of observed trawl distances) were accepted only if in approximate agreement with the tow distance calculated from the recorded tow duration and trawling speed. Trawl distances were then recalculated from a combination of the corrected positions and values derived from the recorded duration and trawling speed.

Trawl durations were derived from the difference between the start and finish times, less the period (recorded by observers) between those times when the net was not fishing, e.g., when the net was lifted off the bottom to avoid foul ground, brought to the surface during turning, or was temporarily left hanging in the water due to equipment malfunction. These trawl durations were then cross-checked with estimates based on the recorded fishing speed and calculated trawl distance. Missing or unusual fishing speed values (outside of the range 1.0–6.0 knots) were substituted with values estimated by median imputation. The longest duration trawls (those over 15 h) were replaced by values calculated from trawl distance and fishing speed if this value was less.

Fishing depth was calculated from the average of the recorded start and finish net depths where possible. Unusually shallow or deep fishing depth and bottom depth values were set to the average value for other trawls on the day, where possible, and otherwise trimmed to a minimum of 100 m and a maximum of 1000 m. For records where one or both of these values was not recorded, bottom depth was taken from the remaining value or from the seabed depth, if recorded. According to the trawl-path codes recorded by observers, about 23% of trawls were recorded as not being on the seabed at all times, most of the remainder being midwater or a combination of midwater and bottom trawling. Most trawls (71%) followed a straight path or a constant depth contour; while nearly a quarter of trawls (24%) incorporated a U-turn or zigzag in the trawl path.

Losses of fish from the net can occur through a mixture of burst codends, burst windows/escape panels, and rips in the belly of the net. Observers estimate the amounts "total greenweight on surface" and "total greenweight on board", and these sometimes differ if fish were lost from the net, either at or below the surface, but also simply because the observer may have revised their estimate of the total catch once the net was aboard. Valid differences between these values were interpreted here as lost fish and included as part of the discards from the trawl, with corrections made for any obvious recording errors. For example, where the recorded value for "total greenweight on board" was greater than "total greenweight on surface" the weight of fish lost was set to zero unless it was clearly due to a transposition of the two values. These and any other differences in the two recorded values were interpreted as valid fish losses only if they were accompanied by an appropriate code identifying the cause of the loss. Observed cases of lost fish were rare in this fishery and occurred in about 1% of observed tows and accounted for about 3% of the estimated amount of fish brought to the surface. The criteria used to identify erroneous records across a range of fields, and their frequency in the observer data, are given in Table 1.

Table 1: Criteria used to identify likely errors in the observer data, and the number of records that met those criteria for trawls that targeted hoki, hake, ling, silver warehou, or white warehou for the 1990–91 to 2016–17 fishing years. Missing or outlying values were replaced by values estimated from within the dataset and retained in the analyses.

Field (range)	Number of records	
	Initial	Final
All rows	83 855	82 986
Missing/outlying start longitude (< 160° E or < 170° W)	11	0
Missing/outlying end longitude (< 160° E or < 170° W)	40	2
Missing/outlying start latitude (<35° S or >55° S)	26	14
Missing/outlying end latitude (<35° S or >55° S)	55	17
Calculated distance missing or > 100 km	149	34
Missing/outlying gear depths (<100 m or > 1000 m)	7 882	7 778
Missing/outlying bottom depth (<100 m or > 1000 m)	3 566	3 454
Missing/outlying fishing duration (>15 h)	325	39
Missing/outlying fishing speed (<1 or > 6 knots)	1 322	0
Fish lost at subsurface missing	552	315
Fish lost at surface missing	564	322

Observer data were available from 166 trawl vessels, ranging in length from 15 to 105 m. Information about the presence of a meal plant on each vessel was also extracted from the *cod* database. No fishing vessel or fishing company was identified in this report.

The weight of each species retained and discarded in each "processing group" was obtained from the observer databases. A processing group is a group of one or more tows for which data about the level of discards and processed catch is available. Usually this represents a single trawl, but because it is not always possible to keep track of the catch from individual trawls once they enter the factory or the processing area of the vessel, processing data from two or more trawls sometimes must be combined into a single processing group. To be able to use the discard information from processing groups comprising more than one tow, species discard weights in these groups were distributed among the composite tows in proportion to the recorded total catch for the relevant tows. Checks were made for records where the redistribution of discards, (and any overall differences in recorded catch and discard amounts), resulted in discard weights that exceeded catch weights; where they did, the discard value was set to be equal to the catch.

Using the dataset described above, the weights of species caught and (for the first four categories) discarded in each tow were calculated for the following species categories.

- Target species (discards only): Hoki, hake, and ling (although silver warehou and white warehou were used to define the target fishery, they are excluded from this definition for consistency with previous analyses).
- QMS: All QMS species combined (fish and invertebrate), excluding hoki, hake, and ling. The composition of this category expanded over time as species were added to the QMS (Table B 1); observers recorded 76 non-target QMS species in this fishery.
- Non-QMS fish: All non QMS fish species combined. The composition of this category contracted over time as species were added to the QMS (Table B 1); observers recorded 442 species which were non-QMS fish species at some time during the study period.
- Non-QMS invertebrate: All non-QMS invertebrate species combined. The composition of this category contracted over time as species were added to the QMS (Table B 1); observers recorded 366 non-QMS invertebrate species or species groups in this fishery.
- Schedule 6 species. QMS species which can be returned to the sea under certain circumstances; RSK, SCH, SPO, SSK, BWS, MAK, POS, SPD, KIN, PTO, STN, SWO (see relevant sections of the Fisheries Act 1996 for more details).
- Slickheads (Family Alepocephalidae); BAT, BSL, REU, RGN, RTT, SBI, SLK, SSM, TAL

- Morid cods (Family Moridae); BRC, DCO, GGC, GGL, GNO, GRC, GRG, HJO, LAE, LEG, LEV, LPI, LPS, MOD, PCO, PLU, PTH, RCO, RIB, ROC, SBR, SMC, VCO
- Rattails (all species, Family Macrouridae); BAC, BJA, CAS, CBA, CBI, CBO, CCO, CCR, CCX, CDX, CEX, CFA, CFE, CFX, CGX, CHY, CIN, CIX, CJX, CKA, CKE, CKX, CLE, CMA, CMI, CMU, CMX, COL, COM, CPI, CRD, CSE, CSL, CSP, CSU, CTH, CTR, CVY, CXH, GAO, GRV, HAN, HYM, JAV, MCA, MHO, MLA, MRC, NBU, NES, NNA, NPU, NZC, NZK, OMU, PIN, RAT, SQM, TRX, TVI, VNI, WGR, WHR, WHX
- Sharks (Chondrichthyes); all sharks, dogfishes, skates, rays, chimaeras (comprises 97 species codes).
- Individual species/species complexes that comprised the main observed bycatch species, i.e., BAR, BOE, BYX, GIZ, GSH, GSP, JAV, JMA, LDO, ORH, RCO, RIB, RSO, SBW, SND, SPD, SPE, SQU

The above abbreviations and group names (QMS, non-QMS fish, non-QMS invertebrates) are used throughout the remainder of this report along with standard Fisheries New Zealand species codes (see Table A1 or http://marlin.niwa.co.nz to match codes to species scientific and common names). Bycatch was estimated for all species/species group codes but discards were only estimated for Target species, QMS, non-QMS fish, non-QMS invertebrate, and all species combined.

Summaries of the observed catch and percentage discarded of individual species, broad taxa, and species categories are tabulated in Table A1 to A3.

2.2 Commercial fishing return data

Catch-effort, daily processed, and landed data were obtained from the Fisheries New Zealand catch-effort database "warehou" as extract 11384. The data consisted of all fishing and landing events associated with a set of fishing trips that reported any positive catch or landing of hoki, hake, ling (HOK, HAK, LIN) between 1 October 1990 and 30 September 2017 (the extract was processed before the addition of silver warehou and white warehou to the target fishery definition, but is expected to cover most if not all tows that targeted these species). This included all fishing recorded on Trawl Catch, Effort and Processing Returns (TCEPRs); Trawl Catch Effort returns (TCERs); Catch, Effort and Landing Returns (CELRs) and included high seas versions of these forms (HS-TCEPRs and or HS-CELRs). Data were groomed for errors using checking and imputation algorithms developed in R (R Core Team 2018). Tow positions, trawl length and duration, fishing speed, and depths were all groomed, primarily employing median imputation and range checks to identify and deal with missing or unlikely values and outliers, in a similar procedure to that used for observer data. Table 2 summarises the data trimming and Table 3 the data grooming of these records prior to analyses.

All records were assigned to the area defined in Figure 1 using the recorded position coordinates or General Statistical Areas.

Table 2: Details of record removal during the grooming process of commercial catch-effort data. "Records" is the number of unique records retained at each step; "Trips" is the number of unique trips in the data set; and "Catch" is the total greenweight of all species that remained in the effort dataset after each step in the grooming process. The last two rows summarise the data used in the analyses described in this report. HHL hoki, hake, ling.

Step	Description	Records	Trips	Effort Catch
1	Original extract	2 253 838	264 003	10 760 906
2	Trawl (MW and BT)* only	1 919 718	171 700	10 373 019
3	Target HHL + SWA + WWA only	615 634	35 210	5 707 271
4	Fishing years 1991–2017 only	598 455	34 385	5 474 737
5	Fishing years 2003–2017 only	243 044	15 522	2 405 986

* See below for details of other trawl methods used

Table 3: Criteria used to identify likely errors in the commercial effort data for the 1990–91 to 2016–17 fishing years, by form type. –, no data.

Field (range)	Initial dataset			Final dataset		
	CEL	TCE	TCP	CEL	TCE	TCP
All rows	14 179	16 351	563 713	795	16 346	563 130
Missing/outlying start longitude (< 160° E or < 170° W)	13 384	1	449	–	–	–
Missing/outlying end longitude (< 160° E or < 170° W)	14 179	16 351	437	795	16 346	55
Missing/outlying start latitude (<35° S or >55° S)	13 389	84	633	5	84	216
Missing/outlying end latitude (<35° S or >55° S)	14 179	16 351	628	795	16 346	259
Calculated distance missing or > 100 km	14 179	16 351	637	795	16 346	175
Missing/outlying gear depths (<100 m or > 1000 m)	14 179	122	2 963	795	386	1 388
Missing/outlying bottom depth (<100 m or > 1000 m)	14 179	163	4 909	795	387	1 925
Missing/outlying fishing duration (>15 h)	470	10	2 259	40	9	2 194
Missing/outlying fishing speed (<1 or > 6 knots)	14 179	13	528	795	105	130

These commercial catch data were used to directly estimate the total annual non-target catch in the fishery, as both the total catch and target species catch (unless it is outside of the top five or eight species by weight and therefore generally small) are recorded for each tow or group of tows. These estimates were provided here for comparison with the observer-based estimates and in contrast to the observer-based estimates, no scaling is required. However, a study of the New Zealand ling longline fishery, comparing commercial catch reports between observed and unobserved vessels, casts some doubt on the use of this approach. This study indicated that under-reporting and non-reporting of bycatch species was common, in that fishery at least. For example, they found that only a quarter of the catch of the main bycatch species (spiny dogfish) was reported between 2001 and 2004 (Burns & Kerr 2008). This method also has the limitation that because only the top five or eight species by weight were recorded, it is not possible to properly estimate the bycatch of individual species or species groups.

In addition to the estimated catch data recorded by vessels, the disposal of all catch is recorded on Catch Landing Returns (CLRs). Codes used on this form under *destination_type* which may provide information on discarding include the following:

A   Accidental loss
D   Discarded (non-QMS)
M   QMS species returned to sea (those in Part 6A of the Fisheries (Reporting) Regulations 2001, currently only spiny dogfish)
X   QMS species returned to sea (those listed in Schedule 6 of the Fisheries Act (1996) but excluding those in Part 6A of the Fisheries (Reporting) Regulations 2001 (spiny dogfish).

Although these returns are designed to capture information on the disposal of all catch recorded in catch/effort forms, in reality there has probably been more of a focus on fish physically landed onshore, with discarded bycatch not fully recorded. In addition, these returns relate to the catch from several days or from whole trips rather than from individual tows, and so they may relate to more than one target fishery. For these reasons, no specific analysis of these records was undertaken.

An innovative approach to trawl fishing, termed precision seafood harvest (PSH) using modular harvesting system (MHS) technology, is being increasingly used in this fishery to more precisely target specific species and fish sizes. This technology has the potential to substantially reduce bycatch, and therefore discards, of unwanted fish and in future will need to be accounted for in the estimation models. Currently the use of MHS technology is minor and not addressed specifically in the models used here but reporting codes are established for the method and a summary of its usage is provided. The number of MHS trawls in the target trawl fishery increased from 53 to 786 in the five years since records began, representing 160 t of combined target species catch in 2012–13 and 3980 t in 2016–17 (Table 4). The focus on smaller catches when using

MHS is evident in the comparison of its percentage of total tows (maximum of 5.9%) compared with its percentage of total catch (maximum of 2.7%). Over 98% of the reported MHS tows recorded hoki as the target species.

Table 4: The use of modular harvesting system (MHS)technology in the trawl fishery targeting hoki, hake, ling, silver warehou, and white warehou.

Fishing year	Effort (n.tows)			Catch (t)		
	All methods	MHS	(%)	All methods	MHS	(%)
2012–13	14 354	53	0.4	142 042	160	0.1
2013–14	15 833	126	0.8	154 923	663	0.4
2014–15	16 348	447	2.7	170 753	2 291	1.3
2015–16	14 955	880	5.9	146 362	3 904	2.7
2016–17	15 380	786	5.1	150 782	3 980	2.6

2.3 Stratification

Area as a predictor variable has proven to be an important driver of bycatch and discard rates in all offshore fisheries examined, and it is becoming increasingly useful for these analyses to also provide breakdowns for standardised fishery areas. We therefore selected fishing year and area as the primary strata for analyses, with additional variables included as appropriate. The set of standard areas used in the 2017 Aquatic Environment and Biodiversity Annual Review (Ministry for Primary Industries 2017) were adopted for this study (Figure 1). Given that the sub-Antarctic hoki fishery straddles some of the standard area boundaries, specifically STEW, SUBA and AUCK, data from these areas were aggregated to estimate a single coefficient for these areas combined. This coefficient was then applied to the commercial effort within each area to allow bycatch and discards to be predicted according to the standard area specifications.
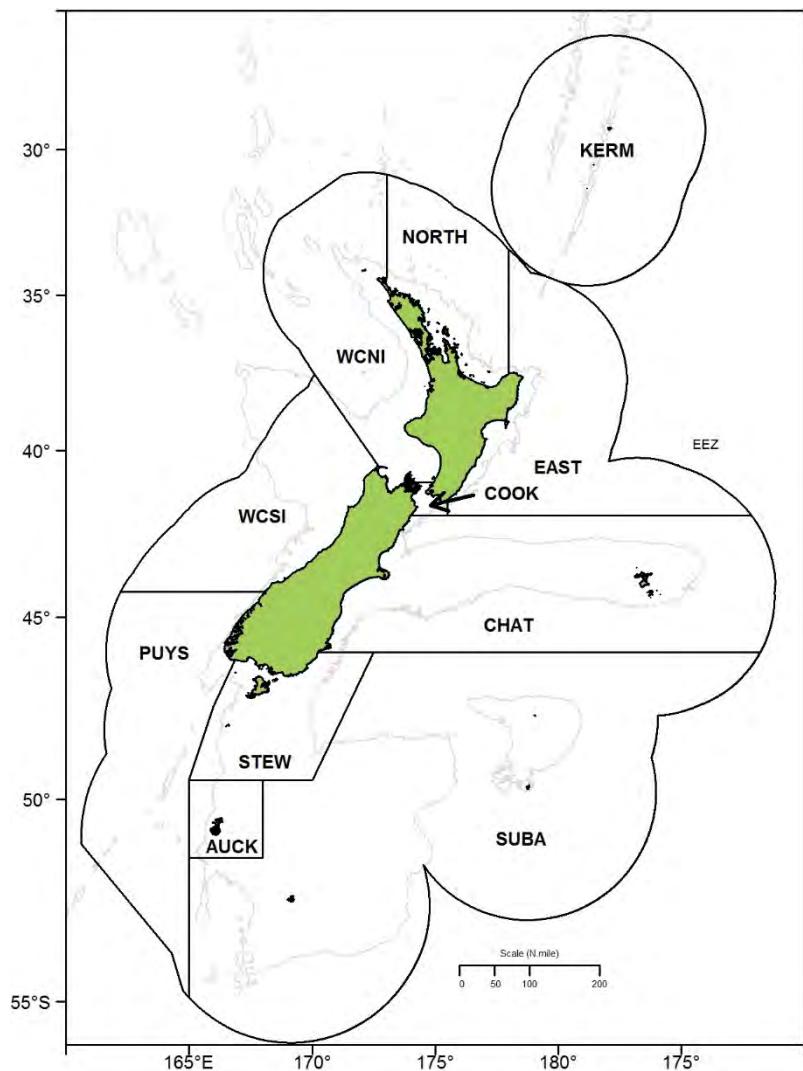
Figure 1: Areas used for estimation of total non-protected fish and invertebrate bycatch in offshore fisheries: KERM, Kermadec region; NORTH, Northern North Island; WCNI, West coast North Island; East, East coast North Island; COOK, Cook Strait; WCSI, West coast South Island; CHAT, Chatham Rise; PUYS, Puysegur; STEW, Stewart-Snares shelf; AUCK, Auckland Islands; SUBA, sub-Antarctic. The grey lines indicate the 1000 m isobath.

From empirical explorations of the data, it was clear that net type (mid-water versus bottom trawl) was an important determinant of bycatch and discards, and vessel class was important for discards, and consideration of this was specifically requested by Fisheries New Zealand managers. Vessels were divided into three classes: large "Soviet-class" trawlers of any flag state or ownership (BATM); other foreign owned vessels (FOVs); and domestic vessels. Importantly, any vessels that were reflagged to New Zealand were retained in the FOV category. With the recent changes to legislation requiring all vessels to be flagged to New Zealand, the proportion of effort from vessels of this class (known from this and previous studies to produce substantially greater discards) has declined (Figure 2). These additional covariates (net-type and vessel class) were therefore included in the models.
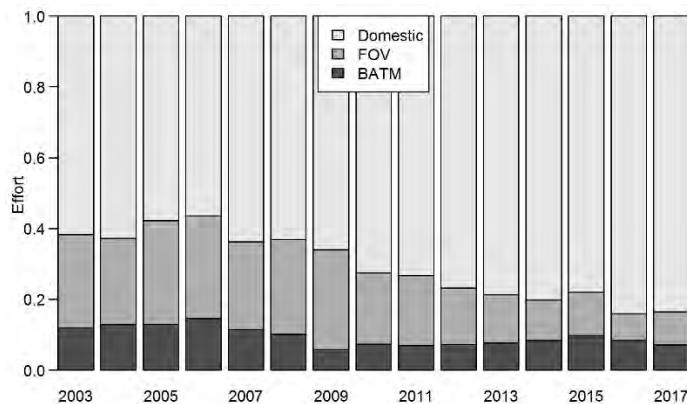
Figure 2. Annual proportion of effort by vessel class in the hoki, hake, ling, silver warehou, and white warehou trawl fishery. See text above for explanation of the legend codes; note that FOV includes any vessels reflagged to New Zealand during this period; BATM is a Russian acronym translating to Big Autonomous Trawler Reefer.

Each record in the observer and commercial effort datasets was assigned to an area (see Figure 1) as described above. The number of observed trawls in each area over the 27 years examined is shown in Table **5**.

Table 5: Number of observed trawls (bottom trawl/midwater trawl for WCSI) that targeted hoki, hake, ling, silver warehou, or white warehou by area (see Figure 1 for area boundaries) and fishing year.

Fishing year	CHAT	COOK	EAST	NORTH	PUYS	AUCK	STEW	SUBA	WCNI	WCSI (BT/MW)	Total
1990–91	861	0	0	0	110	2	375	100	0	1 255 (161/1 094)	2 703
1991–92	490	0	0	0	208	4	618	244	0	857 (83/774)	2 421
1992–93	263	14	0	0	132	31	640	49	0	1 416 (384/1 032)	2 545
1993–94	908	37	1	0	57	8	361	8	0	1 629 (165/1 464)	3 009
1994–95	506	0	0	0	21	3	199	21	0	841 (54/787)	1 591
1995–96	749	40	0	5	64	9	214	6	0	1 054 (153/901)	2 141
1996–97	425	0	0	6	32	0	99	0	0	694 (1/693)	1 256
1997–98	1 655	203	47	8	0	7	312	10	0	906 (127/779)	3 148
1998–99	1 317	294	2	0	29	10	568	191	0	1 111 (359/752)	3 522
1999–2000	784	163	2	0	52	53	750	353	4	1 162 (259/903)	3 323
2000–01	1 332	263	1	0	118	38	479	209	0	1 097 (169/928)	3 537
2001–02	975	143	1	0	93	8	561	317	1	1 333 (632/701)	3 432
2002–03	905	133	9	0	66	42	461	126	0	952 (399/553)	2 694
2003–04	602	128	0	0	67	17	174	114	0	1 382 (421/961)	2 484
2004–05	813	139	1	0	67	2	176	14	1	1 092 (264/828)	2 305
2005–06	770	65	0	1	53	5	398	2	0	1 153 (509/644)	2 447
2006–07	887	224	7	0	47	3	463	13	6	677 (147/530)	2 327
2007–08	872	200	0	0	12	61	544	136	0	795 (409/386)	2 620
2008–09	733	168	0	0	42	48	571	128	1	712 (126/586)	2 403
2009–10	746	356	3	3	59	6	810	18	1	799 (437/362)	2 801
2010–11	881	89	1	4	40	36	532	59	0	680 (352/328)	2 322
2011–12	1 030	192	2	0	88	11	605	39	6	1 061 (432/629)	3 034
2012–13	1 733	198	0	0	129	28	1 350	127	1	2 250 (856/1 394)	5 816
2013–14	1 304	229	21	29	61	44	1 162	189	0	2 244 (773/1 471)	5 283
2014–15	765	404	51	81	83	31	904	61	0	2 614 (895/1 719)	4 994
2015–16	1 224	157	1	23	106	29	609	21	3	2 128 (652/1 476)	4 301
2016–17	1 120	125	29	42	67	35	543	76	5	1 903 (1 035/868)	3 945

2.4 Calculation of bycatch and discards

2.4.1 Statistical model structure

The bycatch and discards data recorded by observers typically followed a semi-continuous distribution, with a high proportion of zeros and a positive skewed continuous distribution of non-zero catches. The model therefore consisted of a two-part, binomial/log-normal statistical structure, fitted to tow-by-tow observer sampling data X_i (in kilograms) using a Bayesian estimation framework. Estimated parameters were then used to predict the catch for unobserved commercial fishing effort.

Fishing effort consists of observed and unobserved components, which are given the notation o and r, the latter being referred to as the residual effort. The total effort for strata j is therefore:

$$n_j \approx o_j + r_j$$

with the approximation necessary because of occasional double counts.

The observed zero/non-zero data were fitted using a Binomial likelihood. To increase the speed of computation, the proportion of positive catches θ was estimated using the summed count data. For example, for strata j:

$$Y_j = \sum_{i=1}^{o_j} I(X_{ij} > 0) \sim B(o_j, \theta_j)$$

where $I(.)$ is an indicator function equal to one if the condition inside the parentheses is met.

The positive catch data were included on a tow-by-tow basis, which is necessary for estimation of the standard error term σ. For observer record i, we therefore have:

$$X_{ij}|X_{ij} > 0 \sim LN(\mu_j, \sigma^2)$$

The two-model parts were considered to be independent, giving the full likelihood per stratum as:

$$L(\theta_j, \mu_j, \sigma) = \prod_{i=1}^{o_j} \{(1 - \theta_j).I(X_{ij} = 0) + \theta_j.f_{LN}(X_{ij}|X_{ij} > 0, \mu_j, \sigma)\}$$

where f_{LN} is the pdf of a log-normal distribution evaluated at X_{ij} and θ is the pmf of a Bernoulli distribution evaluated at one.
Both θ and μ were predicted using shared covariates:

$$logit(\theta_j) = \gamma_0 + x_j^{'}.\boldsymbol{\gamma}$$

$$ln(\mu_j) = \beta_0 + x_j^{'}.\boldsymbol{\beta}$$

where $x_j^{'}$ in this case represents a row from the design matrix. Parameterisation of the model therefore involved estimation of the intercept terms β_0 and γ_0, and coefficient vectors $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$. For the current analysis, covariates considered were: fishing year, standard area, fishing method and vessel category. For the log-normal model part, a year/area interaction was included as a random effect. Furthermore, a standard error per year was estimated to account for changes in quality of the data over time, giving it a hierarchical structure. When modelling species groups, the year/area interaction was necessary to account for changing composition of the group being modelled (because the area effect may change over time if the species composition changes). However, for the single species or unchanging grouped data (e.g. sharks, rattails), whether there were sufficient data to estimate the interaction term was assessed separately for each model application: if the model failed to converge the interaction term was omitted for the final model run.

Following fits of the model it was then necessary to generate the predicted catch from the residual (unobserved) commercial fishing effort. Because observed and un-observed effort cannot be matched, the residual effort was calculated on an aggregated scale by model strata (e.g. the sum of the unobserved effort for a particular year/area combination):

$$r_j = max(n_j - o_j, 0)$$

At this aggregated scale, we then simulated values for:

$$Z_j = \sum_{i=1}^{r_j} X_{ij}$$

which is the summed catch across unobserved effort for a given strata. Simulated values are given the tilde notation $\tilde{Z}_j$. The observed catches X_{ij} were treated as known, giving the total predicted catch per strata as:

$$\tilde{Z}_j + \sum_{i=1}^{o_j} X_{ij}$$

The $\tilde{Z}_j$ were generated through posterior predictive simulation, which involves sampling parameter values from their posterior distributions and using them to generate random observations from either the binomial or log-normal model components. Specifically, for posterior samples $\{\theta_{j(p)}, \mu_{j(p)}, \sigma_{(p)}\}$, we simulated the number of positive tows from the Binomial distribution:

$$\tilde{Y}_{j(p)} \sim B(r_{j(p)}, \theta_{j(p)})$$

and then:

$$\tilde{Z}_{j(p)} = \sum_{i=1}^{\tilde{Y}_j} \tilde{X}_{ij(p)} \text{ with } \tilde{X}_{ij(p)} \sim LN(\mu_{j(p)}, \sigma_{(p)}^2)$$

from the log-normal distribution. The total catch for a particular posterior draw is therefore:

$$\sum_{i=1}^{\tilde{Y}_j} \tilde{X}_{ij(p)} + \sum_{i=1}^{o_j} X_{ij}$$

the distribution of which across samples yielding a posterior distribution of the predicted catch.

Performance of the model was diagnosed first by assessing convergence of the estimation routine. This was done through visual inspection of the MCMC trace outputs. Second, prediction by the fitted model (i.e. its suitability for estimation of unobserved bycatch or discards) was assessed through a comparison of the median posterior expected values and simulated predictions with the observer records. This was done for both the binomial and log-normal model parts. For the binomial model, the expected value for a particular posterior draw is:

$$E[Y_{j(p)}] = o_j . \theta_{j(p)}$$

and for the lognormal model part:

$$E[Z_{j(p)}] = \theta_{j(p)} . \exp(\mu_{j(p)} + \log(o_j) + \sigma_{(p)}^2/2)$$

Bayesian estimation was performed in the R-package **rstan** (Stan Development Team, 2016). Coefficients were given standard normal prior densities:

$$\{\boldsymbol{\gamma}, \boldsymbol{\beta}\} \sim N(0, 1)$$

with the exception of the year/area interaction which was treated as a random effect and therefore had an estimated standard error τ. The intercept terms were given augmented priors, meaning that their priors were centred on maximum likelihood values estimated analytically from the data (Sullivan & Greenland 2013):

$$\gamma_0 \sim N(\hat{\gamma}_0, 1)$$
$$\beta_0 \sim N(\hat{\beta}_0, 1)$$

This was important for model convergence, particularly for the model runs with small quantities of data, since strata with no data will assume the intercept model value.

Error terms were given standard half-normal (truncated at zero) distributions:

$$\{\boldsymbol{\sigma}, \tau\} \sim N_+(0,1)$$

All model runs were initialised with parameters at their maximum penalised likelihood values, and consisted of at least two MCMC chains of 1500 samples each, with the first 500 discarded. Chains were checked visually for convergence, and estimated values were obtained as the posterior median with uncertainty reported as the 95% credibility interval.

2.5 Analysis of temporal trends in bycatch and discards

Annual estimates of bycatch and discards in each species category and overall (with confidence intervals) were plotted for the time-series examined. In addition, annual bycatch of the main individual QMS and non-QMS species (see Section 2.1.1) were also estimated.

Locally weighted regression lines were calculated and shown on plots for the main categories to highlight overall patterns of change over time. In addition, to provide an indication as to the long-term trend in annual amounts, linear regressions (with lognormal errors) were also produced. The direction and steepness of the slopes of these lines were determined and the significance of the difference of these slopes from a slope of zero (indicating no trend) was tested.

2.6 Including spatial correlation in bycatch estimation

We extended the basic model by including spatially correlated random effects. Remembering that θ is the binomial probability of a positive tow, and μ is the conditional catch rate for positive tows, then we first specify the subscripts j, to represent the year and other non-spatial covariates, and k to represent the spatial effects. The model is:

$$\text{logit}(\theta_{jk}) = \gamma_0 + \boldsymbol{x}_{j\cdot}' \cdot \boldsymbol{\gamma} + \phi_k^{[\theta]}$$

$$\ln(\mu_{jk}) = \beta_0 + \boldsymbol{x}_{j\cdot}' \cdot \boldsymbol{\beta} + \phi_k^{[\mu]}$$

where

$$\{\boldsymbol{\phi}^{[\theta]}, \boldsymbol{\phi}^{[\mu]}\} \sim MVN(\mathbf{0}, \boldsymbol{\Sigma})$$

are spatial random effects represented by a Gaussian Markov random field: a multivariate normal prior distribution with a covariance matrix structured to allow spatially dependent correlation between the estimated coefficients. Intuitively, this spatial dependence allows information to be shared between neighbouring locations, which aligns with our assumption that areas in close geographical proximity are likely to have similar biophysical properties and therefore similar catches. Because the current application is intended as a proof of concept only, we developed the model for a single standard area only, the Chatham Rise, and specified spatial location via a set of $1° \times 1°$ grids covering the whole area. Tows were allocated to a grid using the mid-point (or start if the end point was not available). Furthermore, we only assumed correlation for the lognormal model part, leaving the spatial grid coefficients for the binomial model as uncorrelated, with standard normal priors:

$$\boldsymbol{\phi}^{[\theta]} \sim MVN(\mathbf{0}, \mathbf{I})$$

Conditional autoregression (CAR) provides a way of specifying spatial correlation within the context of a Gaussian Markov random field (Besag et al. 1991), and using this approach we therefore write the prior for $\boldsymbol{\phi}^{[\mu]}$ as:

$$\boldsymbol{\phi}^{[\mu]} \sim MVN(\mathbf{0}, [\tau \cdot (\boldsymbol{D} - \rho \cdot \boldsymbol{W})]^{-1})$$

where τ is the precision parameter, **D** is a diagonal matrix specifying the number of neighbours per grid, **W** is the adjacency matrix and $|\rho| < 1$ is the spatial correlation parameter. Both τ and ρ were estimated, whereas **D** and **W** are input as covariate data. The adjacency matrix **W** was calculated using the **spdep** R package (Bivand & Piras 2015), whereas the diagonal of **D** is the sum of the rows in **W**. For estimation of τ and ρ we used Gamma and uniform hyper-priors respectively:

$$\tau \sim G(2,2)$$
$$\rho \sim U(0,1)$$

To evaluate performance of the model we calculated a discrepancy between observed and expected values for both model parts. We define the discrepancy as the sum of the residuals:

$$D^{[B]} = \sum Y_i - \hat{Y}_i$$
$$D^{[LN]} = \sum \log(X_i/\hat{X}_i)$$

with the summations taken over all data records. Comparisons were made between the current model (with a CAR prior) against the same model with no CAR prior, and also a model with no grid coefficient (i.e. assuming no area effect). In addition to the discrepancy, we compared the actual bycatch estimates produced by each model. We applied the models to the "total bycatch" species group, plus, in decreasing levels of bycatch: JAV, SPD, LDO, FRO, RCO, BAR. Estimation was performed using Bayesian MCMC as described previously.

3 RESULTS

3.1 Distribution and representativeness of observer data

There was a considerable amount of data collected over the 27-year period that observers have operated in this fishery; the nearly 83 000 observed tows (by 166 vessels) is considerably greater than that achieved in any other New Zealand fishery. The annual level of observer coverage in relation to overall effort in the fishery was variable but was better than 10% by catch weight in all but one year and has generally increased over time, from 10–15% before 2005–06, 20–30% until 2011–12, and over 30% thereafter. The requirement for 100% coverage on foreign owned vessels since 2012–13 also positively affected observer coverage in this fishery (Table 6). The fraction of trips observed each year is not presented in Table 6, as an observer 'trip' is not necessarily equivalent to a 'trip' as recorded by the commercial catch-effort system and short trips may be less likely to be observed.

The areas with the highest observer coverage included the west coast South Island (WCSI, both midwater and bottom trawls), the sub-Antarctic (SUBA), and Puysegur (PUYS); with lower coverage in the larger Chatham Rise (CHAT) fishery (Table 7). Coverage across the fleet was best in the sub-Antarctic and Puysegur fisheries, and was limited mainly to larger vessels, where less than 15% of trawling was by vessels not observed during the period. In the smaller fisheries (e.g. areas NORTH and WCNI) and midwater fishing on the WCSI, about a third of the trawling effort was by vessels not observed.

Table 6: Summary of effort and estimated catch (t) in the target trawl fisheries for hoki, hake, ling, silver warehou, and white warehou for observed tows and overall, by fishing year. Trips include those with any trawls that targeted any of the five target species. HHL = hoki, hake, ling.

Fishing year	Number of trawls		Number of vessels		Number of trips[*]		HHL catch		Percentage observed	
	Observed	All	Observed	All	Observed	All	Observed	All	Catch	Trawls
1990–91	2 703	21 710	24	105	25	825	38 251	214 078	17.9	12.5
1991–92	3 003	22 736	23	117	27	782	34 846	213 377	16.3	13.2
1992–93	2 545	23 919	22	105	34	754	28 173	197 388	14.3	10.6
1993–94	3 009	21 679	27	112	43	1 030	42 317	184 355	23.0	13.9
1994–95	1 591	27 453	17	114	20	1 014	30 950	208 372	14.9	5.8
1995–96	2 141	31 961	27	130	34	1 439	27 899	222 103	12.6	6.7
1996–97	1 256	35 214	22	139	25	1 515	18 306	238 686	7.7	3.6
1997–98	3 148	36 352	43	134	52	1 335	35 455	267 287	13.3	8.7
1998–99	3 522	32 124	40	113	49	1 016	37 781	247 641	15.3	11.0
1999–2000	3 323	32 601	37	87	44	1 016	34 683	250 505	13.8	10.2
2000–01	3 537	31 646	42	88	73	969	33 504	237 112	14.1	11.2
2001–02	3 432	28 218	36	84	49	802	31 304	210 666	14.9	12.2
2002–03	2 694	28 051	33	84	45	867	20 747	188 537	11.0	9.6
2003–04	2 484	22 984	32	76	38	809	19 020	139 284	13.7	10.8
2004–05	2 305	16 957	32	70	43	591	19 200	123 659	15.5	13.6
2005–06	2 447	14 684	28	69	40	637	23 312	119 741	19.5	16.7
2006–07	2 327	13 896	35	55	51	500	23 096	107 767	21.4	16.7
2007–08	2 620	13 889	31	81	53	835	24 798	101 431	24.4	18.9
2008–09	2 403	12 750	35	79	58	830	24 680	102 485	24.1	18.8
2009–10	2 801	12 934	35	86	62	970	30 298	113 755	26.6	21.7
2010–11	2 322	13 322	27	83	53	1 005	25 734	125 321	20.5	17.4
2011–12	3 034	13 677	32	86	68	988	37 977	136 996	27.7	22.2
2012–13	5 816	14 353	30	79	128	988	67 138	142 042	47.3	40.5
2013–14	5 283	15 833	32	78	124	1 070	62 292	154 923	40.2	33.4
2014–15	4 994	16 348	35	81	120	1 144	65 494	170 753	38.4	30.5
2015–16	4 301	14 955	31	87	99	1 164	49 858	146 362	34.1	28.8
2016–17	3 945	15 380	36	79	107	1 181	44 170	150 782	29.3	25.7
All years	82 986	585 626	166	390	1 487	25 702	931 282	4 715 406	19.7	14.2

* Note that an observed trip is not equivalent to a commercial trip

Table 7: Summary statistics for the hoki, hake, ling, silver warehou, and white warehou target trawl fishery, by area, including observer coverage and major data quality factors for fishing years 1990–91 to 2016–17 (e.g. number of tows with positional data). Data for midwater (MW) and bottom (BT) trawls are shown separately for WCSI due to the high level of midwater fishing in this area.

Area	Median vessel length (m)	Total effort Number of tows	Percent of tows observed	Percent of tows with position data	Percent of tows by vessels not observed
CHAT	64.5	211 426	11.7	99.9	24.6
WCSI (MW)	82.4	114 575	20.6	99.8	38.6
STEW	66.0	84 117	17.5	100.0	33.8
COOK	40.8	73 501	5.4	98.5	22.7
WCSI (BT)	64.0	52 151	19.7	99.6	19.3
PUYS	66.1	14 353	15.8	99.9	32.7
SUBA	66.0	14 275	18.5	100.0	12.5
EAST	37.0	10 217	1.8	99.1	27.5
NORTH	21.2	5 158	3.9	99.5	36.9
AUCK	66.0	4 869	11.7	100.0	13.9
WCNI	29.3	971	3.1	93.7	38.5

The spatial distribution of target trawl fishing effort between 1 October 1990 and 30 September 2017 is shown for all commercial tows and all observed tows in Figure 3a. Observer coverage was well spread across the main target species fisheries in WCSI, CHAT, STEW, AUCK, and SUBA, with little coverage of the smaller fisheries around the North Island. The spatial pattern of fishing effort and associated observer coverage was relatively constant over time, but when effort increased in the southern SUBA during the early 2000s this was well covered by observers (Figure 3b).
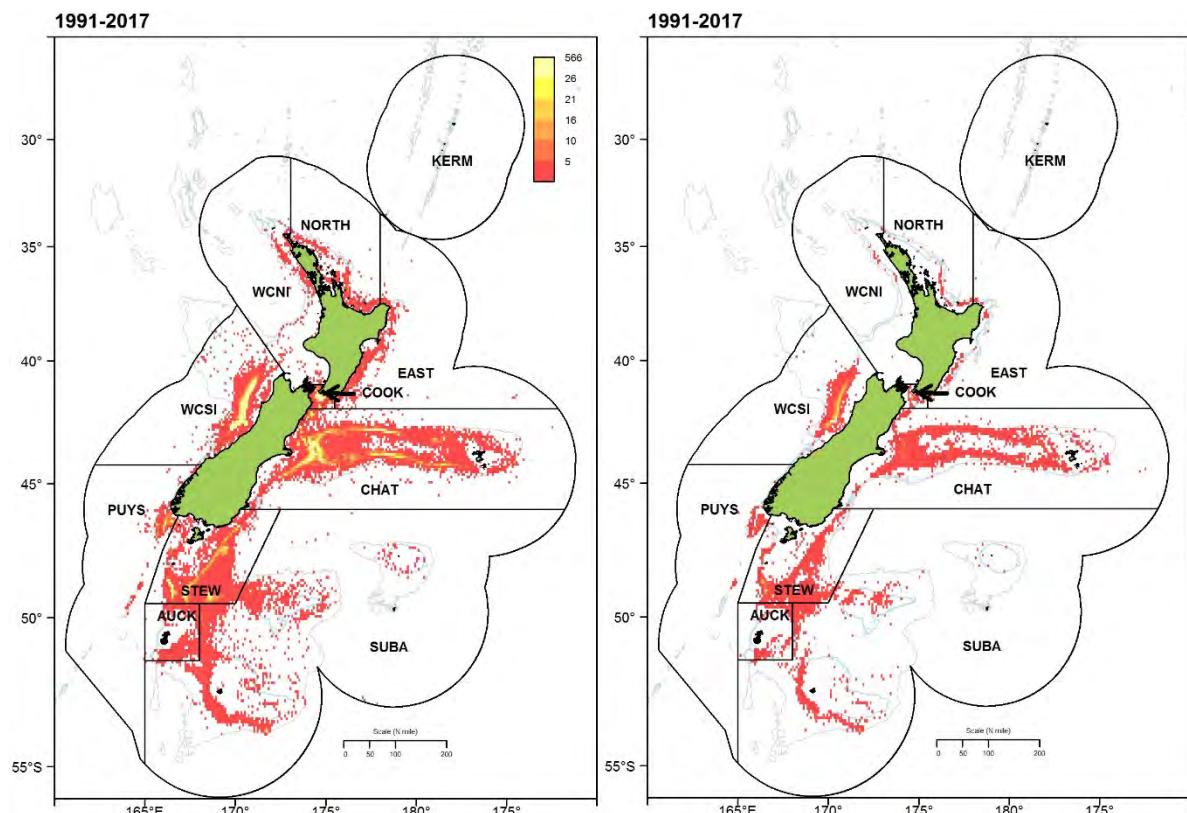
Figure 3a: Density plots showing the distribution of all commercial HOK, HAK, LIN, SWA, and WWA target tows with recorded position data (left) and all such tows recorded by observers (right), for fishing years 1990–91 to 2016–17. The legend indicates the average number of tows per year in each 0.1° cell; solid lines mark the boundary of the EEZ and areas used in the analyses; the pale blue and grey lines show the approximate 500 and 1000 m isobaths, respectively.
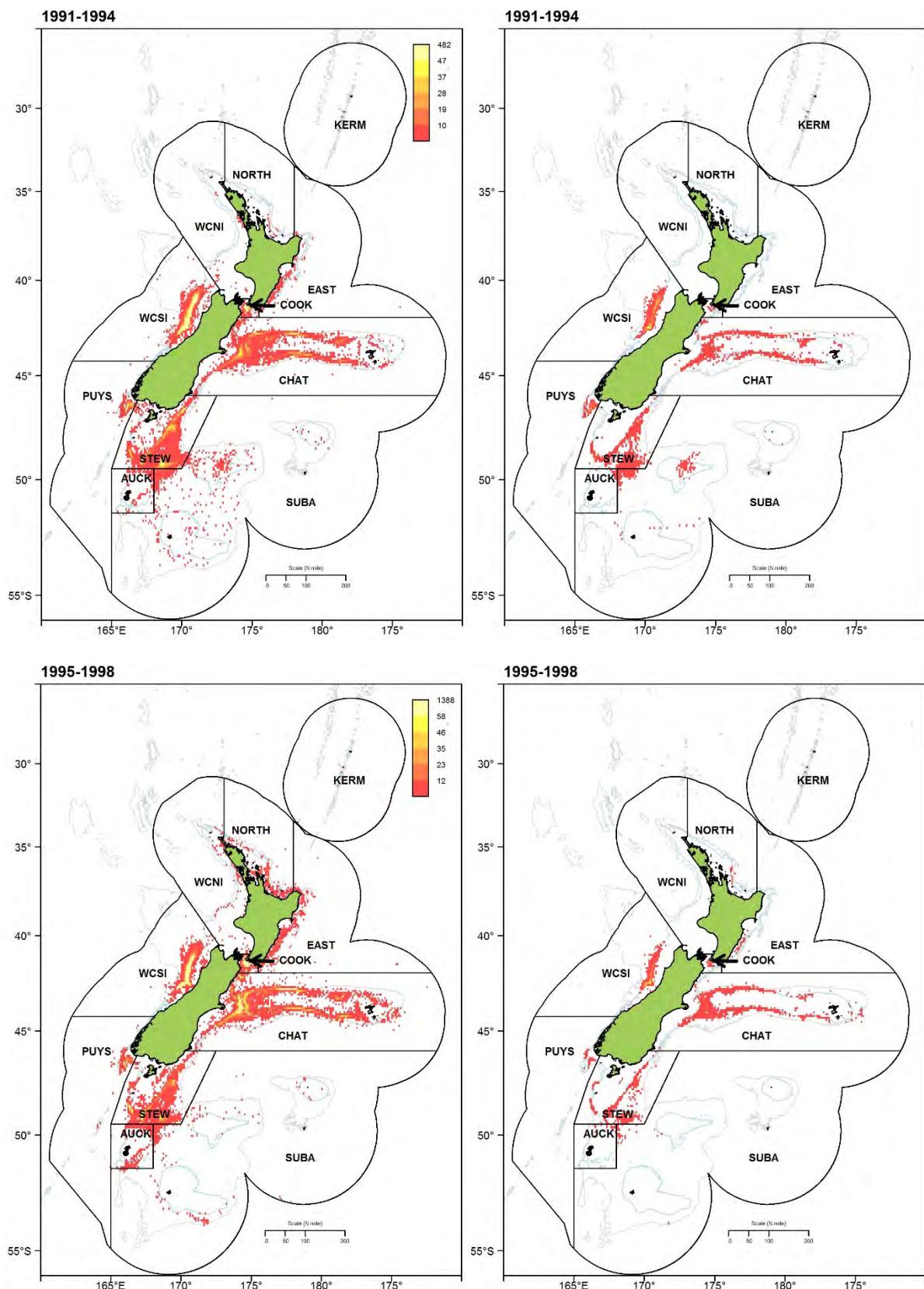
Figure 3b: Density plots showing the distribution of all commercial HOK, HAK, LIN, SWA, and WWA target tows with recorded position data (left) and all such tows recorded by observers (right), by blocks of years. The legend indicates the average number of tows per year in each 0.1° cell. See Figure 3a caption for more details.
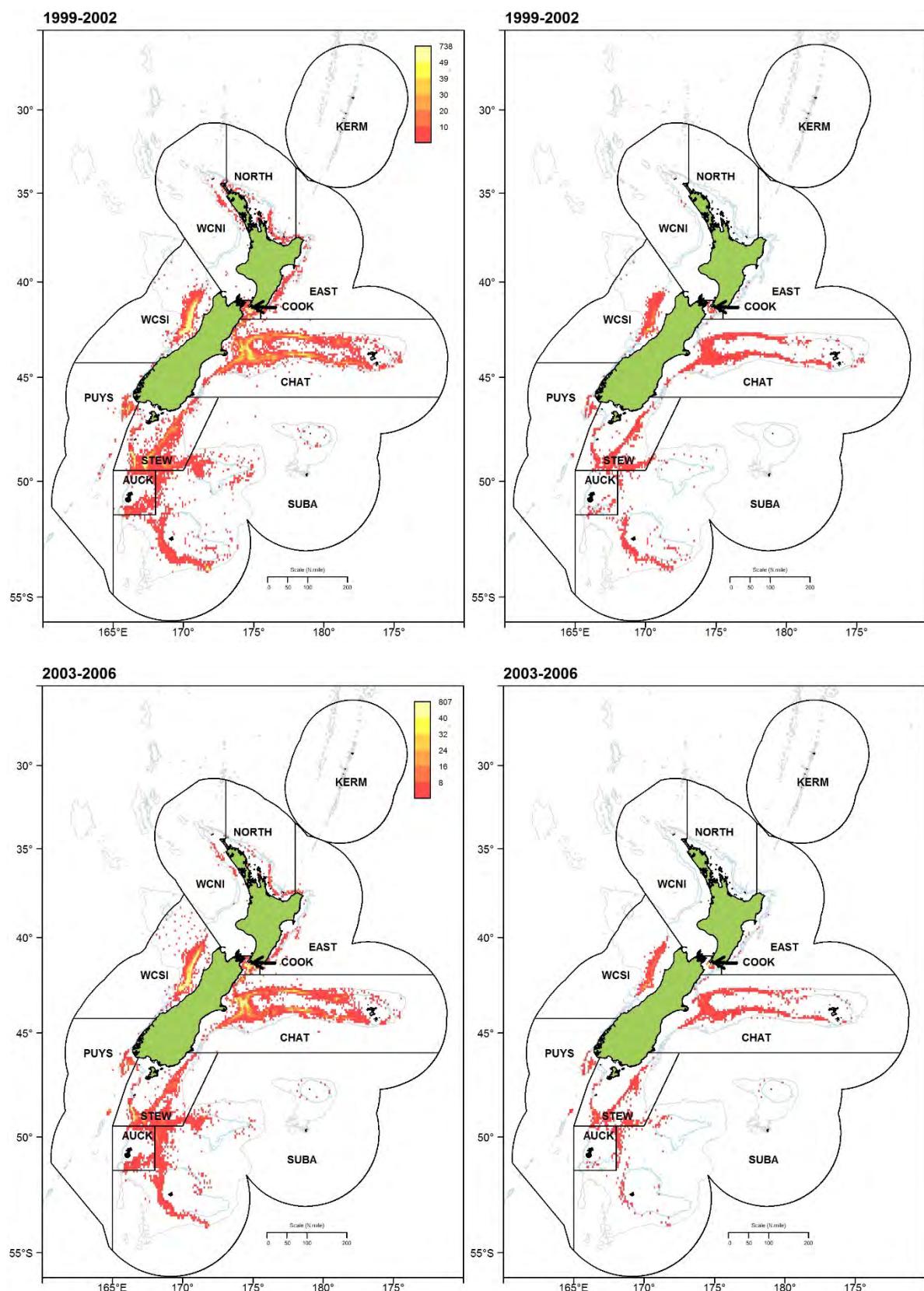
Figure 3b: continued.
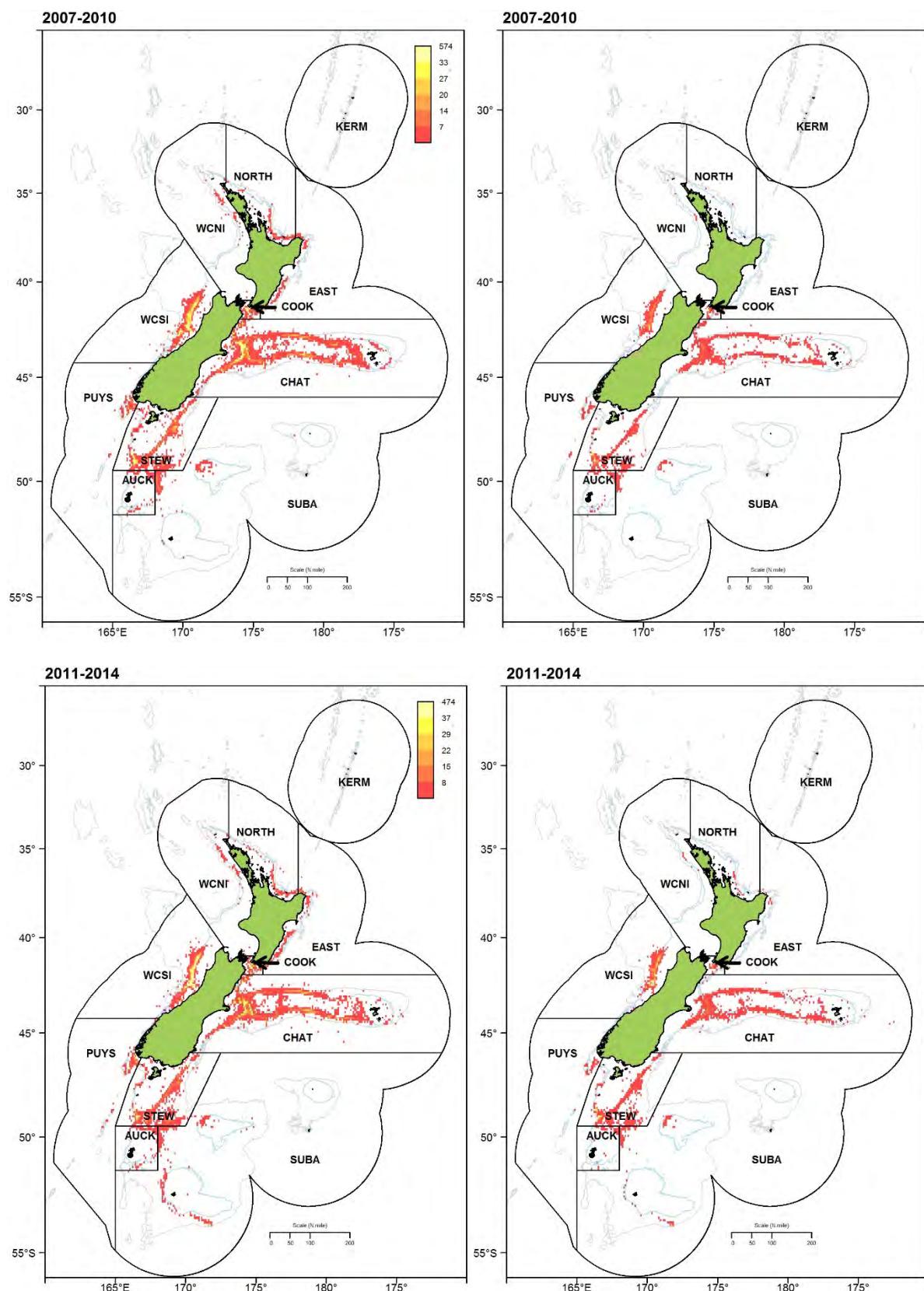
Figure 3b: continued.
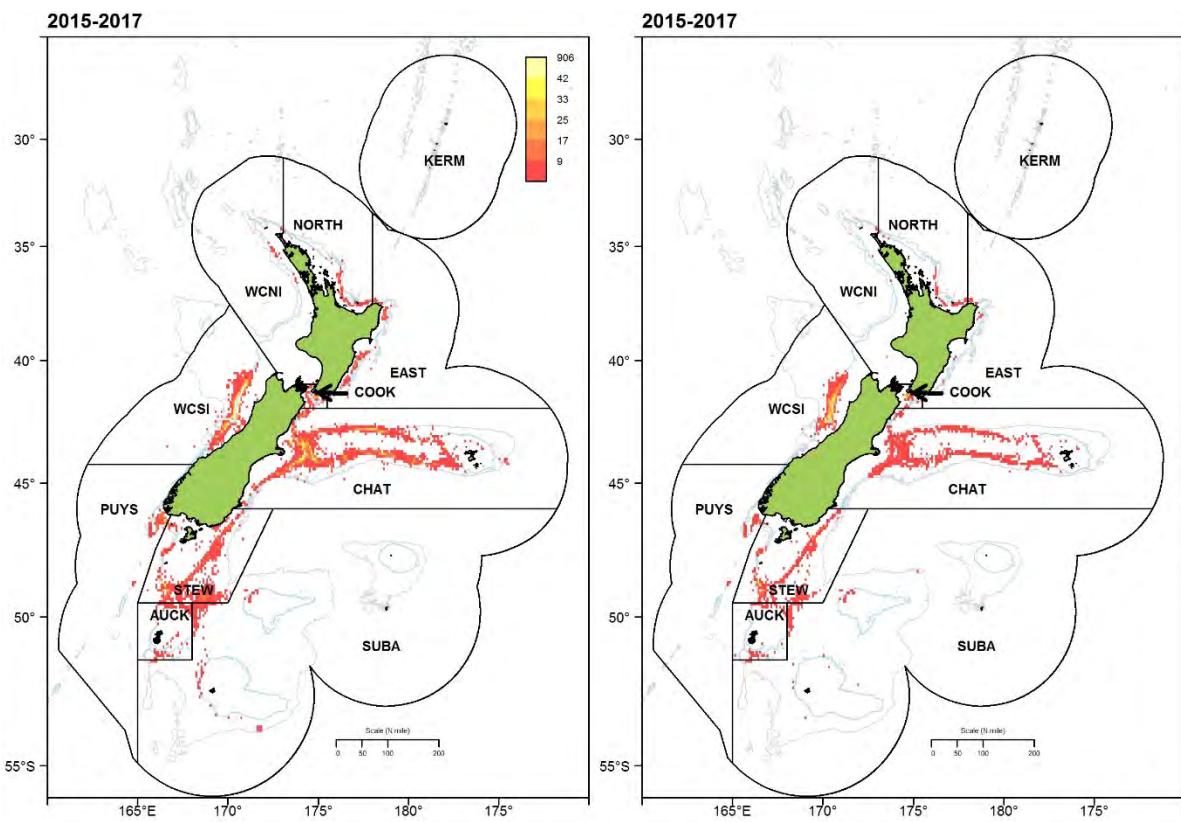
Figure 3b: continued.

To more objectively assess spatial observer coverage, a comparison of the latitude and longitude of observed tows with all commercial tows recorded with position data was produced using density plots (Figure 4).

These plots show that the spread of observed trawls over the longitudinal and latitudinal extent of the fishery was well matched for all years combined, although regions centred at about 171° E and 174° E (relating to the centre of effort in the WCSI and CHAT fisheries, respectively) were slightly over-represented by observer sampling in all periods.
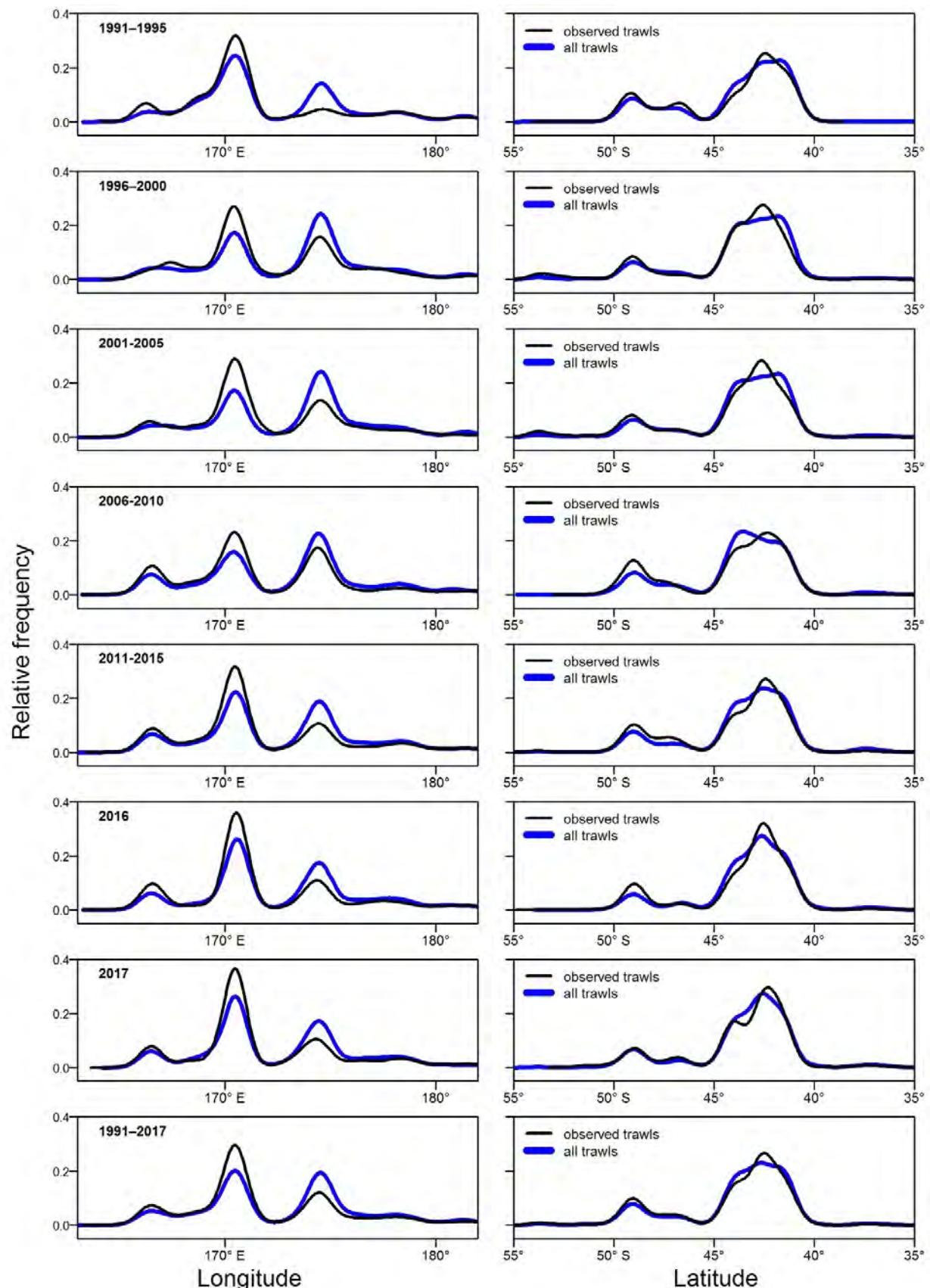
Figure 4: Comparison of start positions (latitude and longitude) of observed tows with those of all commercial tows in the HOK, HAK, LIN, SWA and WWA target trawl fishery, by blocks of fishing years from 1990–91 to 2014–15, for individual fishing years 2015–16 and 2016–17 and for all years combined, for fishing years 1990–91 to 2016–17. The relative frequency was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.

Comparisons made between vessel sizes in the commercial fleet and the observed portion (Figure 5) showed that, across all years, the full range of vessel sizes was well covered by observers in these fisheries. The 390 vessels operating in this fishery over the 27 years examined ranged in size from about 200 to 4500 t (GRT) and, although not strongly dominated by any size class there were peaks of effort for vessels of about 2000 t, 2500 t, and 4500 t in most years. The larger vessels were slightly over-represented by observers in most years, and overall, while only the smallest vessels were consistently under-represented. Vessel size is strongly linked to fishing area; the larger vessels were mainly associated with the larger or more distant fisheries (areas AUCK, CHAT, WCSI, SUBA, STEW) whereas the smaller fisheries around the North Island (including COOK) were fished mainly by smaller vessels (see Table 7). There are also operational rules and a code of practice for the hoki fishery that impact fleet fishing patterns including: foreign owned vessels (prior to 1 May 2016) and all vessels longer than 46 m may not fish anywhere inside the 12-mile Territorial Sea; in WCSI much of the hoki spawning area in the Hokitika Canyon and most of the area from there south to the Cook Canyon are closed to vessels over 46 m overall length; in Cook Strait, the spawning area is closed to vessels over 46 m overall length; and targeting restrictions apply to vessels over 28 m in several areas where small hoki are in high abundance (Ballara & O'Driscoll 2018).

The spread of observer effort throughout each fishing year was compared with the spread of total effort in the fishery by applying a density function to the numbers of trawls per day (Figure 6).

Although this fishery operates year-round, there is a significant seasonal component to it, with a strong peak of effort centred around the June–September spawning period of hoki on the west coast South Island, Cook Strait, and smaller grounds off the east coast South Island and Puysegur. Observer effort has tended to be more evenly spread, with coverage throughout the year in most years and only a modest increase in effort during the hoki spawning period. This means that the spawning period was relatively under-sampled and the off-season over-sampled in many years. There were a few years, mainly between 2010–11 and 2015–16, when observer effort was more closely matched to overall effort. This was most likely due to the generally higher coverage achieved in these years due to the requirement around foreign owned vessels.
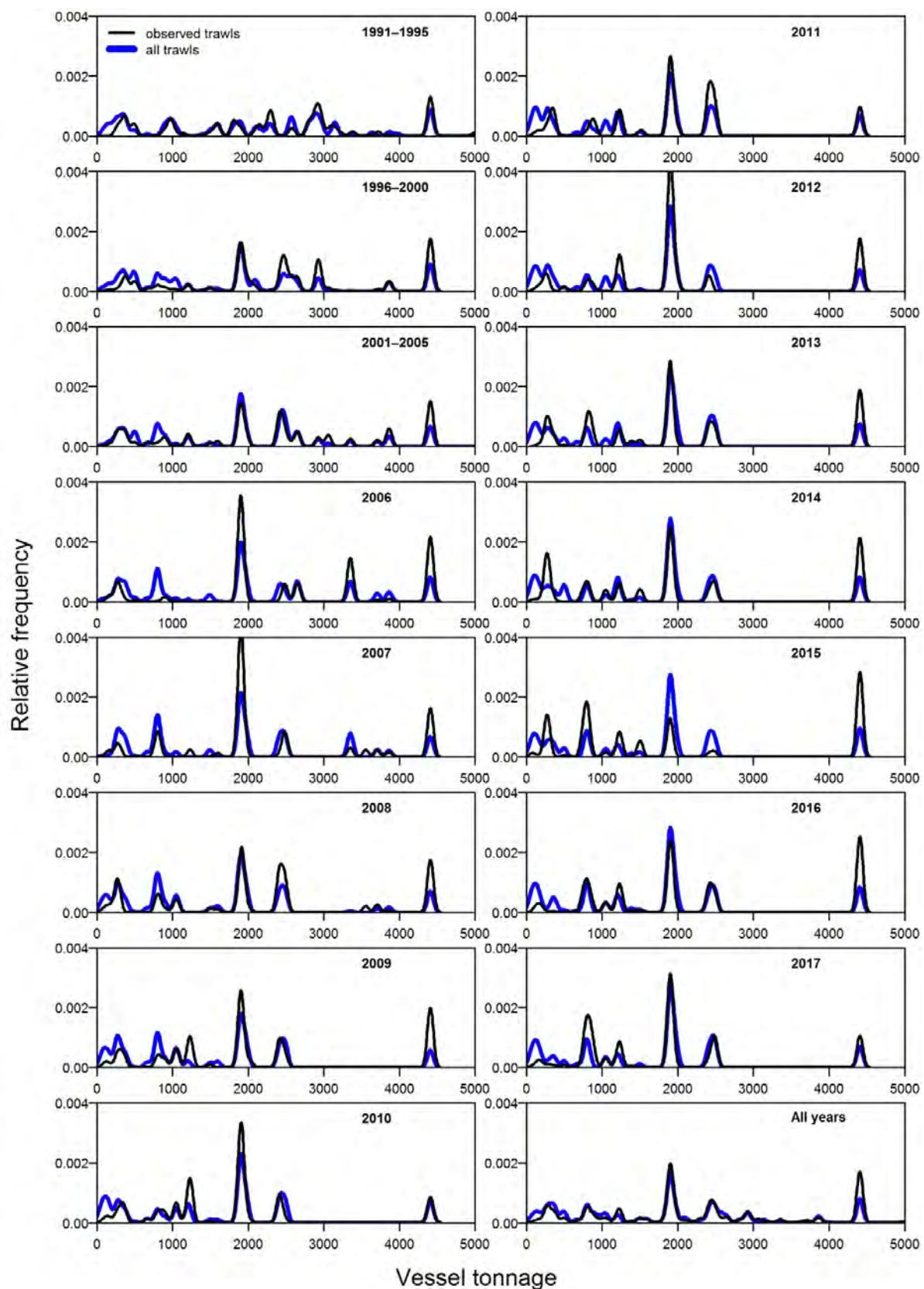
Figure 5: Comparison of vessel sizes (Gross Registered Tonnage) for observed tows vs all recorded commercial tows for fishing years from 2002–03 to 2015–16 and for all years combined, in the HOK, HAK, LIN, SWA and WWA target trawl fishery, by blocks of fishing years from 1990–91 to 2004–05, for individual fishing years 2005–06 to 2016–17 and for all years combined, for fishing years 1990–91 to 2016–17. The relative frequency of the numbers of tows was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.
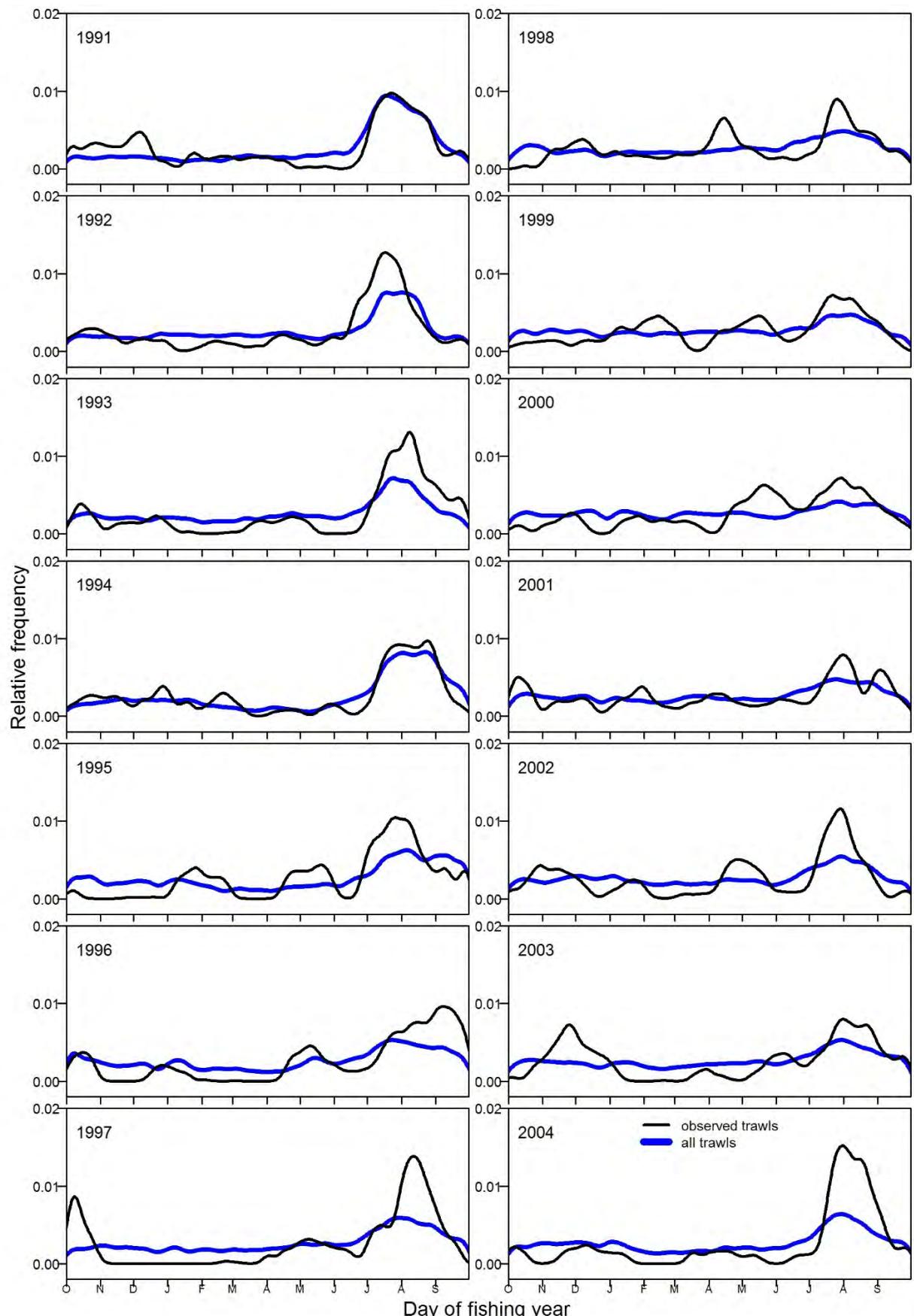
Figure 6: Comparison of the temporal spread of observed tows with all commercial tows for the target HOK, HAK, LIN, SWA and WWA fishery. The relative frequency of the numbers of tows was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.
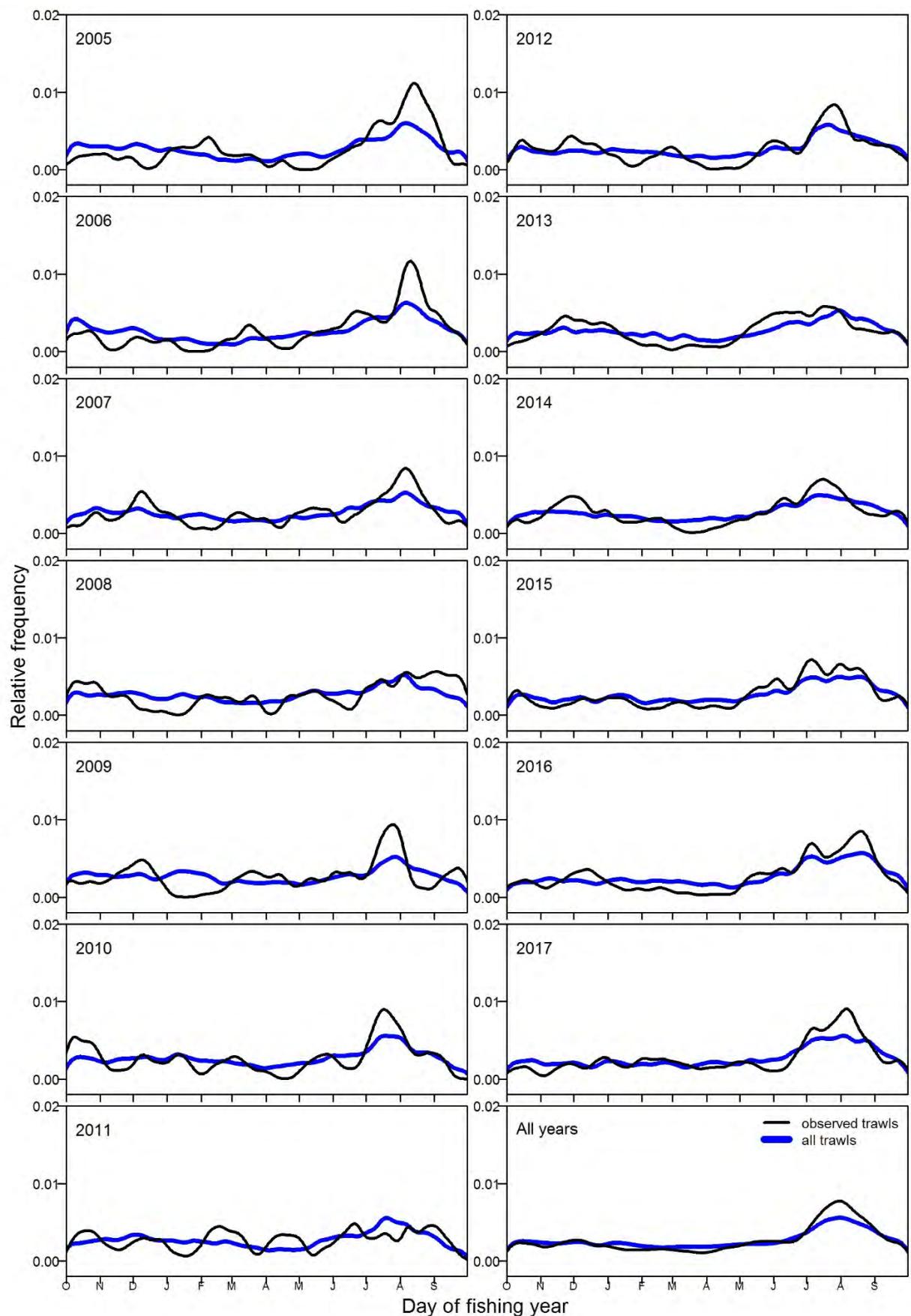
Figure 6: continued.

3.2   Completeness of observer catch recording for individual tows

Prior to the introduction of new observer logbook forms in 2007, observers recorded the method by which the contents of the trawl catch were accounted for using a three-part method code. This complex three-part method code could indicate whether the recorded "total greenweight on board" was based on the observer's own records or the vessel's catch effort logbook, whether only the target species, or target species plus QMS species catch, was recorded, and whether processed, mealed, and discarded catch was accounted for. The estimation method and perceived reliability of the estimation were also incorporated into the code. The use of this approach meant that for any given trawl there was a possibility that not all of the components of the catch (as separated by species and processing method) were recorded. The new observer logbook (2007) form dispensed with the three-part method code approach as it was believed that observers should always account for all of the catch from each trawl, and generally always have.

This aspect of the observer data was examined in a recent analysis of bycatch and discards in the arrow squid and scampi trawl fisheries (Anderson & Edwards 2018) and revealed that the method code was frequently used incorrectly, with many invalid codes entered. Further, an examination of total bycatch between nominally "all recorded" and "not all recorded" trawls did not show a consistent difference, with higher catch for "all recorded" trawls in the scampi fishery but higher catch for "not all recorded" trawls in the arrow squid fishery.

For this analysis we have applied the assumption used in the new observer logbooks to all records that precede it, i.e. that observers always account for all of the catch from each trawl, and this is likely to be true in the majority of cases.

3.3   Bycatch data

3.3.1   Overview of raw bycatch data

Over 800 bycatch species or species groups were identified by observers in the target trawl fishery, most being non-commercial species, including invertebrate species, caught in low numbers (see summaries in Table A1–A3, and Figure 7). Hoki accounted for about 73% of the total estimated catch from all observed tows targeting HOK, HAK, LIN, SWA, and WWA between 1 Oct 2002 and 30 Sep 2017. The other main catch species were hake (6.7%), ling (5.2%), silver warehou (3.9%), javelinfish (1.9%), unspecified rattails (1.6%), spiny dogfish (1.4%), and white warehou (1.3%) (Figure 7). Of these, javelinfish (37%), unspecified rattails (43%), and spiny dogfish (69%) were the fish species with the largest rate of observed discarding in this fishery. Other species frequently caught and often discarded included shovelnose dogfish, Baxters dogfish (*Etmopterus granulosus*), redbait (*Emmelichthys nitidus*), silverside (*Argentina elongata*), leafscale gulper shark (*Centrophorus squamosus*), and silver dory (*Cyttus novaezealandiae*).

Arrow squids were the ninth most common bycatch species by weight (0.5% of the total catch) and were the only invertebrates in the top 30 bycatch taxa. As a valuable quota species, they were mostly retained. Other squids and octopuses, sponges, echinoderms, and crabs were the other main invertebrate bycatch groups caught, all at less than 0.05% of the total catch, and most of these were discarded (see Table A2 for a list of the main observed invertebrate bycatch species).

Many invertebrates, in particular corals, echinoderms, and crustaceans, were identified to species, especially in the more recent records. This is due to the continuously improving knowledge of the New Zealand marine invertebrate fauna, both in general and specifically by fisheries scientists and observers, and the availability of high quality invertebrate identification guides (e.g. Tracey et al. 2011). See Table A1 and A2 for a list of the main observed bycatch species and Table A3 for a summary by higher taxonomic group.
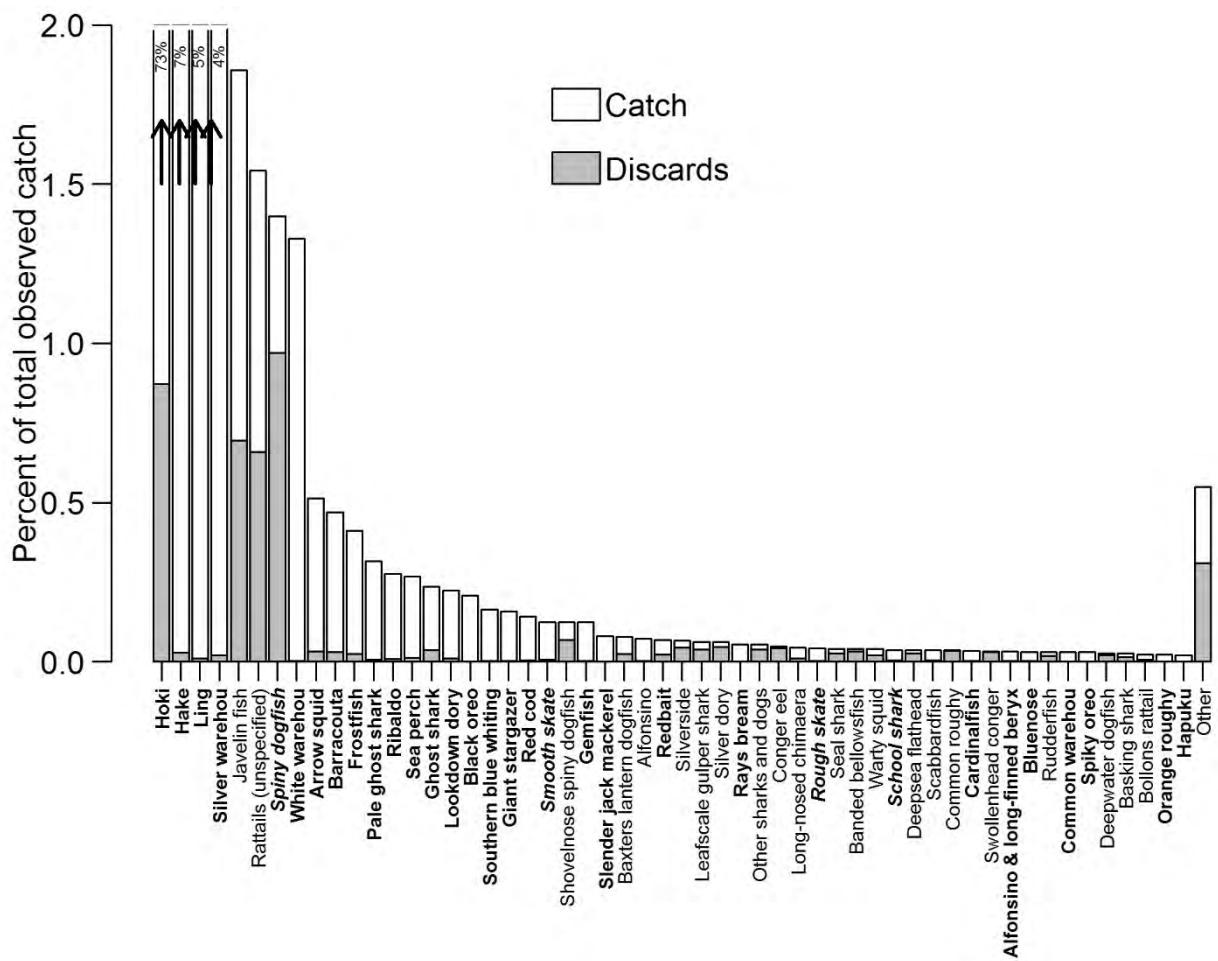
Figure 7: Percentage of the total catch contributed by the main bycatch species (those representing 0.02% or more of the total catch) in the observed portion of the HOK, HAK, LIN, SWA and WWA target trawl fishery for fishing years 2002–03 to 2016–17, and the percentage discarded. The Other category is the sum of all bycatch species representing less than 0.02% of the total catch. Names in bold are QMS species, names in italics are QMS species which can be legally discarded under Schedule 6 of the Fisheries Act (1996).

Exploratory plots were prepared to examine bycatch per trawl (plotted on a log scale) with respect to other relevant available parameters, including depth, duration, vessel, fishing year, month, area, nationality, target species, and gear method (Figure 8–10). Plots were prepared using data from all fishing years (i.e. 1990–91 to 2016–17) and by species category (ALL species, QMS species, non-QMS fish, and non-QMS invertebrates).

Total bycatch per trawl was highly variable between trawls, ranging from 0 to 149 t (Figure 8). Total bycatch per trawl increased with increasing trawl duration. Most trawls (97%) were less than 10 hours in duration but longer trawls were often made and some were over 15 h. Trawling was mostly (95%) at bottom depths of 300–800 m but some fishing was shallower than 200 m and deeper than 900 m. Total bycatch increased slightly with increasing bottom depth, from about 450 kg per trawl at a depth of 200 m to about 900 kg per trawl at a depth of 800 m. There were large differences in bycatch between the 44 vessels represented by more than 500 records before tows with no bycatch were removed, with medians ranging from about 140 kg per trawl to about 2600 kg per trawl, but there was no clear difference in bycatch with vessel size. There was a gradual increase in total annual bycatch per trawl over time, doubling from about 400 kg per trawl in the early 1990s to about 800 kg per trawl by about 2010. There was a peak in total bycatch per trawl in the summer months, with the lowest values during the spawning months. Japanese, Korean, and Belizean vessels had slightly greater bycatch than vessels of other nationalities, with the relatively small number of tows by Chinese vessels showing the lowest total bycatch rates. There were some differences in bycatch levels among the areas examined: median bycatch was lowest in COOK (about 130 kg per trawl), SUBA (about 380 kg per trawl), and midwater fishing in WCSI (about 320 kg per trawl), but similar amongst the remaining areas

(600 to 1000 kg per trawl). Overall, there was lower bycatch from midwater trawls than from bottom trawls, and bycatch was greater when targeting silver warehou and white warehou than when targeting hoki, hake, and ling.

Patterns of bycatch for QMS species in relation to these variables were similar to those for total bycatch (Figure 9), although bycatch was more consistent with depth and the increase in QMS bycatch per trawl over time was more marked.

Bycatch of non-QMS fish species also showed similar patterns to total bycatch and QMS species bycatch, for most of the fishery parameters examined (Figure 10). However, non-QMS species bycatch per trawl increased more strongly with depth than in the other catch categories, there was little indication of increasing rates over time, and the nominated target species had less influence.

Non-QMS invertebrate species bycatch, the smallest bycatch category in terms of catch weight, showed an increase in catch rates with duration and depth, an increase in annual rates over time, and higher rates for trawls not targeting hoki; otherwise patterns of bycatch per trawl were mostly similar to the other catch categories (Figure 11).
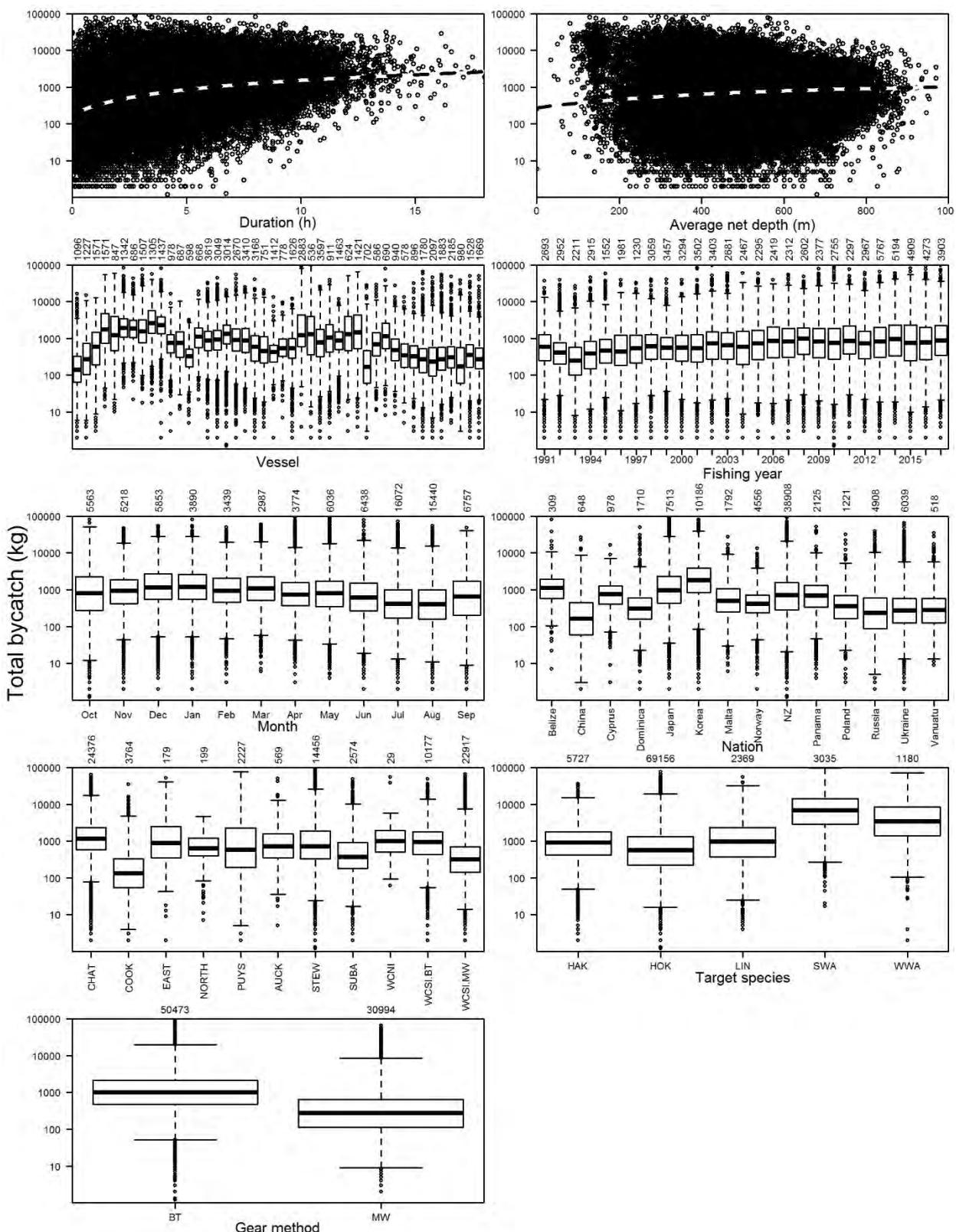
Figure 8: Total observed bycatch (all species) in kg per tow plotted against selected variables in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for the fishing years 1990–91 to 2016–17, on a log scale. The dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with more than 500 records shown). Average depth is the average of the start and finish depths of the tow. See Figure 1 for area codes.
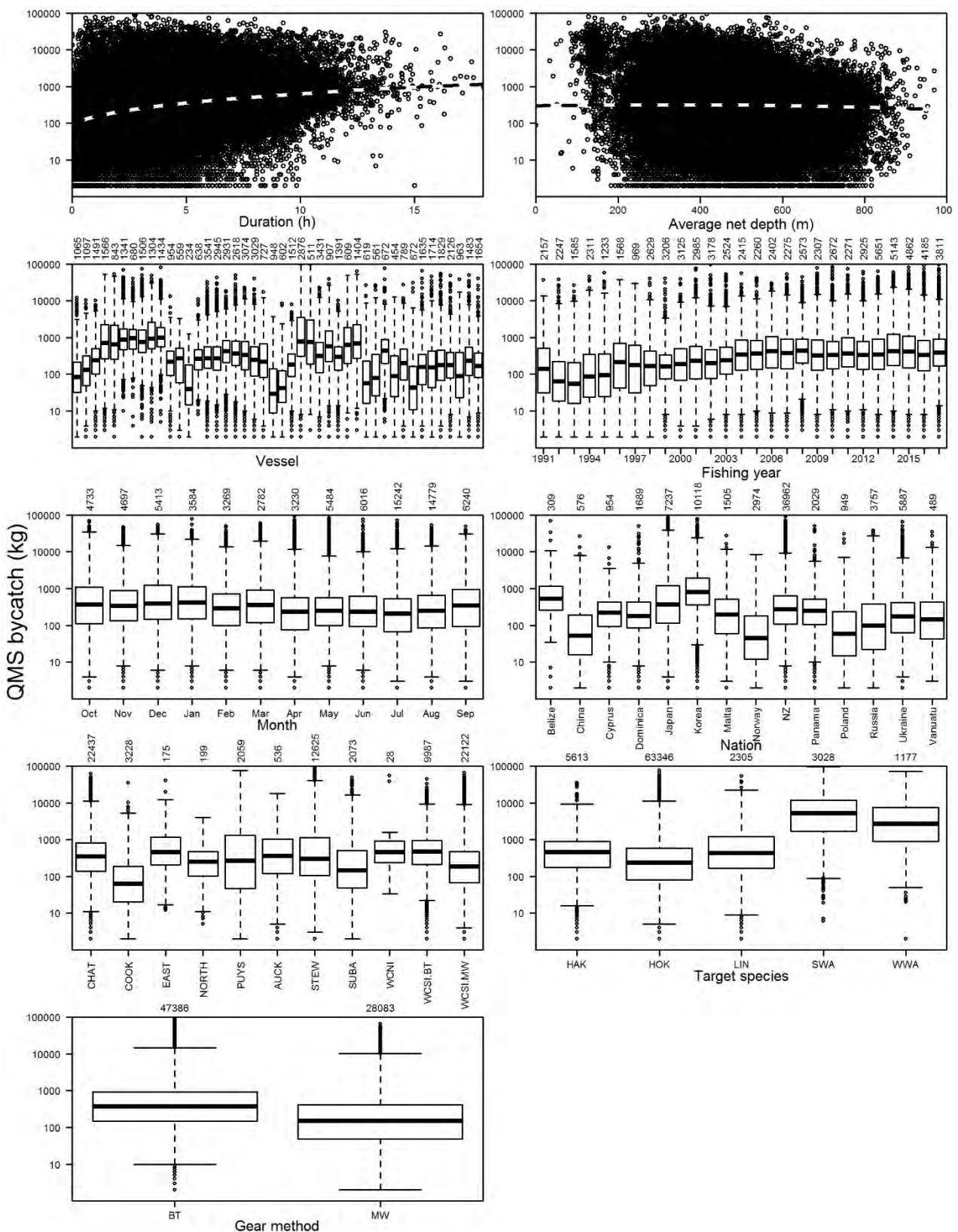
Figure 9: QMS (adjusted) species bycatch in kg per tow plotted against selected variables in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for the fishing years 1991–92 to 2016–17, on a log scale. See Figure 8 for further details.
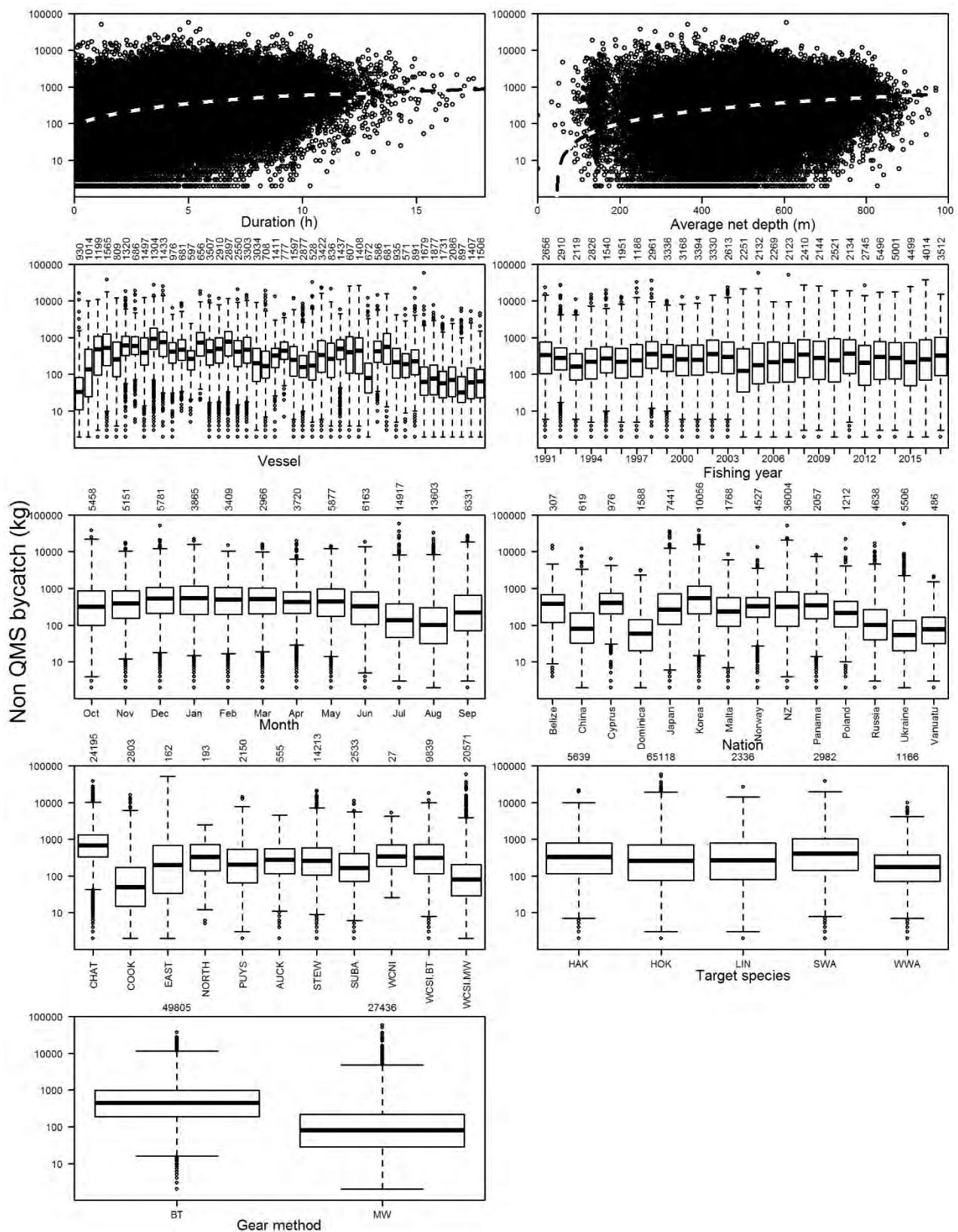
Figure 10: Non-QMS (adjusted) fish species bycatch in kg per tow plotted against selected variables in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for the fishing years 1990–91 to 2016–17, on a log scale. See Figure 8 for further details.
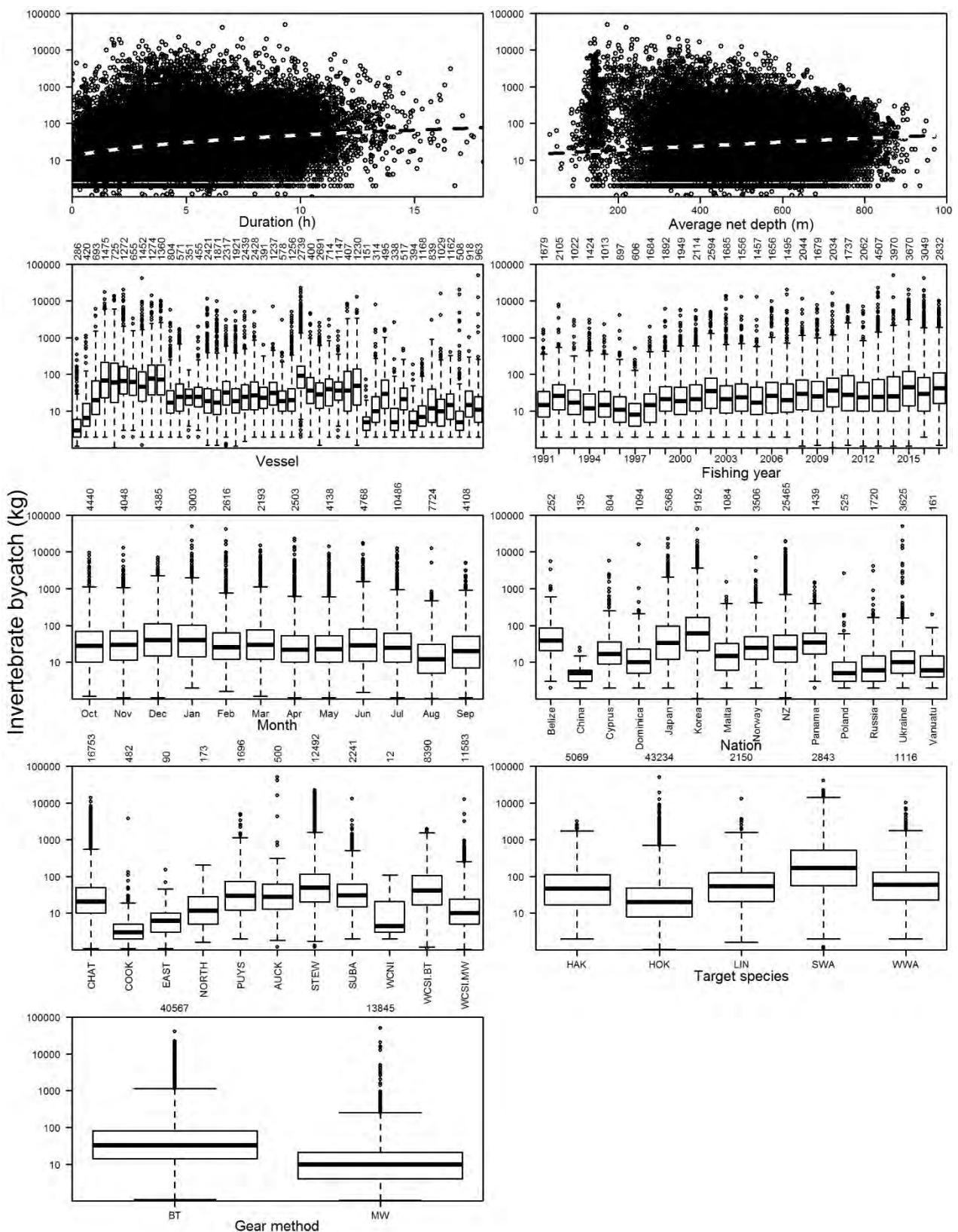
Figure 11: Non-QMS invertebrate (adjusted) species bycatch in kg per tow plotted against selected variables in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for the fishing years 1991–92 to 2016–17, on a log scale. See Figure 8 for further details.

3.4 Discard data

3.4.1 Overview of raw discard data

The bycatch species most discarded by weight in the observed hoki, hake, ling, silver warehou, and white warehou fishery was spiny dogfish, the most commonly caught bycatch species after javelinfish and other (unspecified) rattails, and of which almost 70% was discarded in the period since 1 October 2002 (Table A1, Figure 7). Although only about 1% of the observed hoki catch was discarded, this species still accounted for the second highest observed discards. Of the other major bycatch groups in the fishery, Javelinfish (37%) and other (unspecified) rattails (43%) were also substantially discarded. Rattails were frequently not fully identified by observers, and this group is likely to include a range of species within the genera *Coryphaenoides* and *Coelorinchus*, among others. The javelinfish rattail is readily identified and the separate recording of this is likely to be relatively accurate, although it is sometimes confused with hoki; other rattail species often recorded by species include Bollons rattail (*Coelorinchus bollonsi*) and Olivers rattail (*Coelorinchus oliverianus*). Of the invertebrate species caught most were non-QMS species and were discarded (see Table A2), and those that showed lower levels of discarding, e.g., floppy tubular sponge (*Hyalascus* sp.) (3%) and smooth deepsea anemones (Actinostolidae) (1%) were likely to be the result of poor recording in the processing section of the observer forms and, in reality, were likely to have been very close to100% discarded.

The variability in the level of discards per trawl with respect to some of the available variables is shown for all species combined, QMS species, non-QMS fish species and non-QMS invertebrates in Figure 12–14. The level of total discards was highly variable between trawls, 0–52 t per trawl (Figure 12). Like bycatch, the quantity of total discards increased with increased trawl duration, but there was no apparent relationship between discards and gear depth. Discards were highly variable between the 28 vessels with more than 500 records, with larger vessels generally discarding less per tow than smaller vessels (probably due to greater use of meal plants in large vessels). Since 2005–06 there has been a trend of increasing discards over time. As with bycatch, total discards were highest during the summer months and lowest during the winter hoki spawning period. Differences among vessel categories were pronounced, with the highest discard rates associated with foreign owned or chartered vessels and the lowest with BATM vessels (which are all installed with meal plants). Median discard rates were low for the small amount of fishing effort in area EAST, and lower also in COOK, AUCK, and for midwater trawls in WCSI than in other areas; discard rates were highest for bottom trawling in WCSI. Discard rates were greatest when targeting silver warehou and lowest when targeting hoki. Overall, there were lower discard levels associated with midwater trawls than bottom trawls, and lower discarding where meal processing was occurring.

Patterns of discards for QMS species differed from those for total discards in that there was little increase in discards with increasing trawl duration, discard rates reduced with increasing net depth, and there was less variability among areas (Figure 13). Patterns of discards for non-QMS fish species (Figure 14) were more similar to those for total discards, as this category is the main contributor to total discards.

Discards of non-QMS invertebrate species increased slightly with duration but varied little with depth, and there was little change in annual medians through the period. There was considerable variation among areas, with low discard rates for the few recorded discards in the smaller fisheries around the North Island (COOK, EAST, NORTH, and WCNI) and higher rates in the southern STEW and SUBA areas (Figure 15).
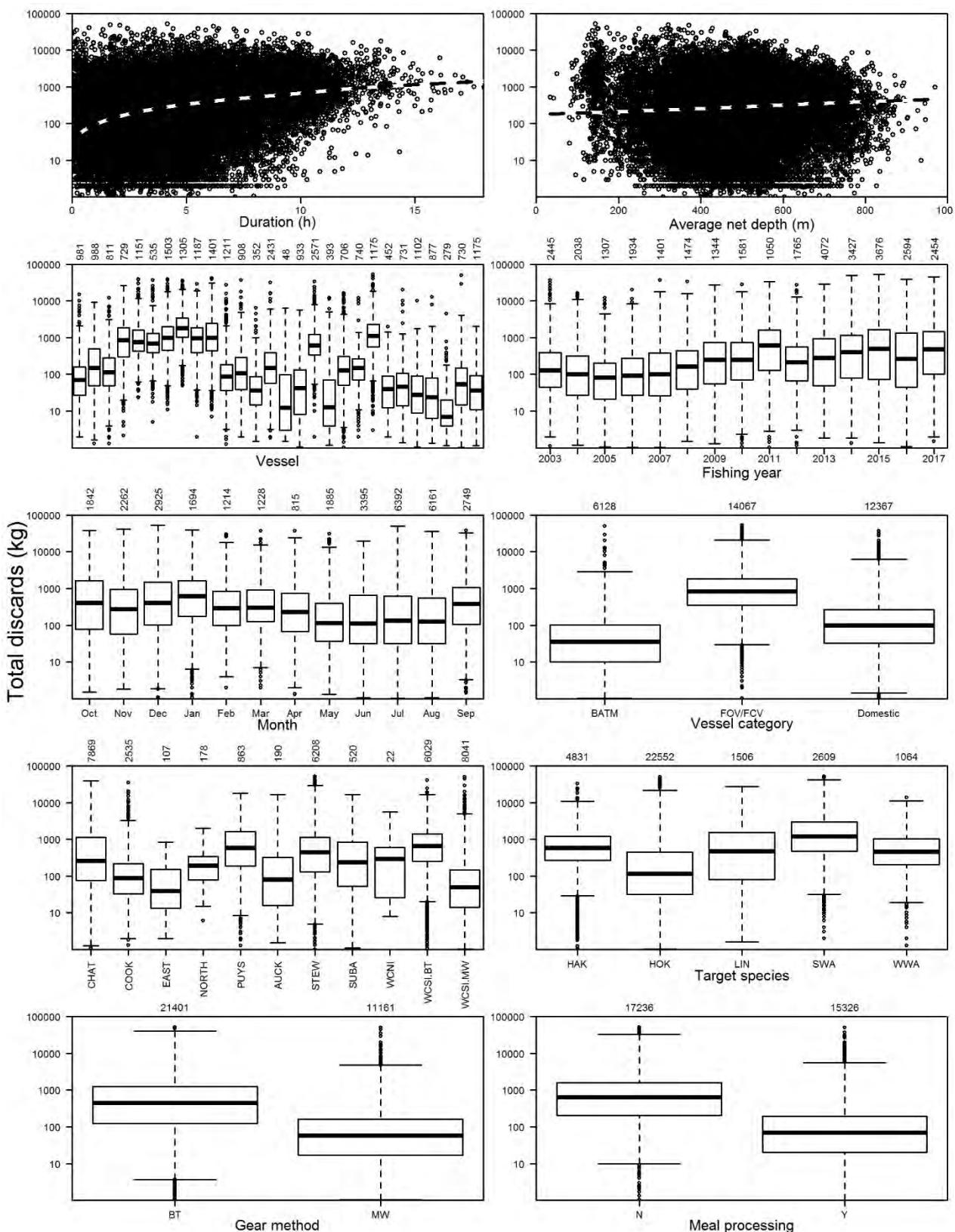
Figure 12: Total observed discards (all species) in kg per tow, plotted against selected variables in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for the fishing years 2002–03 to 2016–17, on a log scale. Vessel categories: BATM, large Soviet-class trawler; FOV/FCV, Foreign Owned/Chartered vessel. See Figure 8 for further details.
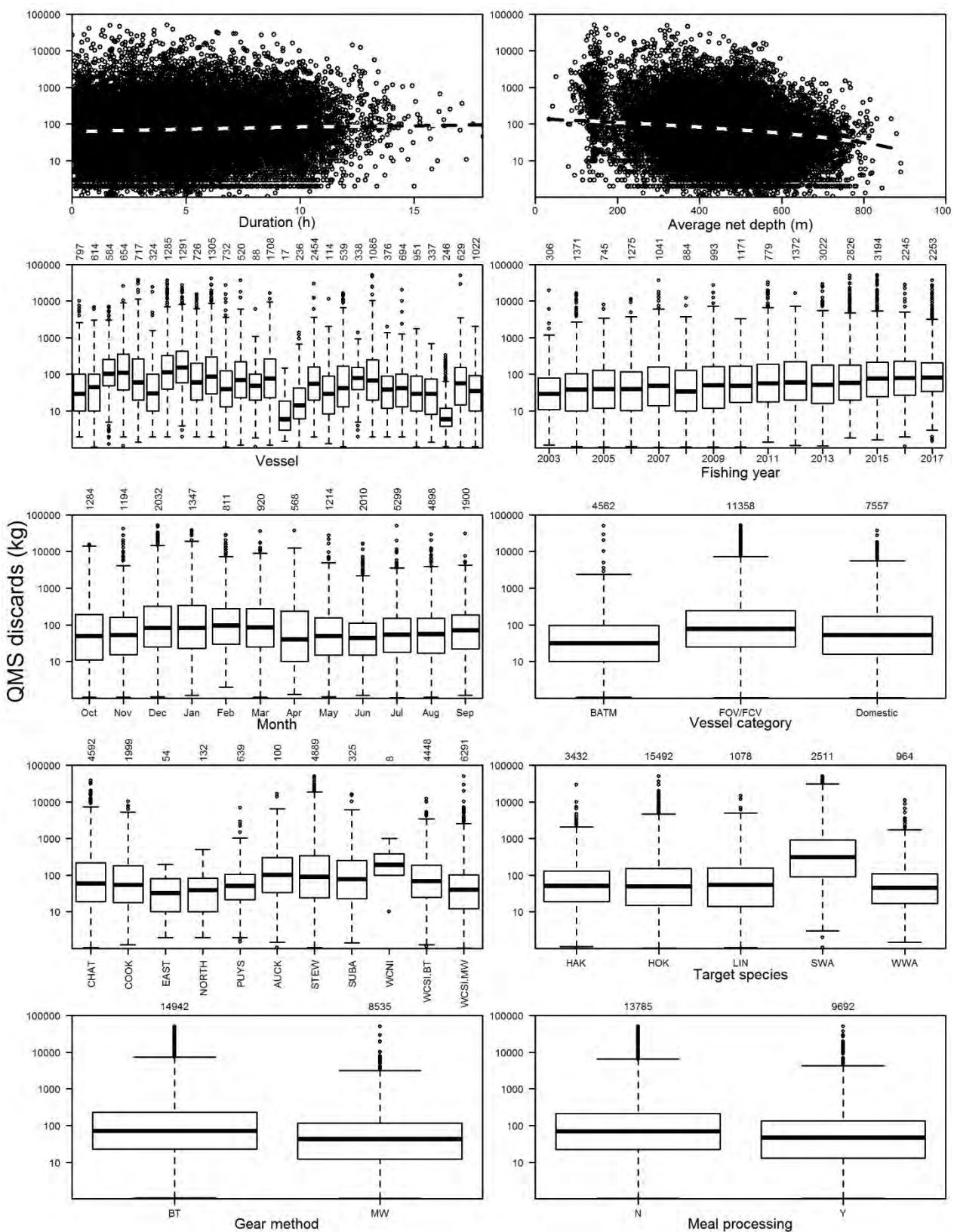
Figure 13: QMS (adjusted) species discards in kg per tow plotted against selected variables in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for the fishing years 2002–03 to 2016–17, on a log scale. Vessel categories: BATM, large Soviet-class trawler; FOV/FCV, Foreign Owned/Chartered vessel. See Figure 8 for further details.
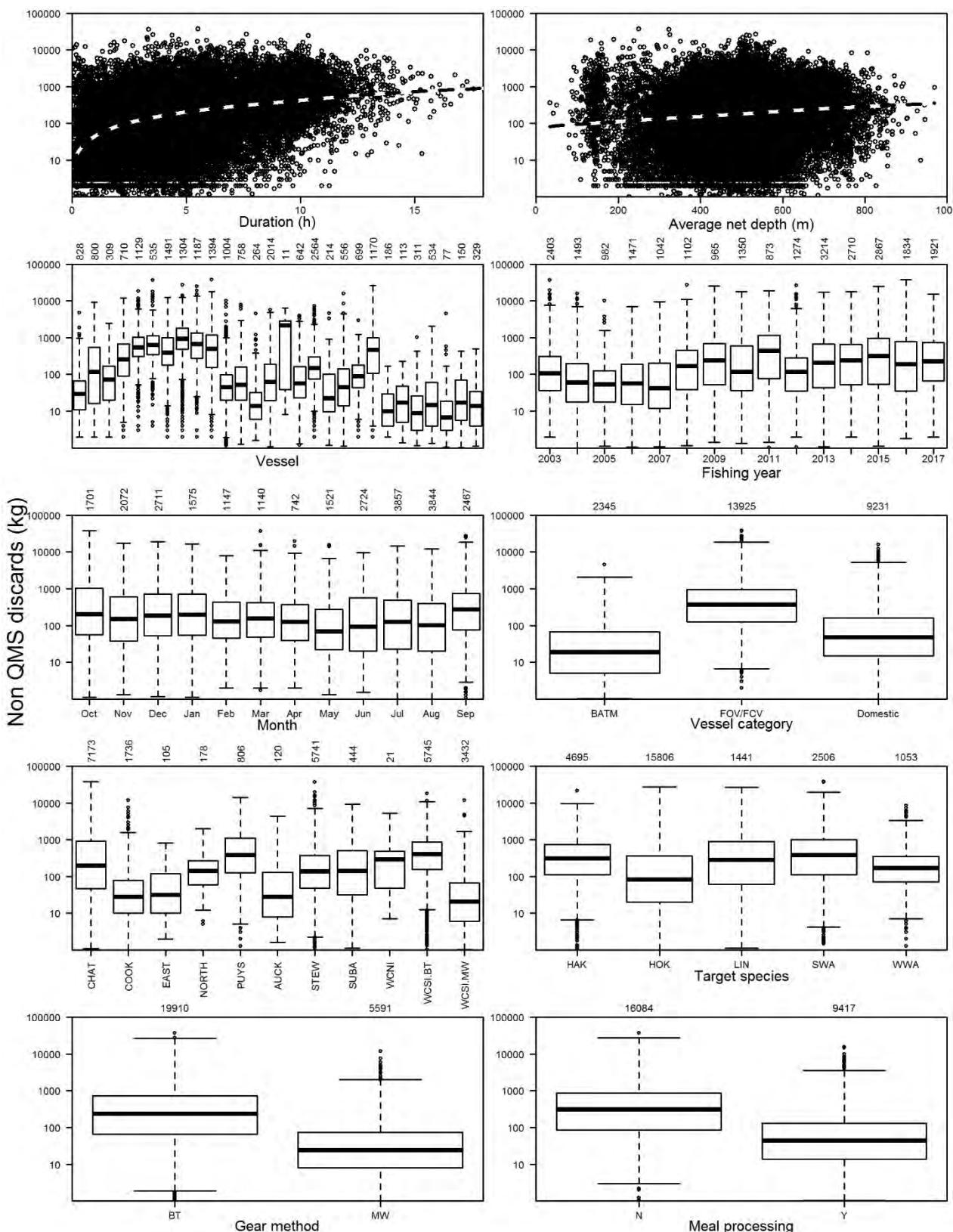
Figure 14: Non-QMS (adjusted) fish species discards in kg per tow plotted against selected variables in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for the fishing years 2002–03 to 2016–17, on a log scale. Vessel categories: BATM, large Soviet-class trawler; FOV/FCV, Foreign Owned/Chartered vessel. See Figure 8 for further details.
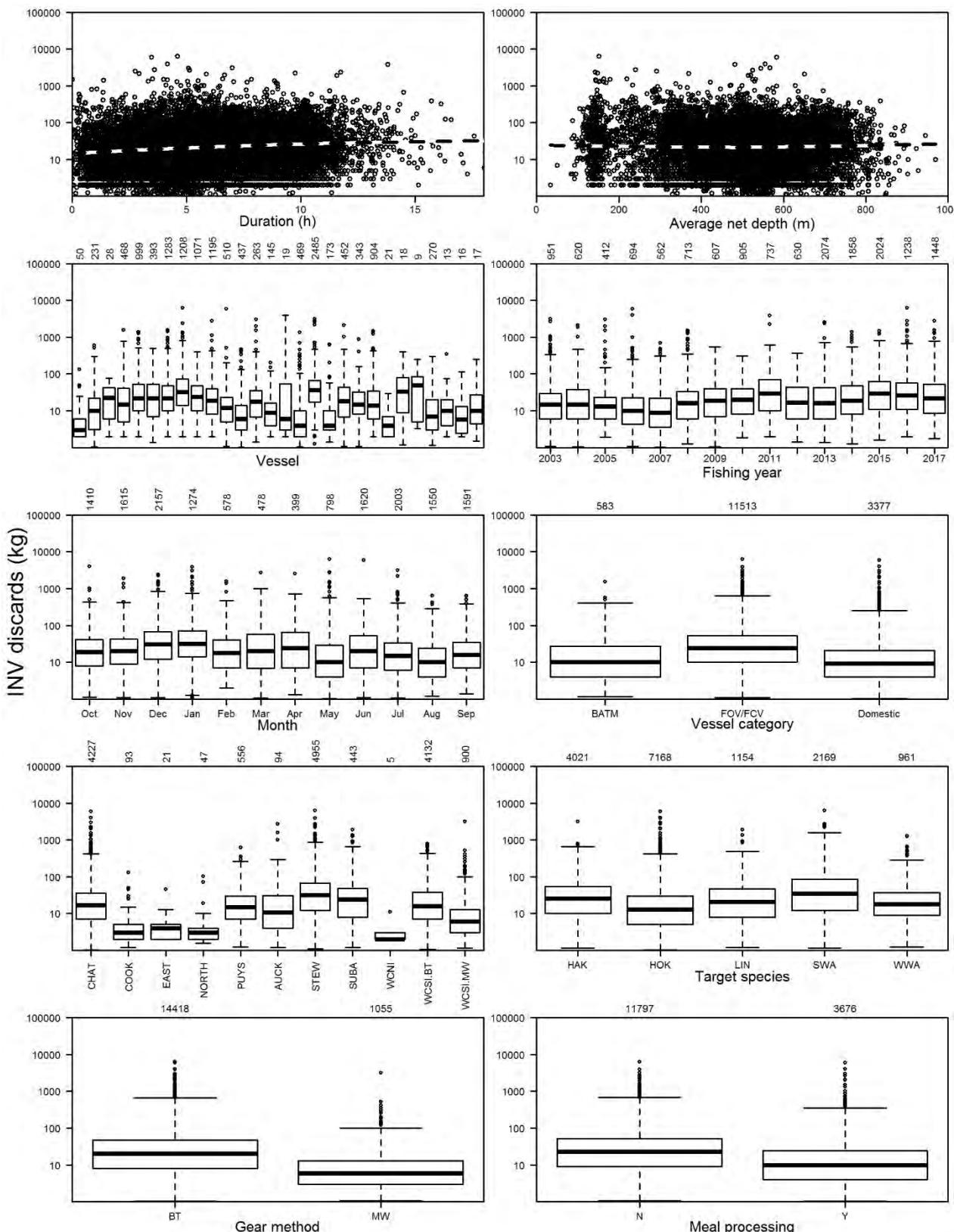
**Figure 15: Non-QMS invertebrate (adjusted) species discards in kg per tow plotted against selected variables in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for the fishing years 2002–03 to 2016–17, on a log scale. Vessel categories: BATM, large Soviet class trawler; FOV/FCV, Foreign Owned/Chartered vessel. See Figure 8 for further details.**

3.5 Estimation of bycatch

3.5.1 Annual bycatch levels

The annual estimated bycatch of QMS species, non-QMS invertebrate species, and all species combined generally increased over time (Table 8), as indicated by the positive slopes of the linear regressions (Table 9). This increasing trend was statistically significant for QMS species and non-QMS invertebrate species (Table 9). For non-QMS fish species, the largest category by weight of catch, there was a (non-significant) decline in bycatch over time.

QMS species
The estimated annual bycatch ranged from a low of about 5000 t in 1992–93 to a high of about 27 000 t in 2014–15 (Table 8, Figure 16), with an increasing trend both early and late in the period. Interpretation of this increasing trend is confounded by the ongoing addition of species to the QMS throughout the period (notably CDL, EPT, FRO, GSH, RIB in 1998–99; GSP, SBW in 1999–2000, RSK, SSK in 2003–04; SPD and LDO in 2004–05; and RBT in 2009–10) (see APPENDIX C: Model convergence diagnostics). Bycatch in this category was highly variable from year to year, emphasised by relatively narrow confidence intervals.

Non-QMS fish species
The bycatch followed a different pattern over time to QMS bycatch, with a period of higher values between 1995–96 and 2002–03 and relatively constant levels in the fishing years before and after. The lowest annual level was about 10 000 t in 1993–94, with the highest level (about 36 000 t) in 1996–97. Levels were relatively constant since 2003–04 and fluctuated between about 8000 t and 17 000 t (Figure 16). The interpretation of trends is confounded by the ongoing shift of species from this category into the QMS category throughout the period (see above).

Non-QMS Invertebrate species
This was at much lower levels than QMS and non-QMS fish bycatch, but generally increased over time from about 500 t per year in the early 1990s to 1000–1500 t in the last few years of the series. There were also several years in the early 2000s with higher non-QMS invertebrate bycatch, with a peak of 1800 t in 2001–02. Some species shifted from this category into the QMS category during the period, e.g., SCI, KIC, GSK in 2004–05, but the effect on the overall trend is likely to be negligible.

Visual inspection of the MCMC traces was used to assess convergence for estimated parameters and was acceptable in all cases. Model MCMC traces of the estimated parameters and derived predicted bycatch are shown for QMS species, non-QMS fish species, and non-QMS invertebrate species categories in Figure C 1–C3. Convergence is demonstrated in all cases. Assessment of the model predictions (comparisons of the median posterior expected values and simulated predictions with the observer records) are shown in Figure C4. These show good agreement in all cases.

The total annual estimated bycatch is composed primarily of non-QMS fish species earlier in the period and a more even mixture of non-QMS fish and QMS species from the mid-2000s onwards. Therefore, the lowest annual levels (about 18 000–24 000 t) occurred in the first four years of the period and were followed by a period of increasing levels to about 40 000–50 000 t per year from 1995–96 to 2003–04. Total bycatch then decreased to about 30 000 t for several years then was generally higher and more variable, peaking at about 46 000 t in 2014–15. The pattern of total annual bycatch approximately followed that of effort and target species catch in the fishery, although the proportion of bycatch was lower relative to catch and effort in the early years of the period (Figure 16). The total bycatch estimates of Ballara & O'Driscoll (2015) are generally lower than the current estimates for much of the overlapping period (1990–91 to 2012–13) but are similar (with strongly overlapping confidence intervals) for several years, especially the earlier years, and overall show the same trend.

Table 8: Estimates of annual bycatch (t) in the target hoki, hake, ling, silver warehou or white warehou trawl fishery, by species category and fishing year; 95% confidence intervals in parentheses.

Fishing year	QMS		Non-QMS fish		Non-QMS Inv.		Total bycatch	
1990–91	10 932	(9 415–13 076)	13 996	(13 021–15 085)	414	(384–449)	23 938	(22 241–25 683)
1991–92	6 200	(5 335–7 345)	14 891	(13 825–16 113)	673	(626–727)	20 500	(19 175–21 977)
1992–93	5 026	(4 206–6 151)	15 724	(13 935–17 723)	381	(343–425)	18 605	(16 689–20 763)
1993–94	9 296	(8 058–11 052)	9 968	(9 296–10 741)	378	(338–424)	17 554	(16 372–18 979)
1994–95	11 789	(9 699–14 588)	16 379	(14 944–18 337)	542	(493–597)	26 023	(23 841–28 483)
1995–96	21 031	(17 383–26 648)	30 810	(26 790–36 388)	428	(381–479)	41 586	(37 399–46 973)
1996–97	22 253	(17 428–30 817)	35 949	(31 363–42 306)	451	(392–528)	48 624	(43 093–55 672)
1997–98	19 093	(16 805–22 484)	33 966	(31 476–37 343)	616	(570–669)	47 430	(44 265–51 620)
1998–99	10 776	(9 928–11 892)	23 237	(21 726–25 033)	734	(673–795)	33 984	(32 030–35 992)
1999–2000	17 097	(15 697–18 711)	26 031	(24 043–28 297)	823	(753–902)	43 473	(40 860–46 544)
2000–01	23 627	(21 410–26 561)	26 249	(24 601–28 218)	1 306	(1 200–1 425)	46 933	(44 110–50 100)
2001–02	14 097	(12 969–15 452)	26 279	(24 349–28 415)	1 810	(1 674–1 979)	43 500	(40 793–46 622)
2002–03	18 416	(16 809–20 178)	23 979	(22 161–25 925)	987	(894–1 102)	44 876	(41 727–48 355)
2003–04	25 815	(23 270–29 297)	15 655	(14 104–17 582)	896	(803–1 005)	42 320	(38 586–46 205)
2004–05	15 659	(14 345–17 402)	12 799	(11 745–14 041)	607	(544–678)	28 835	(26 767–31 001)
2005–06	18 139	(16 483–20 142)	12 992	(11 699–14 555)	686	(615–768)	30 804	(28 570–33 516)
2006–07	17 524	(15 717–19 502)	10 752	(9 746–11 981)	719	(637–817)	27 893	(25 920–30 205)
2007–08	14 140	(13 065–15 575)	14 313	(12 872–16 000)	679	(626–743)	27 173	(25 323–29 134)
2008–09	15 681	(13 981–18 176)	11 584	(10 422–12 975)	564	(508–632)	27 070	(24 991–29 698)
2009–10	13 629	(12 316–15 402)	17 568	(15 543–20 017)	719	(657–793)	31 094	(28 633–33 988)
2010–11	16 597	(14 831–18 937)	10 671	(9 662–11 837)	874	(769–1 000)	25 968	(23 992–28 428)
2011–12	12 941	(11 811–14 301)	8 321	(7 625–9 112)	591	(535–656)	21 151	(19 791–22 621)
2012–13	17 843	(16 324–20 320)	12 818	(11 763–14 000)	870	(800–944)	30 077	(28 207–32 227)
2013–14	24 647	(22 733–26 862)	10 352	(9 720–11 077)	841	(779–911)	35 798	(33 970–38 156)
2014–15	27 121	(25 111–29 395)	16 776	(15 348–18 635)	1 552	(1 430–1 697)	45 863	(42 969–49 202)
2015–16	15 353	(14 071–17 023)	14 874	(13 585–16 205)	1 091	(989–1 221)	31 254	(29 192–33 620)
2016–17	17 713	(16 380–19 175)	17 176	(15 530–19 132)	1 311	(1 192–1 452)	34 865	(32 638–37 381)
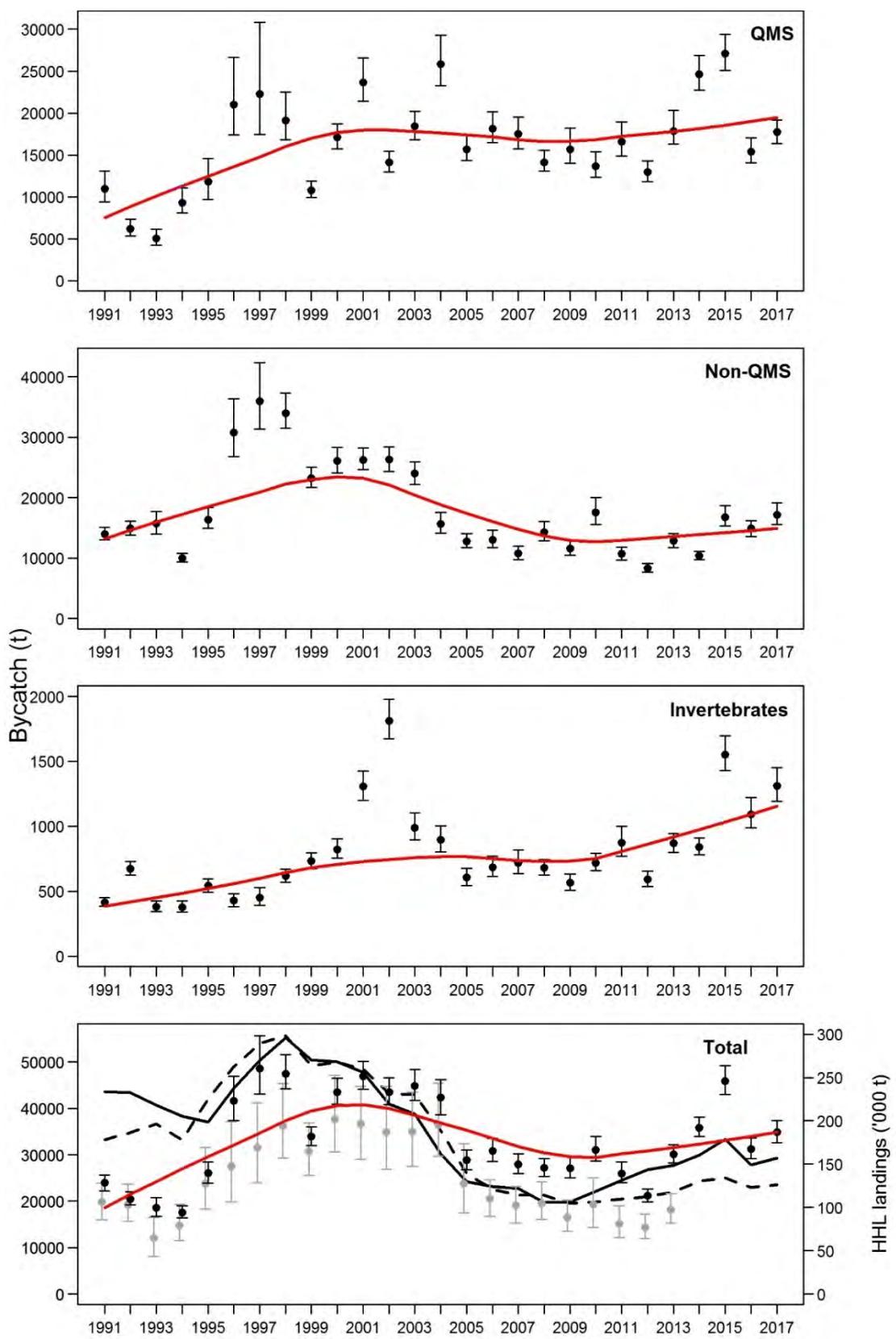
Figure 16: Annual estimates of bycatch in the target hoki, hake, ling, silver warehou or white warehou trawl fishery, by species category, for 1990–91 to 2016–17 (black dots). Error bars indicate 95% confidence intervals. The red lines show the fit of a locally-weighted polynomial regression to annual bycatch. Bottom panel shows estimates (grey dots) of total bycatch calculated for 1990–91 to 2012–13 from Ballara & O'Driscoll (2015), the total annual catch of the target species (solid black line), and annual effort (number of tows) (dashed line), scaled to have the mean equal to that of total bycatch.

The estimated annual bycatch in each of the standard areas, for each catch category, is shown in Figure 17 and Figure 18 and in more detail (with confidence intervals) in Table A4. The majority of bycatch in each category was taken from three main areas, CHAT, STEW, and WCSI, with PUYS and in some years COOK also contributed substantially. The proportion of QMS species bycatch in STEW increased over time and the proportion in WCSI generally decreased (Figure 17). Bycatch of non-QMS fish species in COOK was negligible except for a period during the late 1990s and early 2000s, peaking at about 25% of the total in 1995–96. For non-QMS invertebrate species, the contribution of STEW to total bycatch was greater than in the other catch categories, and the contribution of CHAT less (Figure 18). However, total bycatch was dominated by area CHAT, followed by (in most years) WCSI and STEW.
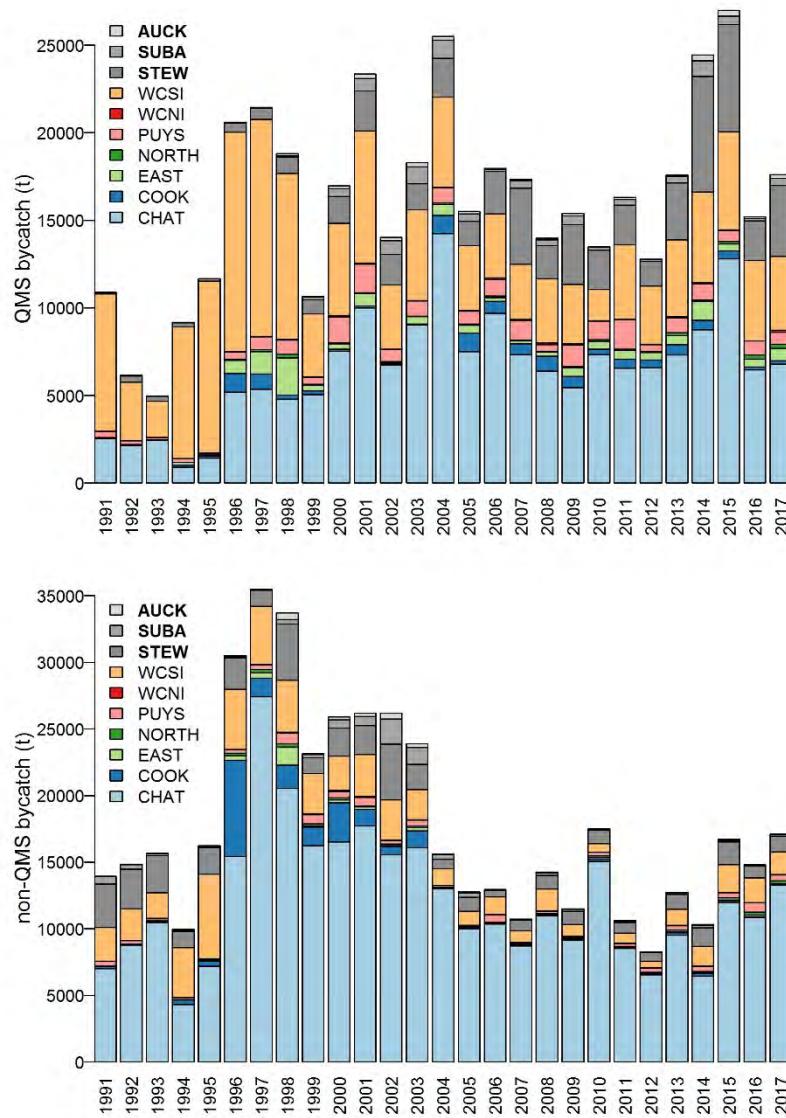
Figure 17: Estimated annual bycatch of QMS species (top) and non-QMS fish species (bottom) in each of ten standard areas.
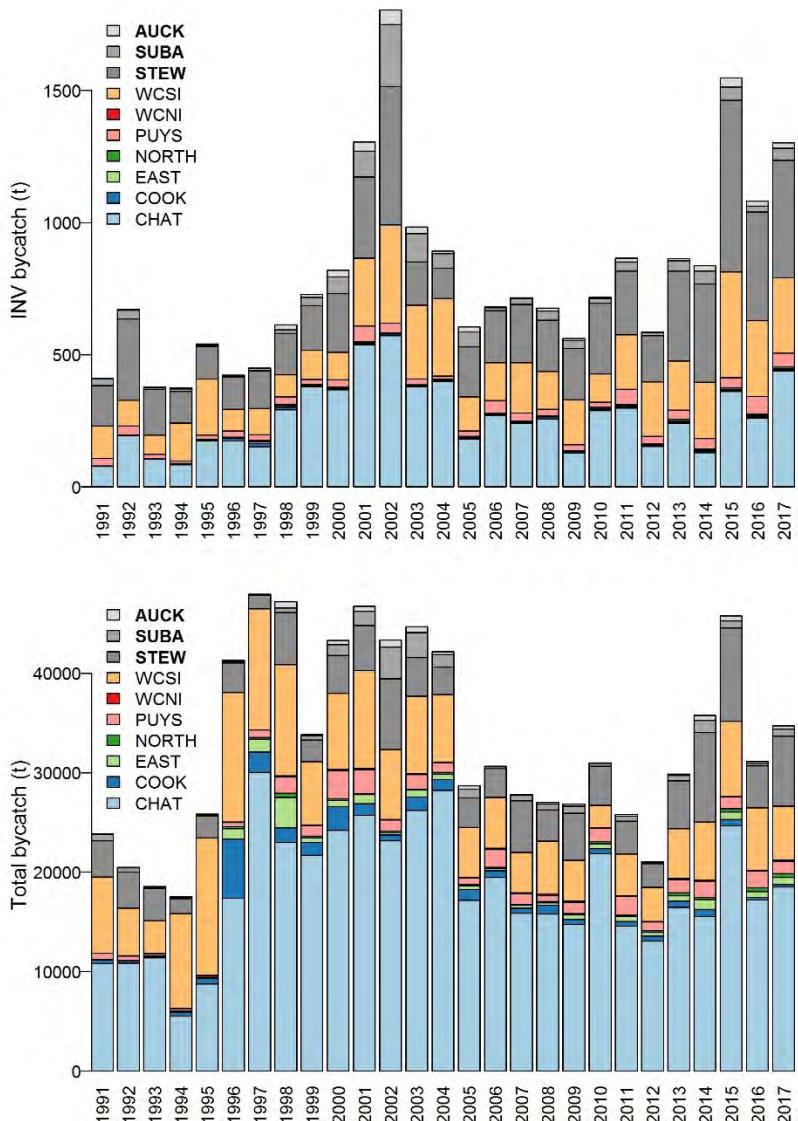
Figure 18: Estimated annual bycatch of non-QMS invertebrate species (top) and all species combined (bottom) in each of ten standard areas. Shades of grey (bold in the legend) combine to illustrate the overall sub-Antarctic region.

Table 9: Summary of results of linear regression analyses for trends in annual bycatch, by species category, in the hoki, hake, ling, silver warehou, and white warehou fishery. The _p_ values indicate whether the slopes differed significantly from zero. Those results where _p_ values are less than 0.01 (generally considered highly significant) are shown in bold.

Species category	Slope	_p_
QMS	**0.026**	**0.007**
NONQMS	-0.020	0.045
INV	**0.031**	**0.001**
Total	0.006	0.411

Total annual bycatch calculated directly from commercial catch-effort forms (estimated total catch minus any estimated catch of the target species) was lower than the estimate based on observer data in all but one of the 27 years examined, and was below the 95% confidence intervals of the estimates based on observer data in all but three years (Table 10, Figure 19). The two sets of estimates follow a roughly similar trend with a 57% correlation.

Table 10: Total annual bycatch estimates for the target hoki, hake, ling, silver warehou, white warehou fishery based on catch effort records (estimated total catch minus any estimated catch of the target species) compared with estimates from observer-based model. Catch-effort based estimates were derived by summing the difference between the recorded total catch and the target species catch for each trawl (TCP and TCE type forms) or group of trawls (CEL type forms).

	Total bycatch (t)		
Fishing year	**Catch-effort-based**	**Observer-based**	**% of observer-based estimate**
1990–91	17 676	23 938	73.8
1991–92	16 440	20 500	80.2
1992–93	14 794	18 605	79.5
1993–94	20 207	17 554	115.1
1994–95	3 899	26 023	15.0
1995–96	15 256	41 586	36.7
1996–97	28 477	48 624	58.6
1997–98	25 122	47 430	53.0
1998–99	22 784	33 984	67.0
1999–2000	28 435	43 473	65.4
2000–01	27 421	46 933	58.4
2001–02	27 109	43 500	62.3
2002–03	29 541	44 876	65.8
2003–04	29 751	42 320	70.3
2004–05	20 829	28 835	72.2
2005–06	18 854	30 804	61.2
2006–07	27 269	27 893	97.8
2007–08	25 348	27 173	93.3
2008–09	23 868	27 070	88.2
2009–10	19 236	31 094	61.9
2010–11	20 439	25 968	78.7
2011–12	18 308	21 151	86.6
2012–13	18 325	30 077	60.9
2013–14	19 785	35 798	55.3
2014–15	20 417	45 863	44.5
2015–16	17 677	31 254	56.6
2016–17	21 111	34 865	60.6
All years	578 378	897 191	64.5
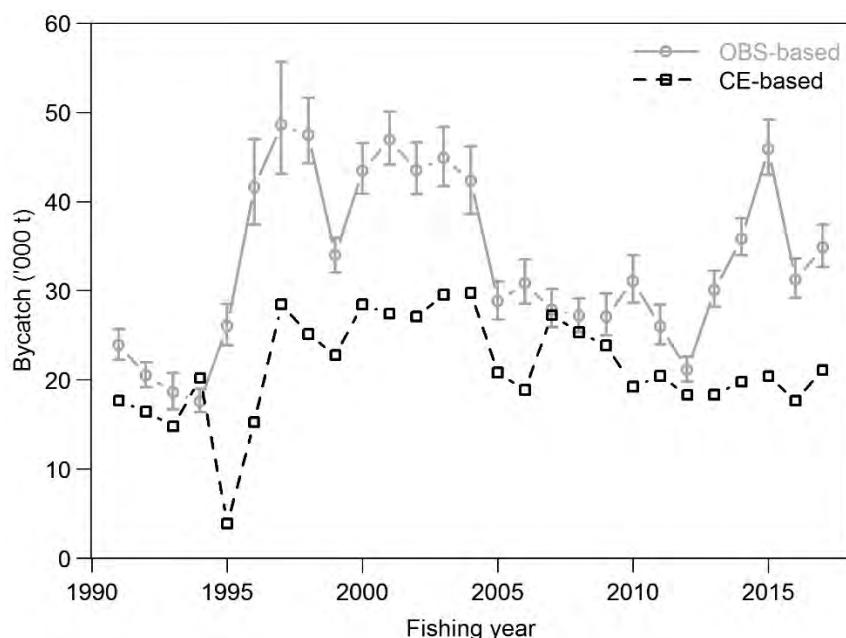
Figure 19: Total annual bycatch in the hoki, hake, ling, silver warehou, white warehou target trawl fishery from scaled up observer catch rates (OBS) and commercial catch-effort (CE) forms (estimated total catch minus any estimated catch of the target species).

3.6 Estimation of discards

3.6.1 Annual discard levels

Regression analyses indicated that discards of non-QMS fish species, non-QMS invertebrate species, and all species combined (Figure 20,
Table 11) decreased significantly over time (Table 12). Discards of target species and QMS species showed an increase over time, but not a significant increase.

Total estimated annual discards in each species category are shown in
Table 11 and Figure 20. Estimated discards of hoki, hake, and ling were 76–2340 t per year, with increasing levels since 2007–08. Target species discards were lower during the period examined than in any year before 1997–98 (as estimated by Ballara & O'Driscoll, 2015), when discards were roughly an order of magnitude greater (Figure 20). The estimates of Ballara & O'Driscoll (2015) were very similar to those of the current assessment for the equivalent years, with broadly overlapping confidence intervals. Discards of QMS species were generally around 2000 t per year or less, with no strong trend over time, although the estimate for 2003–04 was unusually high (about 3500 t). Total discards were dominated by non-QMS fish species, which were mostly 3000–6000 t per year and generally slowly declined over time. There was a large outlying value in this category also, with an estimated 19 000 t discarded in 2002–03. Annual discards of non-QMS invertebrates showed a substantial decline, from about 500 t in 2002–03 to less than 100 t in 2011–12 and have since remained at this level. Estimates of total annual discards were variable but generally declined through the period examined, from about 25 000 t in 2002–03 to 5000–8000 t in the last five years of the series. Estimates of total discards from the previous review (Ballara & O'Driscoll 2015) were generally much lower than the current estimates in most years although they were quite similar in 2009–10 and 2012–13. The Ballara & O'Driscoll (2015) estimates of total discards prior to 2002–03 were generally high relative to both their estimates for later years and to the current estimates for the more recent period.

Visual inspection of the MCMC traces was used to assess convergence for estimated parameters and were acceptable in all cases. Model MCMC traces of the estimated parameters and derived predicted discards are shown for QMS species, non-QMS fish species, and non-QMS invertebrate species categories in Figure C 5–C7. Convergence is demonstrated in all cases. Assessment of the model predictions (comparisons of the median posterior expected values and simulated predictions with the observer records) are shown in Figure C8. These show good agreement in all cases.
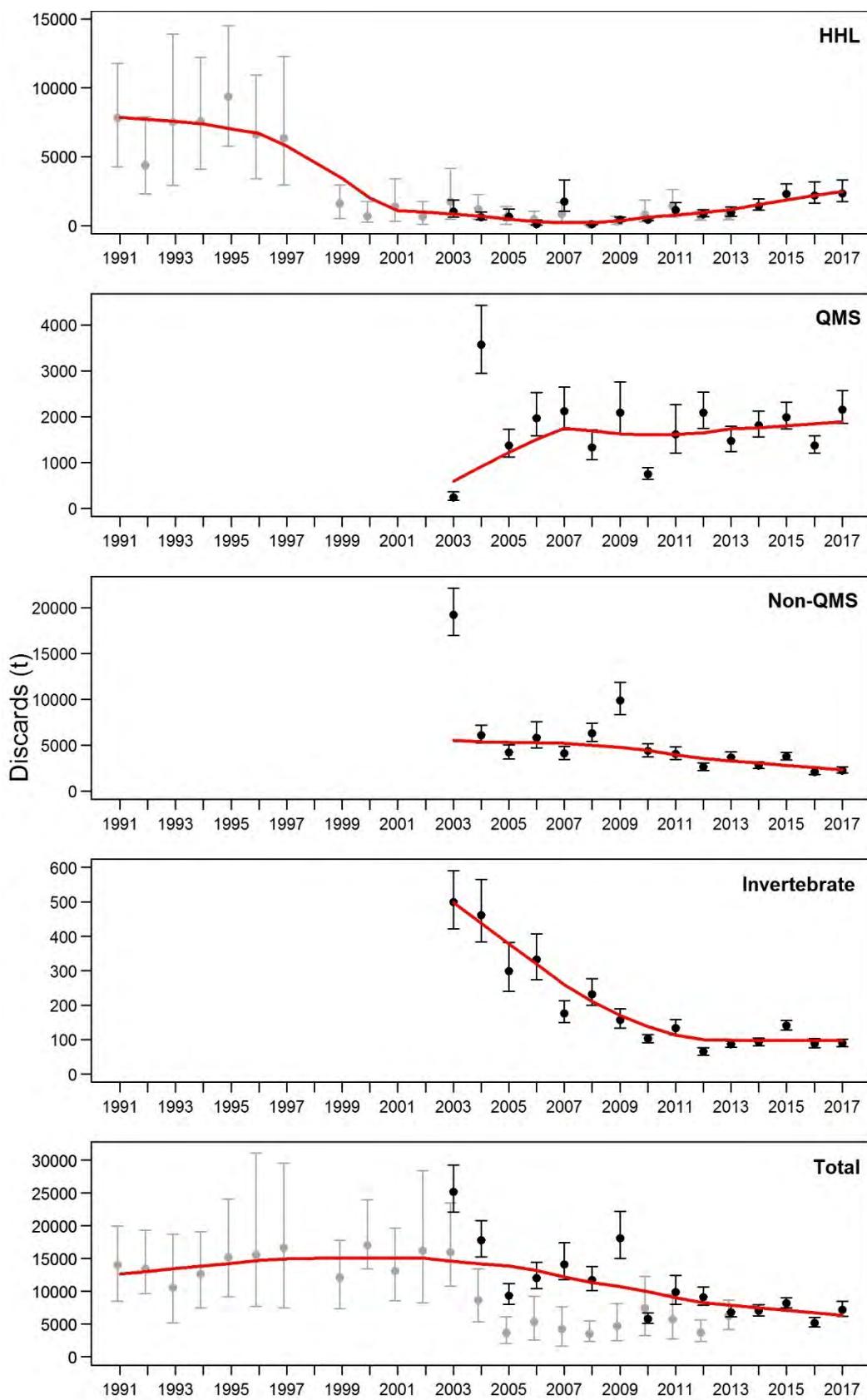
Figure 20: Annual estimates of discards in the target hoki, hake, ling, silver warehou or white warehou trawl fishery, by species category, for 2002–03 to 2016–17 (black dots). Error bars indicate 95% confidence intervals. The red lines show the fit of a locally-weighted polynomial regression to annual discards. Also shown (grey dots, bottom panel) are earlier estimates of target species and total discards calculated for 1991–92 to 2016–17 by Ballara & O'Driscoll (2015).

Table 11: Estimates of total annual discards (t) in the target hoki, hake, ling, silver warehou or white warehou trawl fishery, by species category and fishing year; 95% confidence intervals in parentheses.

Fishing year	HHL		QMS		Non-QMS fish		Non-QMS Inv.		Total discards	
2002–03	1 007	(622–1832)	240	(173-358)	19 212	(16 971-22 113)	500	(422-591)	25 167	(22 061-29 215)
2003–04	604	(411–960)	3 567	(2 9364 421)	6 071	(5 252-7 197)	462	(384-565)	17 812	(15 271-20 781)
2004–05	625	(382–1 197)	1 375	(1 112-1 717)	4 198	(3 524-5 047)	299	(241-383)	9 356	(8 041-11 202)
2005–06	92	(34–401)	1 962	(1 580-2 524)	5 823	(4 736-7 548)	333	(274-407)	12 046	(10 387-14 405)
2006–07	1 753	(1 059–3 302)	2 112	(1 716-2 642)	4 101	(3 463-4 902)	176	(150-213)	14 096	(11 770-17 388)
2007–08	76	(42–150)	1 323	(1 063-1 710)	6 311	(5 430-7 435)	232	(199-277)	11 728	(10 107-13 752)
2008–09	414	(299–595)	2 082	(1 621-2 758)	9 880	(8 335-11 878)	157	(134-189)	18 078	(15 043-22 200)
2009–10	414	(336–523)	740	(635-883)	4 369	(3 753-5 154)	102	(91-114)	5 802	(5 082-6 746)
2010–11	1 118	(802–1 675)	1 616	(1 207-2 261)	4 066	(3 483-4 856)	133	(113-158)	9 866	(8 008-12 421)
2011–12	834	(651–1 140)	2 085	(1 747-2 531)	2 619	(2 247-3 096)	65	(55-77)	9 097	(7 895-10 623)
2012–13	922	(691–1 321)	1 467	(1 242-1 783)	3 660	(3 220-4 292)	86	(78-95)	6 816	(6 066-7 801)
2013–14	1 414	(1 124–1 934)	1 806	(1 559-2 119)	2 789	(2 481-3 190)	92	(82-104)	7 018	(6 271-7 939)
2014–15	2 296	(1 851–3 011)	1 982	(1 738-2 310)	3 776	(3 418-4 242)	141	(128-156)	8 199	(7 484-8 996)
2015–16	2 180	(1 634–3 181)	1 368	(1 205-1 576)	2 083	(1 793-2 501)	88	(77-102)	5 185	(4 538-6 025)
2016–17	2 340	(1 758–3 331)	2 145	(1 850-2 568)	2 253	(1 963-2 619)	89	(79-101)	7 167	(6 198-8 493)

Estimated discards in each of the standard areas, for each catch category, is shown in Figure 21 and Figure 22 and in more detail (with confidence intervals) in Table A5. Target species discards were greatest in the WCSI fishery in most years, with smaller levels in CHAT and STEW. In COOK, they grew from negligible levels in the mid-2000s to about a third of the total between 2014–15 and 2016–17 (Figure 21). Closer examination of the raw observer data for COOK showed that although discarding of the target species was relatively rare in these three years (based on an average of over 220 observed tows per year), discard amounts were substantial when they did occur. In contrast to target species discards, COOK accounted for a substantial fraction of QMS species discards in most years, but WCSI, STEW, and CHAT all contributed roughly similar amounts for the period as a whole. Discards of non-QMS fish species were strongly dominated by CHAT in most years, with WCSI usually the area with the next highest levels, with large contributions from STEW, PUYS, and COOK in some years (Figure 22). Non-QMS invertebrate species discards were also mostly associated with CHAT, at least in the earlier years in the series, with the proportion of the total attributable to STEW growing over time and dominating after 2010–11. The distribution of total discards among areas followed a similar pattern over time to that of the main contributor (non-QMS fish species), with CHAT dominating in many years, but there was a more substantial contribution from WCSI and STEW due to their relatively high contribution to discards in the other species categories.
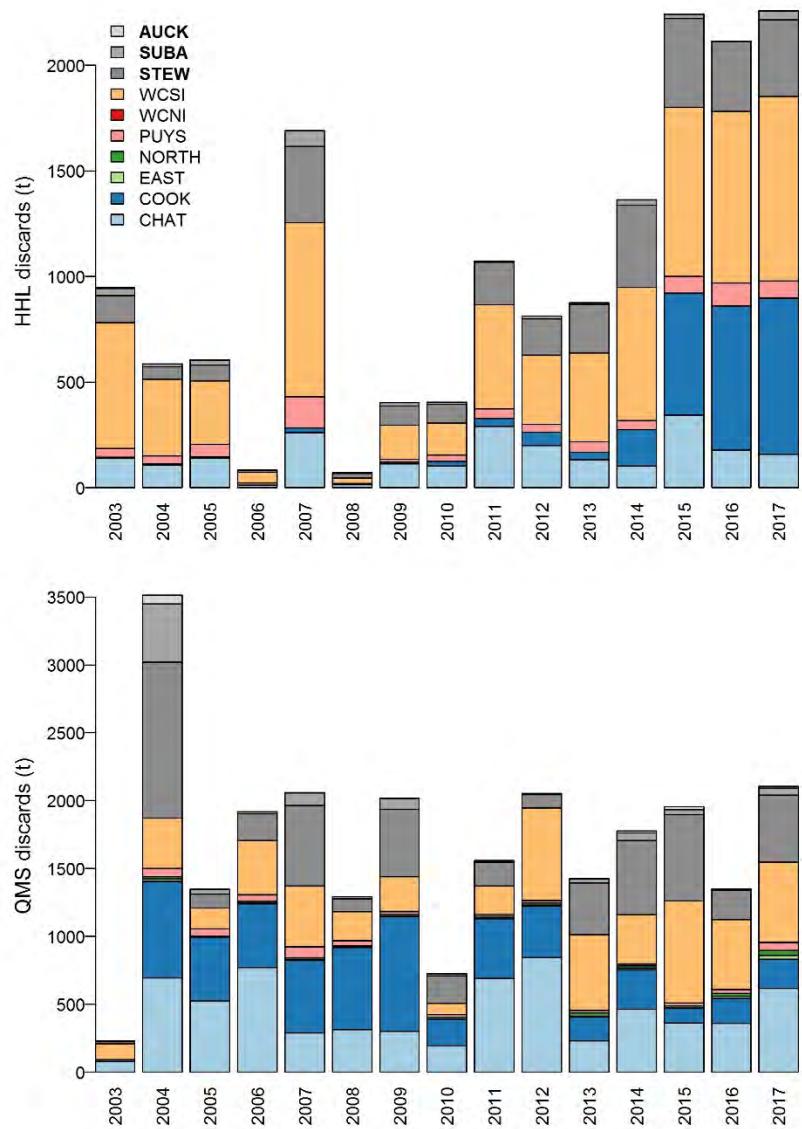
Figure 21: Estimated annual discards of hoki, hake, and ling (top) and QMS species (bottom) in each of ten standard areas. Shades of grey (bold in the legend) combine to illustrate the overall sub-Antarctic region.
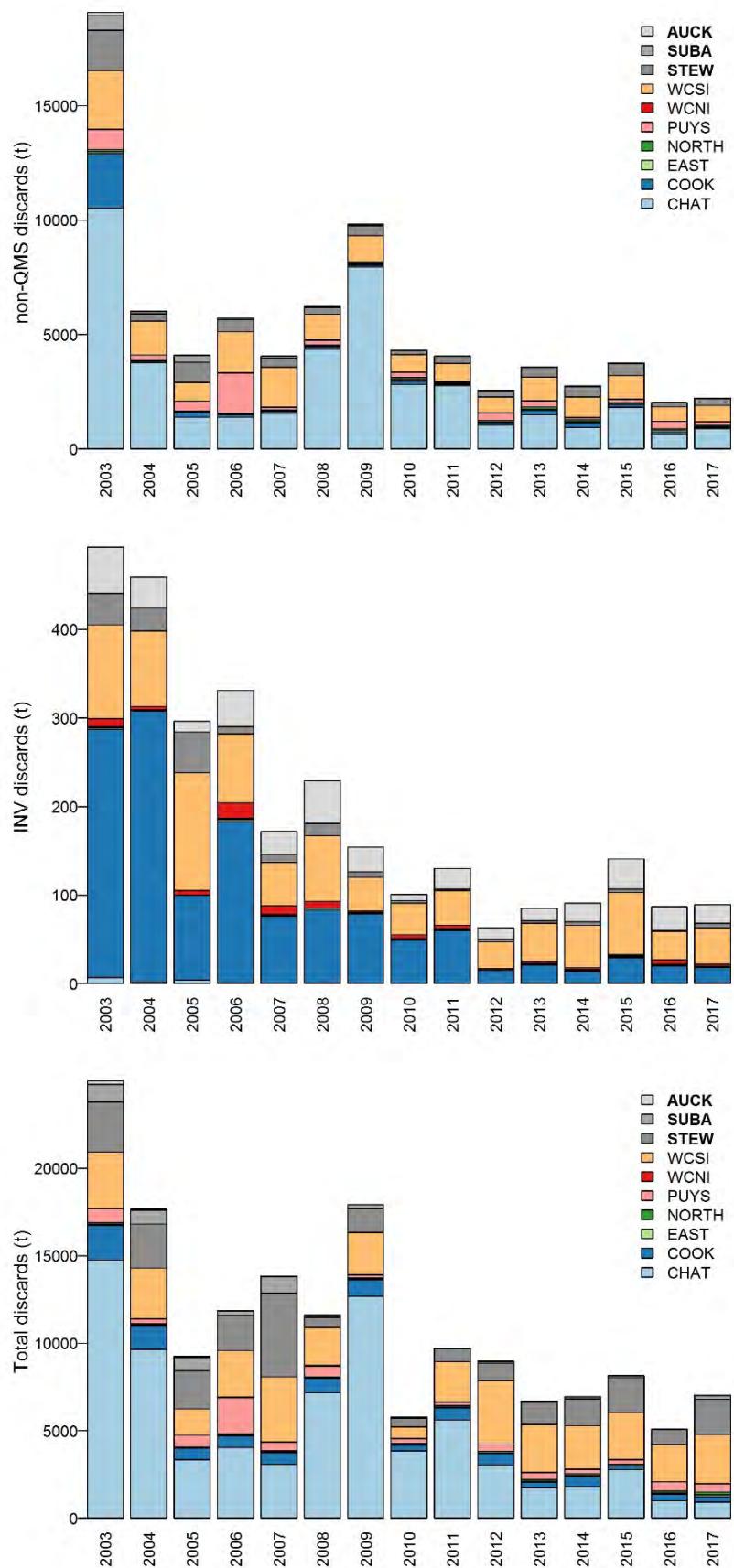
Figure 22: Estimated annual discards of non-QMS fish species (top), non-QMS invertebrate species (middle), and all species (bottom) in each of ten standard areas. Shades of grey (bold in the legend) combine to illustrate the overall sub-Antarctic region.

Table 12: Summary of results of linear regression analyses for trends in annual discards, by species category, for the hoki, hake, ling, silver warehou, and white warehou fishery between 2002–03 and 2016–17. The *p* values indicate whether the slopes differed significantly from zero. Those results where *p* values are less than 0.01 (generally considered highly significant) are shown in bold.

Species category	Slope	*p*
HHL	0.125	0.043
QMS	0.038	0.318
NONQMS	**-0.100**	**0.001**
INV	**-0.128**	**<0.001**
Total	**-0.080**	**0.001**

3.6.2   Observer-authorised discarding

Section 72 of the Fisheries Act (1996) allows for the legal discarding of QMS species not listed in Schedule 6 if authorised by an observer (or fishery officer) who is present at the time. Such discarding is recorded at sea on an "Authority to return or abandon fish to the sea" form and, since 1 October 2013, on CLR forms. To assess the extent of discarding reported in this way, an examination of CLR data was made, based on all fishing trips which mainly targeted HOK, HAK, LIN, SWA, or WWA (over 50% of tows per trip). This showed that in the HOK, HAK, LIN, SWA, or WWA fishery the approximate level of observer authorised discards was substantial; 1130 t in 2013–14, 1400 t in 2014–15, 1260 t in 2015–16, and 1000 t in 2016–17. These amounts represent about 25–35% of the total (CLR) reported discards in those years.

In addition to the CLR system of recording these discards, observers also provided a summary of all approved discarding for each trip in their trip report, but this is not recorded in a database (although for recent years the code OAD (Observer Authorised Discards) has been used for individual species discard amounts). A complicating factor with the data from both sources (if they were to have been incorporated into this study) is that usually the records relate to the combined discards from several fishing events, or the entire trip, and reconciling these data with the catch from individual tows is usually not possible.

Observer authorised discarding has the potential to bias estimation of discards which are based on observed discard rates. Ideally such discards would be ignored in the calculations, but this could be done only by assuming that all QMS species discards in the observer databases were properly approved. This would lead to a discard ratio of zero and imply zero discarding of (non-Schedule 6, or fish smaller then MLS) QMS species in the unobserved portion of the fishery. The annual QMS species discard estimates presented in this report therefore implicitly assume that the level of discarding of QMS species not listed in Schedule 6 and MLS of the Fisheries Act (1996) is unaffected by the presence of an observer on the vessel.

3.7   Bycatch utilisation rates

Annual bycatch and discard estimates in the HOK, HAK, LIN, SWA, and WWA trawl fishery were divided by the estimated annual target species catch, and annual discards were divided by annual bycatch in the fishery, to provide measures of the fishery's utilisation rates (Table 13, Figure 23). The bycatch fraction (kg of bycatch/kg of target species catch) is a measure of how effective the fishery is at restricting the catch to the target species (with any value below 1 indicating that the target species comprises most of the catch), in a form that can easily be compared across any fishery. Similarly, the discard fraction (kg of discards/kg of target species catch) provides a measure of the utilisation rate that can be compared across fisheries. Total discards as a fraction of total bycatch provides an alternative measure of the utilisation of bycatch that may be useful for fishery managers.

The bycatch fraction in the fishery generally increased over time, from 0.09–0.1 in the early 1990s to 0.2–0.25 in most years after 2000–01, but with a dip between 2009–10 and 2014–15 (Figure 23). The discard

fraction was more constant over time, 0.04–0.08 in most years, but was higher (up to 0.17) between 2002–03 and 2008–09 followed by a gradual decrease to the end of the series. Total discards as a fraction of bycatch was highly variable throughout the time series, but generally declined over time, from about 0.6–0.7 in the early 1990s to around 0.2 in the last five years of the series.

Table 13: Estimated annual catch of hoki, hake, and ling (t), total bycatch (t), and total discards (t) in the target trawl fishery; bycatch fraction (kg of total bycatch per kg of hoki, hake, and ling caught), discard fraction (kg of total discards per kg of hoki, hake, and ling caught); and discards as a fraction of bycatch. *, estimates for these years are from Ballara & O'Driscoll (2015). NA, not estimated.

Fishing year	Target species estimated catch	Total bycatch	Total discards	Bycatch fraction	Discard fraction	Discards / bycatch
1990–91	233 340	23 938	*13 984	0.10	0.06	0.58
1991–92	232 731	20 500	*13 385	0.09	0.06	0.65
1992–93	218 246	18 605	*10 562	0.09	0.05	0.57
1993–94	205 108	17 554	*12 622	0.09	0.06	0.72
1994–95	198 409	26 023	*15 172	0.13	0.08	0.58
1995–96	237 408	41 586	*15 549	0.18	0.07	0.37
1996–97	269 546	48 624	*16 633	0.18	0.06	0.34
1997–98	295 659	47 430	*NA	0.16	NA	NA
1998–99	270 545	33 984	*12 062	0.13	0.04	0.35
1999–2000	267 835	43 473	*17 002	0.16	0.06	0.39
2000–01	255 840	46 933	*13 081	0.18	0.05	0.28
2001–02	219 166	43 500	*16 204	0.20	0.07	0.37
2002–03	207 954	44 876	25 167	0.22	0.12	0.56
2003–04	161 660	42 320	17 812	0.26	0.11	0.42
2004–05	129 475	28 835	9 356	0.22	0.07	0.32
2005–06	124 287	30 804	12 046	0.25	0.10	0.39
2006–07	122 074	27 893	14 096	0.23	0.12	0.51
2007–08	105 567	27 173	11 728	0.26	0.11	0.43
2008–09	106 518	27 070	18 078	0.25	0.17	0.67
2009–10	118 469	31 094	5 802	0.26	0.05	0.19
2010–11	131 310	25 968	9 866	0.20	0.08	0.38
2011–12	143 656	21 151	9 097	0.15	0.06	0.43
2012–13	148 525	30 077	6 816	0.20	0.05	0.23
2013–14	160 402	35 798	7 018	0.22	0.04	0.20
2014–15	178 661	45 863	8 199	0.26	0.05	0.18
2015–16	149 150	31 254	5 185	0.21	0.03	0.17
2016–17	156 636	34 865	7 167	0.22	0.05	0.21
All years	5 048 177	897 191	323 689	0.18	0.06	0.36
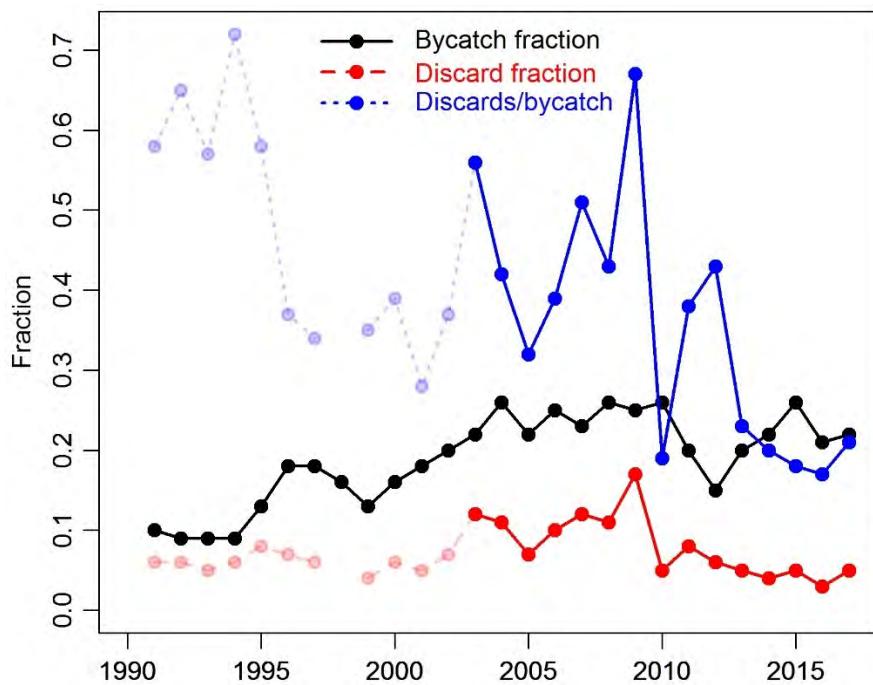
Figure 23. Bycatch and discard fractions in the target hoki, hake, ling, silver warehou, and white warehou trawl fishery. Bycatch fraction, total bycatch divided by total estimated hoki, hake, ling catch; Discard fraction, total discards divided by total estimated hoki, hake, ling catch; Discards/bycatch, total discards divided by total bycatch. Faded sections of the plot indicate data points that are partly or completely derived from the earlier analysis of Ballara & O'Driscoll (2015).

3.8   The effect of observer coverage level on estimates of precision

Precision estimates (CVs) of the main catch categories of bycatch and discards were compared with annual observer coverage levels to determine whether model precision improved with increased levels of observer effort in the fishery (Table 14 and Figure 24).

Estimated precision improved with increased observer coverage for both bycatch and discards in all categories. This is most clearly shown for non-QMS fish bycatch, for which the CV is over 47% when observer coverage was at its lowest (7.7%) in 1996–97 and improved to be less than 20% in all years with over about 24% coverage (Table 14). Precision was generally highest for non-QMS invertebrate species and total (all species) categories, for both bycatch and discards. Discards of the target species (relatively rare but often large amounts) were the most poorly estimated, with CVs over 25% in all years. Non-linear least squares regressions fitted to the data points for all categories indicated that to achieve a CV of, for example, 30% would require observer coverage of about 7% for bycatch and about 27% for discards.

Table 14: Observer coverage (percent of total target species catch) and estimates of precision (CVs) for annual estimates of bycatch and discards in the main catch categories. Rows are ordered from lowest to highest annual observer coverage; — not estimated.

| Fishing year | Observer coverage (%) | Bycatch CVs (%) | | | | Discards CVs (%) | | | | |
		QMS	Non-QMS fish	Non-QMS Inv.	Total	HHL	QMS	Non-QMS fish	Non-QMS Inv.	Total
1997	7.7	47.5	24.6	18.6	21.3	—	—	—	—	—
2003	11.0	14.4	12.5	13.8	12.1	81.0	44.6	21.0	21.2	22.6
1996	12.6	34.7	25.0	14.2	18.7	—	—	—	—	—
1998	13.3	23.2	13.9	10.2	12.7	—	—	—	—	—
2004	13.7	18.5	17.3	14.7	14.8	57.8	29.9	23.6	24.3	24.5
2000	13.8	13.8	13.0	11.7	10.7	—	—	—	—	—
2001	14.1	17.2	11.0	11.5	10.5	—	—	—	—	—
1993	14.3	28.3	18.9	13.1	17.2	—	—	—	—	—
1995	14.9	32.0	16.0	12.0	14.3	—	—	—	—	—
2002	14.9	13.6	12.4	11.5	10.9	—	—	—	—	—
1999	15.3	13.8	11.3	10.7	9.4	—	—	—	—	—
2005	15.5	15.1	13.8	14.0	11.8	83.1	29.8	26.4	28.2	25.5
1992	16.3	24.0	11.9	9.6	10.8	—	—	—	—	—
1991	17.9	25.4	11.4	9.6	11.5	—	—	—	—	—
2006	19.5	15.8	16.9	14.3	12.9	214.2	33.1	35.3	24.2	25.5
2011	20.5	19.2	15.6	17.2	13.6	51.8	44.7	24.3	18.7	34.2
2007	21.4	17.0	15.8	16.1	12.3	91.0	30.5	25.5	20.1	30.9
1994	23.0	24.2	11.0	13.9	11.6	—	—	—	—	—
2009	24.1	20.6	16.9	13.8	13.8	44.2	38.0	27.3	19.5	31.2
2008	24.4	13.6	16.9	11.0	11.2	74.2	32.7	23.6	19.5	23.9
2010	26.6	17.4	20.0	12.1	13.9	27.7	21.4	23.3	12.2	21.1
2012	27.7	14.8	13.4	12.9	10.6	37.6	26.0	22.8	17.3	22.7
2017	29.3	12.4	16.4	13.3	11.0	46.8	23.0	20.2	13.1	23.8
2016	34.1	14.9	13.7	14.0	11.4	48.7	18.2	23.3	15.0	20.9
2015	38.4	12.6	15.2	11.6	11.1	34.8	19.8	15.6	11.0	13.9
2014	40.2	13.3	10.0	10.2	9.4	37.8	21.2	17.8	12.7	17.7
2013	47.3	17.3	13.4	10.8	10.7	44.3	24.8	20.8	10.4	18.8
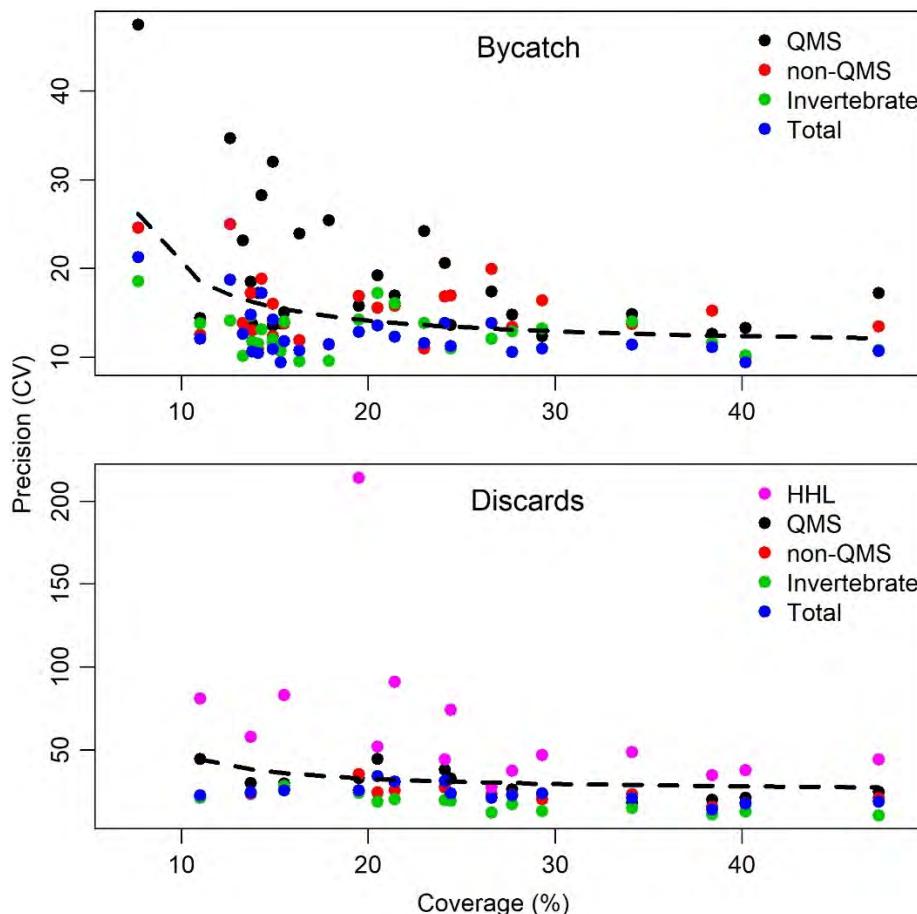
Figure 24: Precision (CV) of annual estimates of bycatch (top) and discards (bottom) plotted against observer coverage levels (percentage of target species catch, see
Table 6), for each of the main categories of catch and discards. The dashed line in each plot represents a non-linear least squares regression through the points.

3.9   Annual bycatch and discards by selected categories and individual species

Annual bycatch and discard estimates for selected catch categories and some of the more commonly caught individual species, along with regression slopes indicating general trends in abundance, are presented in Table A6–Table A8, and Figure 25.

Based on these estimates the bycatch species/species categories caught in the greatest amounts over the entire commercial fishery were (in decreasing order) unspecified rattails (RAT), sharks (SHA), javelinfish (JAV), Schedule 6 species, spiny dogfish (SPD), morid cods (MORID), pale ghost sharks (GSP), frostfish (FRO), sea perch (SPE), ribaldo (RIB), black oreo (BOE), dark ghost shark (GSH), and lookdown dory (LDO) (Table A6, Figure 25). Of the thirty bycatch species/species groups examined, four had a significant decrease in catch over time, and five had an increase in catch over time (the remaining species showed no change at the 1% level of significance). The species that had significant declines were morid cods, jack mackerels, frostfish, and orange roughy; those that had significant increases were slickheads, arrow squid, pale ghost shark, javelinfish, and southern blue whiting (Table A6).

Annual discards of QMS species and of combined groups mainly comprising QMS species (e.g. morid cods) were in most cases only a small fraction of bycatch, and often close to zero (Figure 25). The exceptions to this were the Schedule 6 group of QMS species and spiny dogfish (all of which can legally be returned to the sea). Over the 15-year period of the analysis there were significant increases in discards of arrow squid and giant stargazer, and no significant decreases for any species or groups.
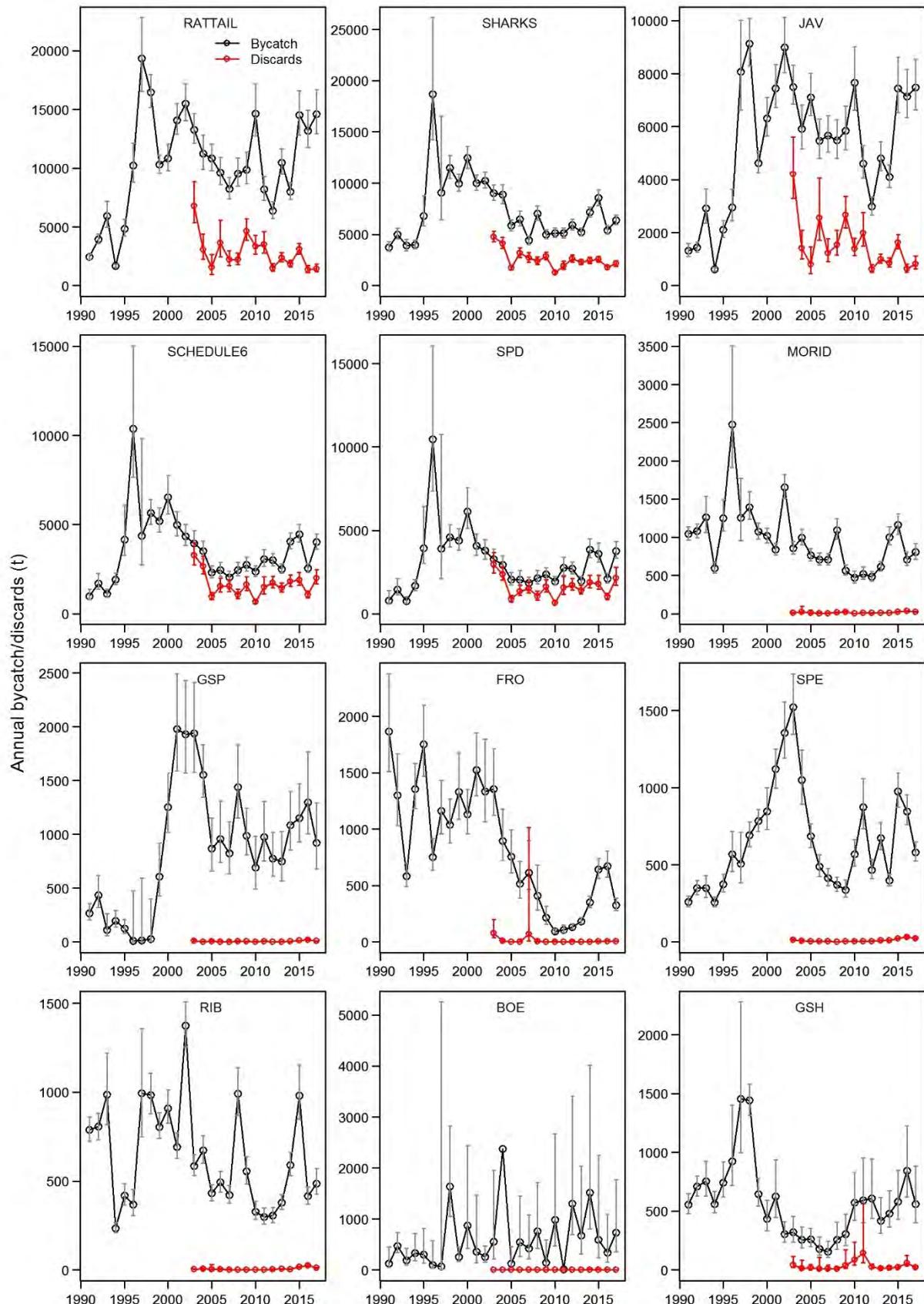
Figure 25: Estimates of annual bycatch and discards in the target hoki, hake, ling, silver warehou or white warehou trawl fishery for selected bycatch species groups and the main individual bycatch species, with 95% CIs. Plots are ordered (from left to right, top to bottom) by decreasing total catch over the period. See Table A1 for species code definitions. Note: the scale changes on the y-axis between plots.
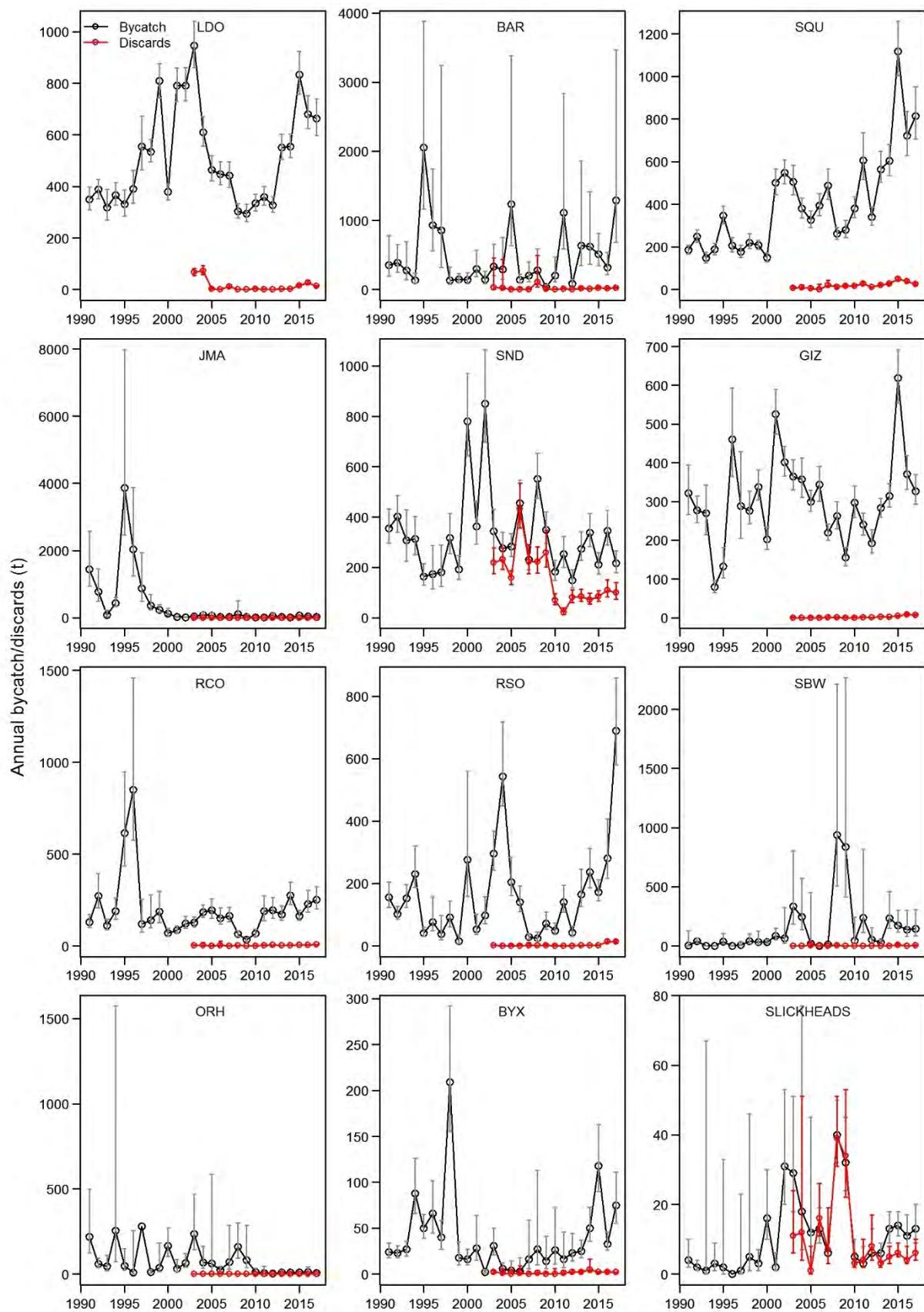
Figure 25: continued

3.10   Investigation of a spatially correlated modelling approach for bycatch estimation

The CAR model was found to perform well, with convergence observed for all test applications and updates to the priors for τ and ρ (Figure 26). Most notably, we were able to estimate spatial grid-level correlations for all species-specific applications except for FRO. Estimates of the bycatch were also consistent with the other spatial and non-spatial models (Figure 27). However, there was no discernible improvement in the fits to the data, and the residual discrepancies were similar for all models, with or without spatial resolution and whether or not a CAR prior was used (Figure 27). This may be because the Chatham Rise represents a reasonably uniform habitat, and therefore data were sufficient to resolve the grid-level model even without a CAR prior. Nevertheless, there are fundamental reasons why higher spatial resolution in the estimation of bycatch is desirable, although to establish this formally would require further investigation.
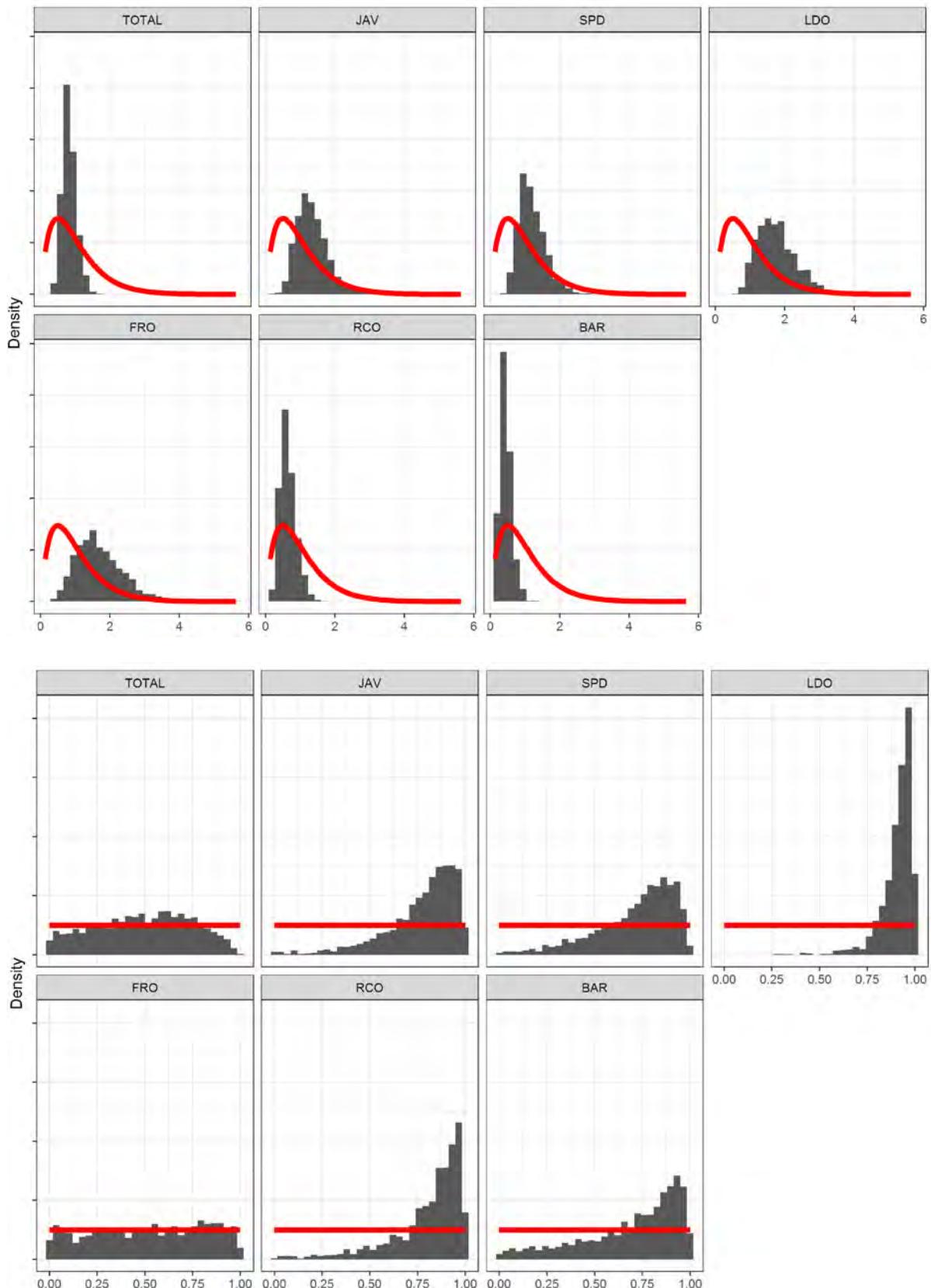
Figure 26: Prior updates to τ (top) and ρ (bottom) parameters for the CAR model applied to estimate total bycatch and bycatch of six individual species, showing the prior distribution (red line) and posterior density histogram (grey bars).
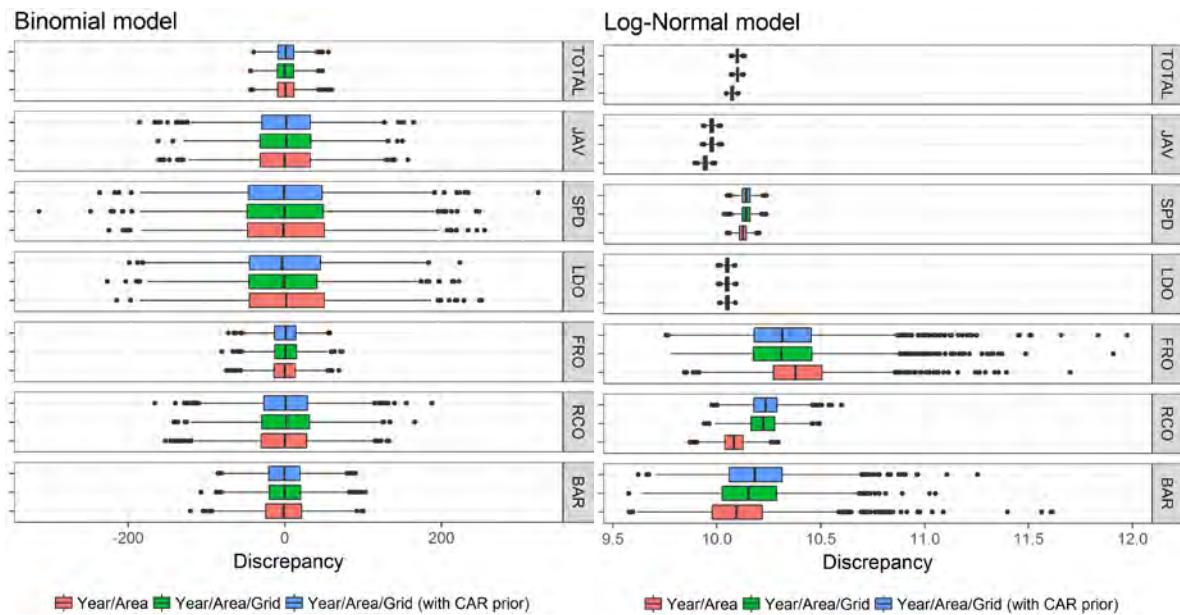
Figure 27: Discrepancy measures for each model, showing the posterior distribution of the sum of the residuals for each model part.

4 SUMMARY AND DISCUSSION

Observer coverage

The annual estimates of bycatch and discards for the hoki, hake, ling target trawl fishery rely on data collected from the observed fraction of the fishery and therefore are likely to be strongly dependent on the level and spread of observer coverage as well as the quality of the data collected. No attempt was made to account for any difference in fishing and onboard processing behaviour that might have occurred between the observed and unobserved sectors of the fishery. Any available information on such differences is largely anecdotal (e.g. Simmons et al., 2015), potentially biased if the providers of such information are not selected randomly, and not easily incorporated into the analysis carried out for this report. Because of the incomplete reporting of observer authorised QMS species discards, and the lack of reliable information on the relative levels of illegal discarding between observed and unobserved vessels, we have taken a pragmatic approach and assumed that discarding of (non-Schedule 6) QMS species is unaffected by the presence of an observer on board.

The level of observer coverage over the 27-year period averaged about 20% of the total estimated target species catch in the hoki, hake, ling, silver warehou, white warehou target trawl fishery, but only about 14% of the total number of trawls—the difference due to the relatively high level of coverage on larger vessels with greater average catches. Observer coverage increased over time, to be greater than 20% in each year after 2005–06 and peaked at close to 50% in 2012–13. For comparison with other offshore fisheries, observer coverage since 1990 averaged 29% in the arrow squid trawl fishery, 10% in the scampi trawl fishery, 33% in the jack mackerel, 50% in the southern blue whiting trawl fishery, 23% in the orange roughy trawl fishery, 20% in the oreo trawl fishery, and 13% in the ling longline fishery (Anderson & Edwards 2018, Anderson 2009; Anderson 2014, Anderson et al. 2017a; Anderson et al. 2017b).

The distribution of observer effort was strongly representative of total commercial effort across the range of available fishery parameters. The major fisheries on the Chatham Rise, the West Coast South Island, the Stewart-Snares shelf, Cook Strait, and the sub-Antarctic were well sampled by observers in most years, however the smaller fisheries around the North Island tended to be poorly-sampled. The main vessels and vessel sizes operating in the fishery all received relatively high levels of coverage, although the largest were oversampled and the smallest under-sampled – a scenario common to most of the offshore fisheries observed

due to the ease with which observers are accommodated on large factory trawlers compared with smaller ice boats. Coverage was spread throughout the year but with a large increase in effort during the hoki spawning period in July–September, which is disproportionate to the modest level of increased effort by the fleet during that time.

Model structure and output

The selection of standard fishery area as the primary variable for stratification of the analyses was a choice made to align the outputs from this analysis with those from each of the other offshore fisheries that are examined under this programme. Although these standard areas do not match the management QMAs for any of the target fishery species, they are a practical combination of default Fisheries Management Areas (FMAs), individual QMAs for many fisheries, and natural physical or biological boundaries.

One of the advantages of the model-based method over the ratio-based method used in earlier analyses for this fishery is that it allows for a natural inclusion of other covariates. The covariates thus selected comprised area, fishing year, and gear-type (bottom or midwater trawl) and, for discards only, vessel class. The inclusion of vessel class as a covariate addressed a potential source of bias in the model. Since 2012–13 100% observer coverage has been required on foreign owned vessels and this resulted in less coverage of domestic vessels. Preliminary analysis of observer records showed that discarding on foreign owned vessels was greater than on domestic vessels in each of the combined species categories examined. Disregarding this in the model structure would have led to underestimation or overestimation of annual discard levels, depending on the relative level of effort by each vessel class in each year

Estimation of bycatch and discards focussed on three broad categories of catch; QMS species, non-QMS fish species, and non-QMS invertebrates. These categories do not match the QMS, non-QMS fish, and non-QMS invertebrate species categories used in previous analyses of this fishery as the allocation of species to these categories is dependent on their date of entry into the QMS, thus altering the composition of each category from year to year. This changing composition needed to be accounted for in the estimation model and was achieved by incorporating a year/area interaction term in the models for these three species groups. These revised categories limited the comparison of results from earlier analyses of the fishery with those from the current study to estimates of *total* bycatch and *total* discards, and discards of the target species, for the 23 (bycatch) or 11 (discards) years in which the studies overlap. Although the overall trends were similar, the updated estimates of total annual bycatch and discards for most of the overlapping years were greater than the earlier estimates for total bycatch and total discards. However, the estimates were more similar between studies for target species discards. These differences may be attributed to the expanded target fishery definition used here (to include silver warehou and white warehou), a change in the estimation model from the ratio method used previously to the statistical model method used here (which more naturally estimates rates in data poor strata), as well as changes in stratification and slight differences in data grooming methods.

Composition and level of bycatch and discards

Since 2002–03, hoki accounted for about 73% of the total estimated catch weight recorded by observers in the fishery, while the other target species accounted for a further 17% – hake (6.7%); ling (5.2%); silver warehou (3.9%); and white warehou (1.3%). About half of the remaining catch comprised javelinfish (1.9%), other (unspecified) rattails (1.6%), and spiny dogfish (1.4%) while the other half comprised mostly a range of other bony fishes and chondrichthyans. Non-QMS invertebrate species bycatch was dominated by the QMS species arrow squid, with non-QMS invertebrates comprising a wide range of molluscs, sponges, echinoderms, crustaceans, and cnidarians, most of which were less than 0.01% of the observed catch during the period.

Bycatch across all years was an even mixture of QMS species and non-QMS fish species, although several species moved from the non-QMS fish category to the QMS category during the period and resulted in decreased contributions of the former and increased contributions of the latter category, and therefore trends are difficult to interpret. The most important of these species were cardinalfish, frostfish, ghost sharks, ribaldo, and southern blue whiting in 1998 and 1999; skates, spiny dogfish, and lookdown dory in

2003 and 2004; and redbait in 2009. Although none of these species accounted for more than 2% of the total observed catch, all were in the top 40 recorded bycatch species. Annual bycatch of non-QMS invertebrate species, although waxing and waning with changes in total fishery effort, increased significantly over time, from about 400–700 t in the early 1990s to over 1100 t after 2014–15. The range of total annual bycatch during the 27-year period analysed was about 17 500–49 000 t, fluctuating over time approximately in keeping with changes in total effort throughout the period.

Total annual bycatch calculated directly from commercial catch records was substantially lower than the observer-based estimates for most years and this method, although attractive due to its ease of calculation and complete coverage of the fishery, doesn't appear to provide a reliable alternative estimate. This estimate, typically based solely on the skippers "eyeball" estimate of the amount of non-target species catch in the cod-end, appears to underestimate total bycatch in this fishery. Importantly, however, it is not an indication of under-reporting of bycatch species; at worst it may suggest a common misinterpretation of the forms whereby total catch and target species catch are given the same value.

Discarding of target species (hoki, hake, ling) was generally low but highly variable, ranging from 76 t to about 2300 t, with the largest levels in the last three years of the series. However, annual discards in this category are substantially less than estimated for most of the 1990s (Ballara & O'Driscoll 2015). Discards of QMS species and non-QMS fish species followed a similar pattern to that of bycatch (for the years in common), with increased QMS discards and a significant decline in non-QMS fish discards. However, discards of non-QMS invertebrate species declined significantly despite increased bycatch over the same period. This is likely to be due to the increased use of meal plants in this fleet, with landings records indicating mealing of large quantities of warty squid, the main (non-QMS) invertebrate bycatch species, in recent years. Total discards ranged from about 5000 t to about 25 000 t per year and decreased significantly between 2002–03 and 2016–17.

The estimation of bycatch levels for several additional species groups plus the main individual bycatch species enables detection of substantial changes in catches over time, and possibly provides an early indication of a change in abundance. There were few significant trends in bycatch levels over time for these taxa, and negative and positive trends were similarly common. The species groups that showed significant declines were morid cods, jack mackerels, frostfish, and orange roughy.

Discards relative to target catch

The discard fraction (kg of discards/kg of target species catch) ranged from 0.03 in 2015–16 to 0.17 in 2008–09, with an overall value for the 27-year period of 0.06, and showed little trend over time. These rates can be compared with recent mean rates in other New Zealand offshore fisheries which are similarly monitored, as follows: arrow squid (0.12), scampi (3.6), southern blue whiting (0.005), jack mackerel (0.007), ling longline (0.3), orange roughy (0.07), and oreos (0.01) (Anderson 2009, 2014, Anderson et al. 2017a, Ballara & O'Driscoll 2015, Anderson et al. 2017b, Anderson & Edwards 2018).

5   ACKNOWLEDGEMENTS

6   REFERENCES

Anderson, O.F. (2009). Fish and invertebrate bycatch and discards in southern blue whiting fisheries, 2002–07. *New Zealand Aquatic Environment and Biodiversity Report 43*. 42 p.

Anderson, O.F. (2012). Fish and invertebrate bycatch and discards in New Zealand scampi fisheries from 1990–91 until 2009–10. *New Zealand Aquatic Environment and Biodiversity Report No. 100*. 65 p.

Anderson, O.F. (2013). Fish and invertebrate bycatch and discards in New Zealand arrow squid fisheries from 1990–91 until 2010–11. *New Zealand Aquatic Environment and Biodiversity Report No. 112*. 62 p.

Anderson, O.F. (2014). Fish and invertebrate bycatch and discards in New Zealand ling longline fisheries from 1992–93 until 2011–12. *New Zealand Aquatic Environment and Biodiversity Report 138*. 66 p.

Anderson, O.F.; Ballara, S.L.; Edwards, C.T.T. (2017a). Fish and invertebrate bycatch and discards in New Zealand orange roughy and oreo trawl fisheries from 2001–02 until 2014–15. *New Zealand Aquatic Environment and Biodiversity Report No. 190*. 216 p.

Anderson, O.F.; Edwards, C.T.T. (2018). Fish and invertebrate bycatch and discards in New Zealand arrow squid and scampi trawl fisheries from 2002–03 until 2015–16. *New Zealand Aquatic Environment and Biodiversity Report No. 199*. 135 p.

Anderson, O.F.; Edwards, C.T.T.; Roux, M-J. (2017b). Fish and invertebrate bycatch and discards in New Zealand jack mackerel trawl fisheries from 2002–03 until 2013–14. *New Zealand Aquatic Environment and Biodiversity Report No. 177*. 71 p.

Anderson, O.F; Gilbert, D.J; Clark, M.R (2001). Fish discards and non-target catch in the trawl fisheries for orange roughy and hoki in New Zealand waters for the fishing years 1990–91 to 1998–99. *New Zealand Fisheries Assessment Report 2001/16*. 57 p.

Anderson, O.F; Smith, M.H (2005). Fish discards and non-target fish catch in the New Zealand hoki trawl fishery, 1999–2000 to 2002–03. *New Zealand Fisheries Assessment Report 2005/3*. 37 p.

Ballara, S.L. (2015). Descriptive analysis of the fishery for hake (*Merluccius australis*) in HAK 1, 4 and 7 from 1989–90 to 2012–13, and a catch-per-unit-effort (CPUE) analysis for Sub-Antarctic hake. *New Zealand Fisheries Assessment Report 2015/12*. 60 p.

Ballara S.L.; Baird, S.J. (2012). Fishery characterisation and standardised CPUE analyses for white warehou, *Seriolella caerulea*, 1989–90 to 2009–10. *New Zealand Fisheries Assessment Report 2012/49*. 265 p.

Ballara, S.L.; O'Driscoll, R.L. (2015). Fish and invertebrate bycatch and discards in New Zealand hoki, hake, and ling fisheries from 1990–91 until 2012–13. *New Zealand Aquatic Environment and Biodiversity Report No. 163*. 120 p.

Ballara, S.L.; O'Driscoll, R.L. (2017). Catches, size, and age structure of the 2015–16 hoki fishery, and a summary of input data used for the 2017 stock assessment. *New Zealand Fisheries Assessment Report 2017/31*. 119 p.

Ballara, S.L.; O'Driscoll, R.L. (2018). Catches, size, and age structure of the 2016–17 hoki fishery, and a summary of input data used for the 2018 stock assessment. *New Zealand Fisheries Assessment Report 2018/38.*

Ballara, S.L.; O'Driscoll, R.L.; Anderson, O.F. (2010). Fish discards and nontarget fish catch in the trawl fishery for hoki, hake, and ling in New Zealand waters. *New Zealand Aquatic Environment and Biodiversity Report No. 48*. 100 p.

Besag, J.; York, J.; Mollie, A. (1991). Bayesian image restoration, with two applications in spatial statistics. *Annals of the Institute of Statistical Mathematics, 43(1)*:1–20.

Bivand, R.; Piras, G. (2015). Comparing Implementations of Estimation Methods for Spatial Econometrics. *Journal of Statistical Software, 63(18)*: 1–36.

Burns, R.J.; Kerr, G.N. (2008). Observer effect on fisher bycatch reports in the New Zealand ling (*Genypterus blacodes*) bottom longlining fishery. *New Zealand Journal of Marine and Freshwater Research 42*: 23–32.

Clark, M.R.; Anderson, O.F.; Gilbert, D.J. (2000). Discards in trawl fisheries for southern blue whiting, orange roughy, hoki, and oreos in New Zealand waters. *NIWA Technical Report 71*. 73 p.

Devine, J. (2009). Descriptive analysis of the commercial catch and effort data for New Zealand hake (*Merluccius australis*) for the 1989–90 to 2005–06 fishing years. *New Zealand Fisheries Assessment Report 2009/21*. 74 p.

Fisheries New Zealand (2018). Fisheries Assessment Plenary, May 2018: stock assessments and stock status. Compiled by the Fisheries Science and Information Group, Fisheries New Zealand, Wellington, New Zealand. 1674 p.

Horn, P.L. (2005). A review of the stock structure of ling (*Genypterus blacodes*) in New Zealand waters. *New Zealand Fisheries Assessment Report 2005/59*. 41 p.

Horn, P.L.; Dunn, A. (2007). Stock assessment of hake (*Merluccius australis*) on the Chatham Rise for the 2006–07 fishing year. *New Zealand Fisheries Assessment Report 2007/44*. 62 p.

Horn, P.L.; Dunn, M.R.; Ballara, S.L. (2013). Stock assessment of ling (*Genypterus blacodes*) on the Chatham Rise (LIN 3&4) and in the Sub-Antarctic (LIN 5&6) for the 2011–12 fishing year. *New Zealand Fisheries Assessment Report 2013/6*. 87 p.

McCaughran, D.A. (1992). Standardized nomenclature and methods of defining bycatch levels and implications. *In*: Schoning, R.W.; Jacobson, R.W.; Alverson, D.L.; Gentle, T.G.; Auyong, J. (eds). Proceedings of the National Industry Bycatch Workshop, 4–6 February 1992, Oregon, pp. 200–201.

Mackay, K.; Dunn, A.; Wood, B.; Mackay, E. (2005). New Zealand Fisheries Management Areas 1:4 000 000. NIWA Miscellaneous Chart Series No. 83.

Ministry for Primary Industries (2017). Aquatic Environment and Biodiversity Annual Review 2017. Compiled by the Fisheries Science Team, Ministry for Primary Industries, Wellington, New Zealand. 724 p.

R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Simmons, G.; Bremner, G.; Stringer, C.; Torkington, B.; Teh, L.C.L.; Zylich, K.; Zeller, D.; Pauly, D.; Whittaker, H. (2015). Preliminary reconstruction of marine fisheries catches for New Zealand (1950-2010). Fisheries Centre Working Paper #2015-87, University of British Columbia, Vancouver, 33 p.

Stan Development Team (2016). RStan: the R interface to Stan. R package version 2.14.1. http://mc-stan.org/.

Sullivan, S.G.; Greenland, S. (2013). Bayesian regression in SAS Software. *International Journal Epidemiology 42:* 308–317.

Tracey, D.M.; Anderson, O.F.; Naylor, J.R. (2011). A guide to common deepsea invertebrates in New Zealand waters. Third edition. *New Zealand Aquatic Environment and Biodiversity Report 86*. 317 p.

7 APPENDIX A: SUMMARY DATA TABLES

Table A1: Observed FISH catch and discards for target HOK, HAK, LIN, SWA or WWA trawls. Species codes, common and scientific names, estimated catch, percentage of total catch, and overall percentage discarded of the top 120 fish species or species groups by weight from observer records for the target trawl fishery from 1 Oct 2002 to 30 Sep 2017. Records are ordered by decreasing percentage of catch. Codes in bold are QMS species (as of 1 October 2016); codes in italics are Schedule 6 QMA species (can legally be returned to the sea). Here GIZ is equivalent to STA (all *Kathetostoma* spp.), RSO is equivalent to SKI (all *Rexea* spp.), and NMP is equivalent to TAR (both tarakihi species). [Continued on next page]

Species code	Common name	Scientific name	Observed catch (t)	% of catch	% discarded
HOK	Hoki	*Macruronus novaezelandiae*	462 579.5	73.05	1.20
HAK	Hake	*Merluccius australis*	42 414.2	6.70	0.42
LIN	Ling	*Genypterus blacodes*	32 949.2	5.20	0.21
SWA	Silver warehou	*Seriolella punctata*	24 380.2	3.85	0.55
JAV	Javelin fish	*Lepidorhynchus denticulatus*	11 844.0	1.87	37.40
RAT	Rattails (unspecified)	Macrouridae	9 838.2	1.55	42.67
SPD	Spiny dogfish	*Squalus acanthias*	8 923.7	1.41	69.35
WWA	White warehou	*Seriolella caerulea*	8 474.7	1.34	0.21
BAR	Barracouta	*Thyrsites atun*	2 989.8	0.47	6.44
FRO	Frostfish	*Lepidopus caudatus*	2 630.8	0.42	5.87
GSP	Pale ghost shark	*Hydrolagus bemisi*	2 009.6	0.32	2.39
RIB	Ribaldo	*Mora moro*	1 756.4	0.28	3.13
SPE	Sea perch	*Helicolenus* spp.	1 708.8	0.27	4.81
GSH	Dark ghost shark	*Hydrolagus novaezealandiae*	1 500.2	0.24	16.04
LDO	Lookdown dory	*Cyttus traversi*	1 436.3	0.23	5.27
BOE	Black oreo	*Allocyttus niger*	1 325.1	0.21	0.07
SBW	Southern blue whiting	*Micromesistius australis*	1 052.5	0.17	2.31
GIZ	Giant stargazer	*Kathetostoma* spp.	1 009.4	0.16	1.94
RCO	Red cod	*Pseudophycis bachus*	909.0	0.14	3.44
SSK	Smooth skate	*Dipturus innominatus*	795.7	0.13	5.54
SND	Shovelnose dogfish	*Deania calcea*	793.3	0.13	55.15
RSO	Gemfish	*Rexea* spp.	789.0	0.12	3.02
JMA	Jack mackerel	*Trachurus declivis, T. murphyi, T. nz*	520.6	0.08	0.64
ETB	Baxters lantern dogfish	*Etmopterus baxteri*	499.4	0.08	31.47
BYS	Alfonsino	*Beryx splendens*	463.1	0.07	4.15
RBT	Redbait	*Emmelichthys nitidus*	436.4	0.07	32.94
SSI	Silverside	*Argentina elongata*	430.5	0.07	67.71
CSQ	Leafscale gulper shark	*Centrophorus squamosus*	402.6	0.06	61.11
SDO	Silver dory	*Cyttus novaezealandiae*	395.2	0.06	76.66
RBM	Rays bream	*Brama brama*	355.3	0.06	3.10
OSD	Other sharks and dogs	Selachii	353.7	0.06	69.55
CON	Conger eel	*Conger* spp.	305.6	0.05	90.02
LCH	Long-nosed chimaera	*Harriotta raleighana*	279.9	0.04	23.65
RSK	Rough skate	*Zearaja nasuta*	271.0	0.04	5.53
BSH	Seal shark	*Dalatias licha*	263.6	0.04	66.67
BBE	Banded bellowsfish	*Centriscops humerosus*	262.1	0.04	78.94
SCH	School shark	*Galeorhinus galeus*	238.4	0.04	10.85
FHD	Deepsea flathead	*Hoplichthys haswelli*	236.3	0.04	74.59
BEN	Scabbardfish	*Benthodesmus* spp.	234.5	0.04	11.96
RHY	Common roughy	*Paratrachichthys trailli*	229.2	0.04	95.92
CDL	Cardinalfish	Epigonidae	224.2	0.04	6.34
SCO	Swollenhead conger	*Bassanago bulbiceps*	213.6	0.03	93.84
BYX	Alfonsino & long-finned beryx	*Beryx splendens & B. decadactylus*	208.3	0.03	9.26
BNS	Bluenose	*Hyperoglyphe antarctica*	196.2	0.03	7.20
RUD	Rudderfish	*Centrolophus niger*	196.1	0.03	64.33
WAR	Common warehou	*Seriolella brama*	193.0	0.03	0.81
SOR	Spiky oreo	*Neocyttus rhomboidalis*	191.6	0.03	4.62
DWD	Deepwater dogfish	-	175.6	0.03	78.51
BSK	Basking shark	*Cetorhinus maximus*	170.2	0.03	56.14
CBO	Bollons rattail	*Coelorinchus bollonsi*	150.3	0.02	31.79
ORH	Orange roughy	*Hoplostethus atlanticus*	142.2	0.02	1.02
HAP	Hapuku	*Polyprion oxygeneios*	139.8	0.02	1.77
SSO	Smooth oreo	*Pseudocyttus maculatus*	127.0	0.02	0.02
ETL	Lucifer dogfish	*Etmopterus lucifer*	120.5	0.02	70.99
POS	Porbeagle shark	*Lamna nasus*	119.4	0.02	64.35

Table A1: continued

Species code	Common name	Scientific name	Observed catch (t)	% of catch	% discarded
SRH	Silver roughy	*Hoplostethus mediterraneus*	105.7	0.02	83.33
NMP	Tarakihi	*Nemadactylus macropterus* & *N.* sp. (king tarakihi)	96.6	0.02	3.30
CBE	Crested bellowsfish	*Notopogon lilliei*	95.8	0.02	98.17
CYP	Longnose velvet dogfish	*Centroscymnus crepidater*	94.1	0.01	56.04
SSH	Slender smooth-hound	*Gollum attenuatus*	91.6	0.01	82.16
TOA	Toadfish	*Psychrolutidae*	84.0	0.01	61.62
NSD	Northern spiny dogfish	*Squalus griffini*	83.1	0.01	74.60
OPE	Orange perch	*Lepidoperca aurantia*	72.3	0.01	20.67
COL	Olivers rattail	*Coelorinchus oliverianus*	71.2	0.01	41.12
BEL	Bellowsfish	*Centriscops* spp.	64.8	0.01	93.42
SWO	Broadbill swordfish	*Xiphias gladius*	57.3	0.01	8.49
MDO	Mirror dory	*Zenopsis nebulosa*	55.9	0.01	3.72
PLS	Plunket's shark	*Proscymnodon plunketi*	55.6	0.01	80.90
SBK	Spineback	*Notacanthus sexspinis*	49.2	0.01	74.30
CAR	Carpet shark	*Cephaloscyllium isabellum*	49.0	0.01	100.00
PIG	Pigfish	*Congiopodus leucopaecilus*	44.1	0.01	100.00
DEA	Dealfish	*Trachipterus trachypterus*	43.4	0.01	18.27
WHX	White rattail	*Trachyrincus aphyodes*	42.7	0.01	65.11
STN	Southern bluefin tuna	*Thunnus maccoyii*	39.8	0.01	56.00
RDO	Rosy dory	*Cyttopsis roseus*	39.3	0.01	87.13
ERA	Electric ray	*Torpedo fairchildi*	36.2	0.01	93.16
SLK	Slickhead	Alepocephalidae	32.7	0.01	100.00
WIT	Witch	*Arnoglossus scapha*	32.6	0.01	90.67
EPL	Bigeye cardinalfish	*Epigonus lenimen*	32.3	0.01	88.33
TOP	Pale toadfish	*Ambophthalmos angustus*	26.3	<0.01	65.05
PDG	Prickly dogfish	*Oxynotus bruniensis*	24.6	<0.01	67.99
YBO	Yellow boarfish	*Pentaceros decacanthus*	23.5	<0.01	77.94
RBY	Rubyfish	*Plagiogeneion rubiginosum*	22.9	<0.01	8.24
HEX	Sixgill shark	*Hexanchus griseus*	22.7	<0.01	92.19
GUR	Gurnard	*Chelidonichthys kumu*	22.3	<0.01	7.79
EMA	Blue mackerel	*Scomber australasicus*	22.3	<0.01	0.06
BEE	Basketwork eel	*Diastobranchus capensis*	22.2	<0.01	78.43
CYO	Smooth skin dogfish	*Centroscymnus owstoni*	22.0	<0.01	82.89
ETM		*Etmopterus* sp.	21.9	<0.01	47.06
NAN	Deepsea smelt	*Nansenia* spp.	20.5	<0.01	0.00
CDO	Capro dory	*Capromimus abbreviatus*	20.0	<0.01	37.60
HCO	Hairy conger	*Bassanago hirsutus*	19.9	<0.01	59.67
HPB	Hapuku & bass	*Polyprion oxygeneios* & *P americanus*	19.5	<0.01	3.97
BCO	Blue cod	*Parapercis colias*	19.0	<0.01	19.48
GON		*Gonorynchus forsteri* & *G. greyi*	18.8	<0.01	100.00
DSK	Deepwater spiny skate (arctic skate)	*Amblyraja hyperborea*	17.9	<0.01	92.15
OSK	Skate other	Rajidae	17.8	<0.01	94.44
HAG	Hagfish	*Eptatretus cirrhatus*	16.4	<0.01	42.65
HJO	Johnson's cod	*Halargyreus johnsonii*	15.8	<0.01	44.56
SKA	Skate	Rajidae & Arhynchobatidae	15.3	<0.01	82.38
THR	Thresher shark	*Alopias vulpinus*	15.2	<0.01	100.00
MAK	Mako shark	*Isurus oxyrinchus*	14.7	<0.01	67.38
BSL	Black slickhead	*Xenodermichthys* spp.	14.5	<0.01	90.76
SCM	Largespine velvet dogfish	*Centroscymnus macracanthus*	14.4	<0.01	58.50
SNI	Snipefish	*Macroramphosus scolopax*	12.8	<0.01	99.99
CYL	Portugese dogfish	*Centroscymnus coelolepis*	12.3	<0.01	89.16
DWE	Deepwater eel	-	12.1	<0.01	41.28
CAS	Oblique banded rattail	*Coelorinchus aspercephalus*	11.9	<0.01	74.32
MOD	Morid cods	Moridae	11.9	<0.01	58.07
BYD	Longfinned beryx	*Beryx decadactylus*	10.8	<0.01	0.37
OPA	Opalfish	*Hemerocoetes* spp.	10.8	<0.01	100.00
MCA	Ridge scaled rattail	*Macrourus carinatus*	9.7	<0.01	43.22
APR	Catshark	*Apristurus* spp.	9.7	<0.01	46.79
EUC	Eucla cod	*Euclichthys polynemus*	9.2	<0.01	99.22
WHR	Unicorn rattail	*Trachyrincus longirostris*	8.8	<0.01	76.59
BTS	Prickly deepsea skate	*Brochiraja spinifera*	8.7	<0.01	96.70
PSK	Longnosed deepsea skate	*Bathyraja shuntovi*	8.4	<0.01	45.70
JGU	Spotted gurnard	*Pterygotrigla picta*	8.1	<0.01	26.03
BAS	Bass groper	*Polyprion americanus*	7.8	<0.01	2.53
LAN	Lantern fish	Myctophidae	7.7	<0.01	20.86

Table A2: Observed INVERTEBRATE bycatch and discards for target HOK, HAK, LIN, SWA or WWA trawls. Species codes, common and scientific names, estimated catch, percentage of total catch, and overall percentage discarded for the top 120 invertebrate species or species groups by weight from observer records for the target trawl fishery from 1 Oct 2002 to 30 Sep 2017. Records are ordered by decreasing percentage of catch. Codes in bold are QMS species; codes in italics are Schedule 6 QMA species (can legally be returned to the sea). [Continued on next page]

Species code	Common name	Scientific name	Observed catch (t)	% of catch	% discarded
SQU	Arrow squids	*Nototodarus sloanii* & *N. gouldi*	3 268.1	0.51	6.45
WSQ	Warty squids	*Onykia* spp.	259.6	0.04	52.77
HYA	Floppy tubular sponge	*Hyalascus* sp.	120.3	0.02	3.05
ONG	Sponges	Porifera	111.6	0.02	36.44
SFI	Starfish	Asteroidea & Ophiuroidea	51.6	0.01	72.71
MIQ	Warty squid	*Onykia ingens*	45.0	0.01	26.15
GSC	Giant spider crab	*Jacquinotia edwardsii*	43.8	0.01	84.40
GLS	Glass sponges	Hexactinellida	43.7	0.01	31.95
OPI	Umbrella octopus	*Opisthoteuthis* spp.	42.8	0.01	96.19
SCI	Scampi	*Metanephrops challengeri*	36.9	0.01	3.75
TSQ		*Todarodes filippovae*	21.6	<0.01	65.92
TAM	Tam O shanter urchin	Echinothuriidae & Phormosomatidae	18.3	<0.01	87.00
ACS	Smooth deepsea anemones	Actinostolidae	17.6	<0.01	1.05
HOR	Horse mussel	*Atrina zelandica*	16.4	<0.01	100.00
DWO	Deepwater octopus	*Graneledone* spp.	14.4	<0.01	88.63
FMA		*Fusitriton magellanicus*	13.8	<0.01	35.50
VSQ	Violet squids	*Histioteuthis* spp.	13.6	<0.01	87.22
GSQ	Giant squid	*Architeuthis* spp.	11.7	<0.01	61.07
SQX	Squid	-	11.6	<0.01	56.90
RSQ	Red squid	*Ommastrephes bartrami*	10.7	<0.01	83.18
OCT	Octopus	*Pinnoctopus cordiformis*	9.5	<0.01	70.44
HMT	Deepsea anemone	Hormathiidae	6.6	<0.01	2.24
QSC	Queen scallop	*Zygochlamys delicatula*	6.3	<0.01	93.96
CRB	Crab	-	5.6	<0.01	100.00
PSI	Geometric star	*Psilaster acuminatus*	5.0	<0.01	78.46
ANT	Anemones	Anthozoa	4.9	<0.01	19.92
CJA	Sun star	*Crossaster multispinus*	4.0	<0.01	80.70
GMC	Garricks masking crab	*Leptomithrax garricki*	4.0	<0.01	100.00
BPI		*Benthopecten pikei*	3.6	<0.01	7.01
PKN	Abyssal star	*Plutonaster knoxi*	3.5	<0.01	40.41
MRQ	Warty squid	*Onykia robsoni*	3.3	<0.01	6.13
JFI	Jellyfish	-	3.2	<0.01	100.00
DMG	Magnificent starfish	*Dipsacaster magnificus*	3.2	<0.01	69.92
GAS	Gastropods	Gastropoda	3.2	<0.01	55.11
PSQ	Large red scaly squid	*Pholidoteuthis massyae*	3.2	<0.01	86.89
ASR	Asteroid (starfish)	-	3.0	<0.01	79.15
ZOR	Rat-tail star	*Zoroaster* spp.	2.7	<0.01	54.35
CPA	Pentagon star	*Ceramaster patagonicus*	2.4	<0.01	13.20
PRK	Prawn killer	*Ibacus alticrenatus*	2.3	<0.01	74.71
HTR	Trojan starfish	*Hippasteria phrygiana*	2.1	<0.01	100.00
GRM	Sea urchin	*Gracilechinus multidentatus*	2.0	<0.01	26.19
NCB	Smooth red swimming crab	*Nectocarcinus bennetti*	1.9	<0.01	94.51
LLC	Long-legged masking crab	*Leptomithrax longipes*	1.9	<0.01	90.18
HTH	Sea cucumber	Holothurian unidentified	1.9	<0.01	62.81
LHO	Omega prawn	*Lipkius holthuisi*	1.9	<0.01	12.30
KIC	King crab	*Lithodes murrayi, Neolithodes brodiei*	1.8	<0.01	2.49
LNV	Rock star	*Lithosoma novaezelandiae*	1.8	<0.01	20.44
GOR		*Gorgonocephalus* spp.	1.5	<0.01	62.13
URO	Sea urchin other	-	1.5	<0.01	84.71
WHE	Whelks	-	1.4	<0.01	80.35
CRM	Airy finger sponge	*Callyspongia* cf *ramosa*	1.3	<0.01	100.00
LMU	Murray's king crab	*Lithodes murrayi*	1.3	<0.01	100.00
EZE	Yellow octopus	*Enteroctopus zealandicus*	1.0	<0.01	42.12
SDM	Pagurid	*Sympagurus dimorphus*	1.0	<0.01	55.69
PLT		*Plutonaster* spp.	1.0	<0.01	28.53
COF	Flabellum coral	*Flabellum* spp.	1.0	<0.01	3.95

Table A2: continued

Species code	Common name	Scientific name	Observed catch (t)	% of catch	% discarded
SMO	Cross-fish	*Sclerasterias mollis*	0.9	<0.01	88.20
PRA	Prawn	-	0.9	<0.01	51.72
PRU		*Pseudechinaster rubens*	0.9	<0.01	73.93
SOT		*Solaster torulatus*	0.9	<0.01	53.29
HDF	Feathery hydroids	Leptomeduseae and Anthoathecatae (excluding Stylasteridae)	0.8	<0.01	100.00
ECT		Echinothuriidae	0.8	<0.01	100.00
PHB	Grey fibrous massive sponge	*Phorbas* spp.	0.8	<0.01	0.13
COU	Coral (unspecified)	Alcyonacea, Gorgonacea, Scleractinia, Antipatharia (O) & Stylasteridae (F)	0.7	<0.01	8.00
GVO	Golden volute	*Provocator mirabilis*	0.7	<0.01	80.02
MOL	Molluscs	-	0.7	<0.01	41.75
TDQ	Dana octopus squid	*Taningia danae*	0.7	<0.01	50.15
DIR	Pagurid	*Diacanthurus rubricatus*	0.7	<0.01	82.50
SMK	Spiny masking crab	*Teratomaia richardsoni*	0.7	<0.01	88.22
TLD	Furry oval sponge	*Tetilla leptoderma*	0.6	<0.01	100.00
MSL	Starfish	*Mediaster sladeni*	0.6	<0.01	83.18
DHO	Sea urchin	*Dermechinus horridus*	0.6	<0.01	43.20
ECH	Echinoderms	Echinodermata	0.5	<0.01	31.20
VOL	Volute	Volutidae	0.5	<0.01	75.28
CBD	Coral rubble - dead	-	0.5	<0.01	100.00
AER		*Aeneator recens*	0.5	<0.01	47.68
PNE		*Proserpinaster neozelanicus*	0.5	<0.01	63.34
PMO		*Pseudostichopus mollis*	0.4	<0.01	37.15
PLY		*Polycheles* spp.	0.4	<0.01	97.05
PAO		*Pillsburiaster aoteanus*	0.4	<0.01	38.52
SSP	Scallop spat	*Pecten novaezelandiae*	0.4	<0.01	100.00
SPT	Heart urchin	*Spatangus multispinus*	0.4	<0.01	34.06
CHQ	Cranchiid squid	Cranchiidae	0.4	<0.01	3.66
SUA	Fleshy club sponge	*Suberites affinis*	0.4	<0.01	0.29
BES		*Benthopecten* spp.	0.3	<0.01	69.55
PZE	Prickly king crab	*Paralomis zealandica*	0.3	<0.01	26.96
PCH		*Penion chathamensis*	0.3	<0.01	66.69
NEB	Brodies king crab	*Neolithodes brodiei*	0.3	<0.01	15.64
SPI	Spider crab	-	0.3	<0.01	100.00
SCA	Scallop	*Pecten novaezelandiae*	0.3	<0.01	7.53
BOC	Deepsea anemone	*Bolocera* spp.	0.3	<0.01	1.79
RGR		*Radiaster gracilis*	0.3	<0.01	52.81
PNN	Feathery sea pens	*Pennatula* spp.	0.3	<0.01	0.40
LMI	Masking crabs	*Leptomithrax* spp.	0.2	<0.01	100.00
BNO		*Benthoctopus* spp.	0.2	<0.01	24.50
SCC	Sea cucumber	*Stichopus mollis*	0.2	<0.01	68.14
ANZ	Knobbly sandpaper sponge	*Ecionemia novaezelandiae*	0.2	<0.01	100.00
GRE	Curling stone sponge	*Geodia regina*	0.2	<0.01	100.00
BHE		*Bathypectinura heros*	0.2	<0.01	84.93
ECN	Echinoid (sea urchin)	-	0.2	<0.01	100.00
OCO	Octopus spp.	*Octopus* spp.	0.2	<0.01	55.14
PAD	Paddle crab	*Ovalipes catharus*	0.2	<0.01	100.00
CIC	Orange frond sponge	*Crella incrustans*	0.2	<0.01	100.00
PTU	Sea pens	*Pennatulacea*	0.2	<0.01	10.41
GPA	Sea urchin	*Goniocidaris parasol*	0.2	<0.01	85.92
DAP	Antlered crab	*Dagnaudus petterdi*	0.2	<0.01	94.89
LSQ		*Lycoteuthis lorigera*	0.2	<0.01	17.34
PAG	Pagurid	Paguroidea	0.2	<0.01	64.12
PHW		*Psammocinia* cf *hawere*	0.2	<0.01	100.00
SUR	Kina	*Evechinus chloroticus*	0.2	<0.01	40.88
ERO	Branching coral	*Enallopsammia rostrata*	0.2	<0.01	3.19
CDY		*Cosmasterias dyscrita*	0.2	<0.01	48.97
KWH	Knobbed whelk	*Austrofucus glans*	0.2	<0.01	20.27
GDU	Bushy hard coral	*Goniocorella dumosa*	0.2	<0.01	100.00
DPP		*Diplopteraster* sp.	0.2	<0.01	43.56
TFA	Frilled crab	*Trichopeltarion fantasticum*	0.1	<0.01	53.15
HSI	Jackknife prawn	*Haliporoides sibogae*	0.1	<0.01	45.49
ODT	Pentagonal tooth-star	*Odontaster* spp.	0.1	<0.01	65.01
LGR	Scaled squid	*Lepidoteuthis grimaldii*	0.1	<0.01	34.33
SSC	Giant masking crab	*Leptomithrax australis*	0.1	<0.01	32.82

Table A3: **Observed bycatch by species group for target fishery trawls. Estimated catch, percentage of total catch, and overall percentage discarded from observer records for the target HOK, HAK, LIN, SWA and WWA trawl fishery from 1 Oct 2002 to 30 Sep 2017.**

Group	Observed catch (kg)	% of catch	% discarded
Fish			
Target (HAK, HOK, LIN, SWA, WWA)	570 797 828	90.14	1.10
Fish (other)[*]	21 990 214	3.45	39.82
Rattails (all species combined)	19 391 583	3.04	14.48
Sharks & dogfish	12 925 336	2.03	64.87
Chimaeras	3 517 264	0.55	8.29
Morid species	2 699 874	0.42	3.89
Rays & Skates	1 199 797	0.19	14.44
Eels	635 340	0.10	87.36
Slickhead species	47 982	0.01	104.05
Invertebrates			
Squid	3 649 860	0.57	11.29
Sponges	279 917	0.04	21.97
Echinoderms	119 002	0.02	70.90
Crustacea	108 708	0.02	57.97
Octopuses	68 153	0.01	89.79
Other molluscs	45 103	0.01	73.68
Cnidaria	35 626	0.01	17.84
Coral species	1 705	<0.01	35.84
Polychaetes	13	<0.01	48.41

* i.e. all fish species not in any of the other categories in this table

Table A4: Estimates of annual bycatch (rounded to the nearest tonne) in the target hoki, hake, ling, silver warehou or white warehou trawl fishery, by species category and standard area. 95% confidence intervals in parentheses.

(a) QMS species

Fishing year	AUCK		CHAT		COOK		EAST		NORTH	
1990–91	1	(0-3)	2 534	(2 055-3 216)	47	(10-207)	25	(4-150)	0	(0-0)
1991–92	4	(2-11)	2 142	(1 747-2 715)	30	(6-129)	14	(2-95)	0	(0-0)
1992–93	5	(2-14)	2 428	(1 822-3 306)	27	(8-93)	29	(6-173)	2	(0-18)
1993–94	12	(6-28)	912	(748-1 173)	103	(54-211)	178	(37-958)	1	(0-13)
1994–95	5	(2-12)	1 430	(1 129-1 880)	110	(27-462)	63	(13-329)	7	(1-52)
1995–96	21	(9-56)	5 188	(4 113-6 701)	1 060	(444-2 604)	755	(143-3 962)	62	(19-221)
1996–97	28	(13-74)	5 360	(3 973-7 357)	855	(184-3 955)	1 287	(264-6 738)	108	(30-386)
1997–98	110	(80-161)	4 799	(4 288-5 419)	228	(167-315)	2 110	(1 323-3 394)	211	(85-509)
1998–99	52	(38-72)	5 053	(4 632-5 556)	206	(167-255)	321	(100-1 055)	50	(10-248)
1999–2000	162	(130-208)	7 525	(6 717-8 454)	118	(88-162)	295	(89-971)	48	(10-234)
2000–01	257	(191-362)	10 001	(8 848-11 336)	108	(80-147)	722	(174-2 660)	34	(7-149)
2001–02	181	(139-242)	6 741	(6 020-7 658)	65	(45-93)	90	(21-364)	36	(8-166)
2002–03	226	(176-305)	9 020	(7 991-10 220)	67	(49-93)	404	(175-888)	35	(8-177)
2003–04	215	(151-314)	14 230	(12 451-16 546)	1 033	(789-1 379)	646	(138-2 804)	96	(20-451)
2004–05	142	(101-211)	7 505	(6 699-8 441)	1 049	(824-1 359)	461	(129-1 563)	57	(11-294)
2005–06	37	(18-85)	9 686	(8 557-11 060)	686	(480-993)	223	(47-969)	82	(20-336)
2006–07	61	(31-152)	7 341	(6 391-8 462)	600	(471-785)	162	(64-438)	65	(14-311)
2007–08	99	(70-148)	6 385	(5 765-7 109)	856	(694-1 067)	229	(47-1 041)	64	(13-279)
2008–09	132	(80-253)	5 460	(4 702-6 365)	622	(472-839)	499	(100-2 264)	81	(17-408)
2009–10	32	(17-71)	7 330	(6 487-8 419)	316	(255-397)	445	(122-1 631)	88	(30-281)
2010–11	124	(78-216)	6 561	(5 748-7 560)	503	(363-711)	502	(135-1 931)	69	(22-225)
2011–12	32	(19-65)	6 583	(5 877-7 392)	446	(359-564)	415	(120-1 435)	80	(17-383)
2012–13	73	(42-160)	7 316	(6 568-8 298)	575	(444-759)	536	(116-2 477)	167	(37-741)
2013–14	348	(237-564)	8 751	(7 801-9 879)	529	(419-675)	1 088	(586-2 017)	77	(43-140)
2014–15	333	(227-537)	12 801	(11 271-14 519)	455	(377-551)	394	(250-649)	139	(93-211)
2015–16	110	(69-194)	6 461	(5 787-7 245)	171	(132-222)	447	(115-1 675)	230	(128-418)
2016–17	193	(126-319)	6 791	(6 077-7 616)	201	(151-271)	692	(404-1 201)	235	(143-394)

Fishing year	PUYS		STEW		SUBA		WCNI		WCSI	
1990–91	351	(220-569)	77	(56-109)	13	(8-22)	1	(0-10)	7 837	(6 562-9 663)
1991–92	220	(166-315)	357	(286-456)	38	(27-61)	4	(0-41)	3 344	(2 759-4 178)
1992–93	118	(72-215)	279	(215-369)	10	(5-23)	12	(1-93)	2 051	(1 712-2 549)
1993–94	196	(105-398)	240	(164-360)	14	(7-35)	6	(1-57)	7 514	(6 454-9 014)
1994–95	95	(36-262)	131	(87-201)	4	(2-11)	23	(4-163)	9 801	(7 988-12 247)
1995–96	417	(214-866)	512	(338-794)	17	(8-53)	15	(2-132)	12 542	(10 092-16 294)
1996–97	734	(337-1 725)	644	(376-1 165)	14	(6-46)	18	(2-165)	12 399	(9 789-16 419)
1997–98	807	(168-3 592)	934	(757-1 157)	77	(54-117)	47	(8-245)	9 485	(8 221-10 962)
1998–99	418	(243-710)	789	(693-911)	149	(121-184)	22	(4-122)	3 606	(3 231-4 045)
1999–2000	1 490	(975-2 302)	1 520	(1 348-1 711)	442	(379-525)	62	(20-209)	5 300	(4 731-5 964)
2000–01	1 622	(1142-2 321)	2 279	(1 929-2 743)	715	(577-930)	59	(10-344)	7 565	(6 652-8 783)
2001–02	686	(480-986)	1 735	(1 520-1 993)	775	(662-925)	17	(4-77)	3 688	(3 295-4 165)
2002–03	867	(568-1 349)	1 486	(1 267-1 763)	970	(818-1 169)	16	(3-106)	5 197	(4 619-5 902)
2003–04	842	(567-1 294)	2 207	(1 816-2 757)	1 028	(815-1 304)	40	(7-254)	5 157	(4 621-5 825)
2004–05	737	(518-1 077)	1 397	(1 123-1 746)	414	(317-542)	54	(10-303)	3 689	(3 295-4 152)
2005–06	946	(614-1 482)	2 413	(2 021-2 912)	132	(87-216)	88	(17-482)	3 660	(3 252-4 178)
2006–07	1 113	(665-1 851)	4 318	(3 583-5 240)	443	(323-652)	47	(14-187)	3 173	(2 679-3 772)
2007–08	361	(184-725)	1 878	(1 647-2 137)	340	(273-433)	103	(18-538)	3 667	(3 263-4 160)
2008–09	1 209	(704-2 106)	3 412	(2 874-4 126)	508	(378-729)	80	(19-369)	3 384	(2 879-4 063)
2009–10	1 072	(704-1 713)	2 241	(1 944-2 605)	148	(104-225)	21	(5-104)	1 789	(1 559-2 087)
2010–11	1 675	(1 016-2 856)	2 264	(1 903-2 774)	326	(237-487)	38	(5-244)	4 252	(3 694-4 952)
2011–12	367	(257-550)	1 411	(1 219-1 657)	88	(61-139)	27	(9-82)	3 338	(2 951-3 819)
2012–13	828	(566-1 313)	3 266	(2 844-3 812)	372	(271-548)	75	(17-354)	4 384	(3 907-5 032)
2013–14	941	(607-1 528)	6 594	(5 773-7 616)	880	(676-1 228)	57	(10-330)	5 182	(4 675-5 839)
2014–15	611	(415-927)	6 129	(5 393-7 091)	467	(342-693)	45	(8-260)	5 618	(5 108-6 198)
2015–16	795	(564-1 154)	2 276	(1 923-2 717)	125	(80-217)	18	(4-85)	4 579	(4 137-5 128)
2016–17	691	(469-1 058)	4 052	(3 474-4 764)	418	(305-619)	115	(33-411)	4 211	(3 806-4 679)

(b) Non-QMS fish species

Fishing year	AUCK		CHAT		COOK		EAST		NORTH	
1990–91	40	(26-64)	7 001	(6 310-7 752)	181	(47-663)	17	(4-68)	0	(0-0)
1991–92	36	(26-52)	8 759	(7 852-9 802)	104	(29-404)	8	(2-38)	0	(0-0)
1992–93	56	(39-81)	10 461	(8 865-12 354)	110	(56-220)	20	(5-85)	10	(2-47)
1993–94	62	(46-88)	4 313	(3 895-4 799)	339	(214-513)	39	(11-135)	4	(1-22)
1994–95	77	(54-119)	7 185	(6 307-8 240)	378	(95-1 474)	43	(9-166)	25	(6-112)
1995–96	101	(69-158)	15 446	(13 624-17 798)	7204	(4 483-11 982)	347	(79-1 427)	188	(71-520)
1996–97	55	(38-86)	27 406	(23 655-31 681)	1404	(338-5 372)	417	(101-1 740)	244	(87-694)
1997–98	501	(402-642)	20 533	(18 857-22 409)	1752	(1 407-2 236)	1 350	(926-2 011)	254	(117-563)
1998–99	79	(62-103)	16 243	(14 962-17 721)	1386	(1 160-1 688)	81	(27-253)	154	(38-593)
1999–2000	225	(186-277)	16 513	(14 913-18 404)	2953	(2 379-3 695)	212	(72-658)	140	(35-537)
2000–01	243	(202-299)	17 712	(16 310-19 308)	1238	(1 029-1 514)	199	(60-689)	62	(14-286)
2001–02	439	(358-553)	15 570	(14 041-17 285)	616	(457-812)	62	(17-229)	109	(26-462)
2002–03	292	(241-364)	16 092	(14 583-17 755)	1268	(1 013-1 625)	254	(126-520)	101	(24-433)
2003–04	70	(52-96)	13 015	(11 473-14 882)	38	(27-53)	46	(11-191)	40	(10-167)
2004–05	107	(79-150)	10 024	(9 074-11 144)	117	(86-160)	14	(4-50)	26	(6-112)
2005–06	8	(4-17)	10 338	(9 167-11 742)	80	(41-158)	24	(6-106)	33	(9-115)
2006–07	11	(6-24)	8 726	(7 784-9 857)	48	(37-64)	77	(33-185)	37	(9-159)
2007–08	54	(36-90)	10 957	(9 671-12 454)	96	(71-132)	37	(9-161)	54	(13-236)
2008–09	40	(25-67)	9 149	(8 082-10 398)	57	(40-83)	49	(12-212)	44	(10-199)
2009–10	14	(7-36)	15 055	(13 139-17 415)	203	(159-268)	113	(39-335)	122	(37-411)
2010–11	44	(30-74)	8 524	(7 595-9 615)	29	(20-42)	72	(19-257)	69	(23-184)
2011–12	15	(9-30)	6 542	(5 906-7 299)	76	(59-99)	50	(17-151)	64	(15-267)
2012–13	26	(15-48)	9 504	(8 583-10 556)	195	(151-257)	80	(19-341)	142	(30-559)
2013–14	75	(56-105)	6 454	(5 897-7 087)	167	(137-205)	64	(41-108)	120	(74-197)
2014–15	92	(65-151)	11 948	(10 580-13 658)	134	(108-167)	81	(50-134)	161	(106-253)
2015–16	43	(28-73)	10 846	(9 769-11 998)	69	(51-93)	120	(37-417)	205	(113-371)
2016–17	56	(36-101)	13 273	(11 775-15 048)	37	(26-53)	89	(52-158)	202	(119-344)

Fishing year	PUYS		STEW		SUBA		WCNI		WCSI	
1990–91	367	(283-479)	3 238	(2 875-3 678)	558	(469-668)	2	(0-13)	2 536	(2 321-2 789)
1991–92	247	(216-286)	2 998	(2 742-3 250)	327	(284-383)	10	(2-54)	2 356	(2 138-2 596)
1992–93	157	(116-214)	2 797	(2 499-3 147)	105	(81-141)	32	(6-144)	1 917	(1 726-2 145)
1993–94	134	(93-201)	1 223	(1 055-1 436)	77	(57-104)	10	(2-52)	3 734	(3 416-4 098)
1994–95	73	(42-127)	2 000	(1 661-2 434)	67	(47-101)	51	(10-236)	6 341	(5 720-7 058)
1995–96	235	(160-350)	2 351	(1 890-2 914)	83	(56-137)	27	(5-147)	4 533	(3 997-5 181)
1996–97	331	(207-530)	1 182	(887-1 597)	30	(19-50)	23	(5-107)	4 389	(3 860-5 032)
1997–98	794	(212-3 103)	4 204	(3 587-4 949)	352	(278-460)	77	(16-356)	3 902	(3 471-4 422)
1998–99	709	(464-1 079)	1 206	(1 079-1 350)	227	(193-271)	37	(7-174)	3 034	(2 754-3 358)
1999–2000	486	(332-715)	2 109	(1 908-2 329)	611	(541-698)	86	(31-257)	2 564	(2 312-2 851)
2000–01	639	(496-853)	2 156	(1 919-2 402)	677	(588-782)	63	(14-302)	3 183	(2 884-3 540)
2001–02	246	(176-341)	4 191	(3 741-4 699)	1879	(1 650-2 165)	34	(8-128)	3 038	(2 759-3 384)
2002–03	444	(319-630)	1 909	(1 682-2 150)	1247	(1 092-1 427)	24	(5-129)	2 258	(2 052-2 502)
2003–04	111	(77-167)	715	(598-849)	333	(271-407)	9	(2-46)	1 246	(1 127-1 389)
2004–05	78	(48-126)	1 040	(863-1 284)	311	(242-401)	5	(1-29)	1 051	(942-1 168)
2005–06	577	(376-860)	517	(436-625)	28	(19-45)	28	(6-150)	1 306	(1 149-1 492)
2006–07	78	(50-127)	776	(661-914)	81	(61-111)	17	(5-53)	875	(758-1 019)
2007–08	155	(73-333)	1 031	(882-1 219)	185	(143-249)	46	(9-242)	1 625	(1 406-1 906)
2008–09	117	(72-191)	991	(855-1 166)	148	(114-202)	37	(9-145)	869	(750-1 030)
2009–10	234	(145-396)	1 016	(871-1 205)	67	(46-112)	13	(3-77)	664	(562-796)
2010–11	216	(138-349)	806	(692-954)	117	(88-161)	11	(2-64)	745	(648-869)
2011–12	314	(227-451)	659	(571-764)	41	(28-63)	12	(4-33)	506	(449-572)
2012–13	321	(227-479)	1100	(967-1 248)	125	(96-176)	30	(7-127)	1 206	(1 081-1 356)
2013–14	359	(249-513)	1394	(1 256-1 561)	187	(154-232)	20	(4-104)	1 489	(1 366-1 629)
2014–15	375	(247-570)	1711	(1 502-1 987)	131	(96-199)	20	(4-116)	2 091	(1 881-2 351)
2015–16	715	(500-1041)	885	(754-1 040)	49	(33-82)	22	(5-98)	1 846	(1 668-2 066)
2016–17	442	(282-703)	1182	(1 000-1 412)	121	(86-180)	32	(9-133)	1 684	(1 500-1 915)

Table A4: continued

(c) non-QMS invertebrate species

Fishing year	AUCK	CHAT	COOK	EAST	NORTH
1990–91	2 (1-3)	78 (70-89)	1 (0-2)	0 (0-1)	0 (0-0)
1991–92	4 (3-6)	194 (166-228)	1 (0-2)	0 (0-0)	0 (0-0)
1992–93	3 (2-5)	106 (86-131)	0 (0-1)	0 (0-1)	0 (0-1)
1993–94	6 (4-10)	84 (72-99)	3 (2-7)	2 (1-3)	0 (0-0)
1994–95	5 (4-7)	173 (151-198)	5 (2-11)	1 (0-2)	1 (0-2)
1995–96	5 (4-8)	173 (148-204)	10 (5-19)	3 (1-7)	2 (1-5)
1996–97	7 (5-11)	152 (128-179)	12 (6-25)	6 (3-12)	6 (3-12)
1997–98	19 (16-23)	292 (267-317)	9 (7-11)	6 (4-9)	5 (3-10)
1998–99	11 (8-15)	378 (341-422)	5 (3-8)	2 (1-5)	3 (2-8)
1999–2000	24 (19-30)	367 (321-422)	6 (4-10)	2 (1-5)	2 (1-6)
2000–01	35 (28-44)	537 (483-604)	5 (3-8)	4 (2-8)	2 (1-4)
2001–02	55 (44-70)	573 (509-655)	5 (3-9)	2 (1-5)	4 (2-10)
2002–03	25 (19-34)	378 (327-438)	4 (2-7)	3 (1-6)	2 (1-5)
2003–04	11 (8-16)	399 (342-465)	5 (3-9)	2 (1-5)	3 (1-6)
2004–05	19 (14-27)	182 (161-205)	5 (3-8)	2 (1-4)	2 (1-4)
2005–06	3 (1-7)	271 (238-315)	3 (2-5)	1 (0-3)	3 (1-8)
2006–07	3 (2-7)	240 (204-284)	4 (2-6)	2 (1-5)	3 (1-7)
2007–08	10 (7-15)	258 (230-290)	7 (5-10)	1 (1-3)	3 (1-6)
2008–09	8 (5-14)	128 (110-151)	5 (3-8)	2 (1-6)	3 (1-6)
2009–10	4 (2-9)	288 (252-330)	4 (3-6)	3 (1-6)	6 (3-11)
2010–11	13 (8-27)	298 (254-353)	4 (2-7)	5 (2-12)	6 (3-14)
2011–12	4 (2-9)	154 (134-180)	2 (2-4)	2 (1-5)	4 (2-9)
2012–13	8 (4-16)	240 (214-273)	5 (3-8)	3 (1-8)	7 (3-15)
2013–14	20 (14-30)	129 (116-145)	6 (4-9)	4 (2-7)	5 (3-8)
2014–15	35 (25-54)	362 (318-415)	4 (3-6)	3 (2-5)	7 (5-10)
2015–16	19 (11-37)	260 (228-300)	4 (3-6)	4 (2-10)	6 (4-12)
2016–17	21 (13-39)	439 (383-510)	3 (2-4)	5 (3-8)	7 (4-13)

Fishing year	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	28 (22-37)	153 (136-174)	26 (22-31)	0 (0-0)	124 (111-138)
1991–92	36 (31-41)	307 (281-337)	33 (29-39)	0 (0-0)	97 (86-110)
1992–93	18 (11-28)	174 (153-200)	7 (5-9)	0 (0-0)	71 (61-83)
1993–94	9 (6-15)	121 (100-148)	8 (5-11)	0 (0-0)	143 (125-166)
1994–95	15 (10-23)	123 (104-145)	4 (3-6)	0 (0-1)	214 (191-243)
1995–96	24 (15-39)	120 (100-145)	4 (3-7)	0 (0-0)	82 (70-96)
1996–97	22 (14-34)	142 (105-195)	4 (2-6)	0 (0-0)	98 (84-115)
1997–98	29 (15-55)	157 (137-180)	13 (11-16)	0 (0-1)	83 (72-95)
1998–99	19 (11-32)	169 (149-194)	31 (26-39)	0 (0-1)	110 (95-130)
1999–2000	28 (18-44)	221 (196-250)	64 (55-77)	0 (0-1)	105 (90-125)
2000–01	60 (43-83)	308 (270-353)	97 (82-115)	0 (0-2)	257 (225-295)
2001–02	35 (24-51)	524 (462-600)	235 (204-275)	0 (0-2)	372 (332-425)
2002–03	22 (14-35)	164 (140-200)	107 (89-132)	0 (0-1)	279 (241-328)
2003–04	10 (7-17)	116 (95-144)	54 (43-68)	0 (0-1)	293 (255-341)
2004–05	21 (14-32)	189 (154-231)	56 (45-73)	0 (0-0)	129 (114-148)
2005–06	49 (32-77)	197 (164-241)	11 (7-18)	0 (0-2)	143 (124-167)
2006–07	30 (18-49)	220 (181-268)	23 (16-34)	0 (0-1)	191 (158-237)
2007–08	24 (14-42)	194 (170-224)	35 (28-45)	1 (0-2)	143 (125-165)
2008–09	21 (13-34)	194 (166-230)	29 (22-39)	1 (0-2)	170 (143-204)
2009–10	20 (13-31)	268 (235-309)	18 (13-27)	0 (0-1)	106 (91-124)
2010–11	56 (34-98)	242 (199-303)	35 (24-58)	0 (0-2)	206 (168-252)
2011–12	29 (20-45)	174 (147-208)	11 (7-18)	0 (0-1)	207 (176-242)
2012–13	36 (24-54)	340 (298-393)	39 (29-54)	0 (0-2)	186 (165-215)
2013–14	39 (27-58)	371 (331-420)	50 (40-65)	0 (0-1)	213 (192-239)
2014–15	37 (26-55)	650 (569-752)	50 (37-72)	0 (0-1)	400 (361-449)
2015–16	69 (48-107)	411 (340-507)	22 (14-43)	0 (0-1)	286 (250-329)
2016–17	52 (35-82)	445 (375-533)	45 (32-69)	0 (0-2)	285 (251-328)

Table A4: continued

(d) ALL species

Fishing year	AUCK		CHAT		COOK		EAST		NORTH	
1990–91	46	(30-77)	10 813	(9 711-12 020)	358	(127-1073)	61	(18-216)	0	(0-0)
1991–92	44	(32-64)	10 864	(9 761-12 098)	195	(64-603)	28	(8-100)	0	(0-0)
1992–93	64	(46-94)	11 412	(9 681-13 356)	127	(69-234)	53	(16-172)	7	(2-28)
1993–94	77	(54-110)	5 542	(4 963-6 175)	374	(245-573)	139	(47-407)	4	(1-18)
1994–95	86	(62-125)	8 750	(7 745-9 882)	548	(178-1 693)	124	(39-399)	24	(7-84)
1995–96	128	(86-199)	17 384	(15 279-19 930)	5 950	(3 803-9 245)	1 051	(323-3 338)	191	(77-452)
1996–97	65	(45-95)	30 019	(26 299-34 555)	2 062	(675-6 152)	1 279	(431-3 812)	183	(79-407)
1997–98	626	(522-758)	22 989	(21 345-24 734)	1 466	(1 211-1 753)	3 072	(2 190-4 247)	394	(200-810)
1998–99	142	(115-177)	21 676	(20 149-23 293)	1 329	(1 137-1 545)	466	(185-1 162)	159	(53-509)
1999–2000	406	(350-481)	24 190	(22 270-26 428)	2 394	(1 993-2 905)	625	(253-1 523)	168	(57-529)
2000–01	508	(425-614)	25 710	(23 840-27 743)	1 185	(1 016-1 397)	905	(313-2 535)	82	(25-278)
2001–02	744	(617-894)	23 169	(21 011-25 479)	577	(457-729)	227	(79-616)	130	(41-431)
2002–03	591	(493-728)	26 210	(23 792-28 942)	1 359	(1 082-1 696)	680	(349-1 323)	121	(40-384)
2003–04	268	(203-357)	28 238	(24 980-31 417)	1 058	(825-1 326)	569	(183-1 798)	150	(43-477)
2004–05	306	(236-405)	17 169	(15 539-18 840)	1 085	(891-1 340)	405	(152-1 139)	90	(29-301)
2005–06	45	(26-86)	19 496	(17 580-21 641)	651	(477-893)	214	(68-703)	125	(43-359)
2006–07	77	(46-136)	15 856	(14 320-17 593)	534	(437-655)	280	(134-604)	103	(33-325)
2007–08	170	(129-238)	15 776	(14 378-17 339)	909	(756-1 103)	254	(84-829)	117	(38-345)
2008–09	189	(129-293)	14 744	(13 290-16 591)	519	(419-647)	448	(140-1 428)	130	(41-408)
2009–10	59	(34-114)	21 855	(19 601-24 290)	527	(443-627)	489	(203-1 184)	188	(75-486)
2010–11	187	(132-272)	14 599	(13 286-16 202)	426	(332-551)	507	(177-1 427)	143	(62-326)
2011–12	55	(36-91)	13 083	(12 031-14 257)	488	(403-596)	399	(149-966)	150	(49-431)
2012–13	114	(74-189)	16 451	(15 183-17 915)	657	(540-799)	512	(178-1 562)	289	(90-886)
2013–14	485	(368-666)	15 554	(14 332-16 955)	706	(591-850)	998	(622-1 663)	216	(138-339)
2014–15	514	(384-731)	24 659	(22 255-27 368)	650	(556-757)	758	(509-1 150)	302	(215-427)
2015–16	207	(142-320)	17 227	(15 701-18 917)	239	(194-295)	570	(201-1 449)	404	(239-674)
2016–17	342	(241-502)	18 530	(16 943-20 359)	231	(187-291)	697	(452-1 073)	395	(267-598)

Fishing year	PUYS		STEW		SUBA		WCNI		WCSI	
1990–91	609	(469-804)	3 650	(3 199-4 140)	627	(521-758)	4	(1-21)	7 658	(7 007-8 402)
1991–92	492	(432-561)	3 627	(3 357-3 930)	398	(346-459)	15	(4-57)	4 802	(4 401-5 264)
1992–93	222	(172-297)	3 233	(2 877-3 646)	122	(92-163)	35	(11-121)	3 271	(2 979-3 616)
1993–94	244	(170-354)	1 535	(1 309-1 787)	94	(71-132)	14	(4-60)	9 507	(8 705-10 362)
1994–95	130	(81-221)	2 244	(1 896-2 686)	75	(52-110)	71	(19-260)	13 792	(12 413-15 354)
1995–96	428	(295-636)	2 977	(2 459-3 659)	104	(71-167)	38	(10-176)	13 021	(11 554-14 757)
1996–97	737	(478-1 146)	1 381	(1 063-1 828)	34	(23-56)	34	(8-125)	12 162	(10 852-13 882)
1997–98	1 662	(536-4 909)	5 249	(4 602-6 045)	446	(360-556)	113	(33-400)	11 155	(10 165-12 245)
1998–99	1 080	(730-1 634)	2 167	(1 974-2 396)	414	(359-482)	56	(17-202)	6 347	(5 813-6 914)
1999–2000	2 813	(2 035-3 863)	3 819	(3 512-4 170)	1110	(991-1236)	143	(58-345)	7 628	(6 998-8 289)
2000–01	2 447	(1 908-3 132)	4 542	(4 079-5 080)	1 417	(1 246-1 621)	116	(33-442)	9 819	(8 965-10 771)
2001–02	1 145	(857-1 543)	7 096	(6 380-7 900)	3 180	(2 825-3 604)	56	(18-190)	7 028	(6 445-7 700)
2002–03	1 464	(1 073-2 054)	3 885	(3 438-4 390)	2 537	(2 229-2 924)	46	(12-176)	7 803	(7 095-8 647)
2003–04	959	(677-1 371)	2 738	(2 332-3 222)	1 272	(1 056-1 540)	48	(12-188)	6 851	(6 250-7 536)
2004–05	689	(497-949)	2 986	(2 509-3 566)	891	(728-1 098)	51	(14-200)	5 000	(4 584-5 508)
2005–06	1 789	(1 260-2 575)	2 929	(2 531-3 425)	162	(116-237)	118	(31-434)	5 139	(4 645-5 680)
2006–07	1 080	(726-1 603)	5 208	(4 556-5 972)	542	(427-697)	57	(23-156)	4 078	(3 611-4 625)
2007–08	593	(330-1 069)	3 168	(2 848-3 577)	576	(482-692)	147	(44-504)	5 304	(4 775-5 911)
2008–09	1 134	(740-1 735)	4 730	(4 181-5 402)	705	(570-900)	135	(42-433)	4 103	(3 635-4 718)
2009–10	1 347	(907-1 992)	3 953	(3 490-4 467)	266	(199-371)	34	(9-138)	2 271	(2 004-2 555)
2010–11	1 930	(1 300-2 915)	3 303	(2 899-3 761)	481	(384-615)	47	(12-177)	4 174	(3 712-4 730)
2011–12	871	(656-1 168)	2 358	(2 107-2 667)	149	(112-200)	40	(17-105)	3 461	(3 126-3 819)
2012–13	1 372	(1 015-1 892)	4 834	(4 374-5 388)	551	(444-705)	95	(29-353)	4 987	(4 560-5 480)
2013–14	1 609	(1 142-2 318)	9 030	(8 210-9 931)	1 214	(997-1 489)	80	(22-295)	5 864	(5 406-6 373)
2014–15	1 170	(841-1 649)	9 369	(8 395-10 459)	723	(554-973)	70	(20-280)	7 567	(6 999-8 223)
2015–16	1 702	(1 258-2 332)	4 196	(3 666-4 843)	238	(166-366)	42	(13-157)	6 303	(5 818-6 859)
2016–17	1 269	(903-1 780)	7 029	(6 202-7 933)	730	(581-956)	99	(39-265)	5 410	(5 014-5 875)

Table A5: Estimates of annual discards (rounded to the nearest tonne) in the hoki, hake, ling target trawl fishery, by species category and standard area. 95% confidence intervals in parentheses.

(a) Hoki, hake, ling

Fishing year	AUCK	CHAT	COOK	EAST	NORTH
2002–03	6 (1-38)	141 (70-357)	4 (0-78)	0 (0-0)	0 (0-0)
2003–04	0 (0-5)	108 (63-204)	5 (0-45)	0 (0-1)	0 (0-0)
2004–05	1 (0-8)	140 (76-294)	6 (0-52)	0 (0-0)	0 (0-0)
2005–06	0 (0-2)	12 (3-67)	0 (0-7)	0 (0-0)	0 (0-0)
2006–07	1 (0-16)	260 (141-560)	23 (2-165)	0 (0-1)	0 (0-0)
2007–08	0 (0-0)	15 (7-34)	0 (0-6)	0 (0-0)	0 (0-0)
2008–09	0 (0-0)	113 (76-181)	7 (1-44)	0 (0-0)	0 (0-0)
2009–10	0 (0-3)	104 (79-141)	21 (7-63)	0 (0-1)	0 (0-0)
2010–11	0 (0-6)	290 (187-501)	37 (7-200)	0 (0-4)	0 (0-0)
2011–12	0 (0-3)	199 (137-299)	64 (20-206)	0 (0-5)	0 (0-1)
2012–13	0 (0-0)	133 (79-273)	36 (7-223)	0 (0-2)	0 (0-1)
2013–14	0 (0-4)	103 (61-204)	172 (64-501)	0 (0-14)	0 (0-2)
2014–15	2 (0-15)	343 (254-487)	577 (309-1111)	1 (0-41)	0 (0-4)
2015–16	1 (0-13)	179 (112-330)	681 (331-1448)	1 (0-68)	0 (0-7)
2016–17	3 (0-20)	158 (97-285)	739 (377-1440)	2 (0-72)	0 (0-5)

Fishing year	PUYS	STEW	SUBA	WCNI	WCSI
2002–03	41 (17-157)	127 (67-303)	35 (15-130)	0 (0-0)	596 (361-1199)
2003–04	38 (20-91)	58 (33-118)	14 (7-42)	0 (0-0)	363 (243-608)
2004–05	59 (30-147)	75 (41-161)	25 (12-71)	0 (0-0)	300 (180-618)
2005–06	10 (3-56)	9 (3-52)	1 (0-10)	0 (0-0)	51 (19-231)
2006–07	148 (75-365)	361 (201-755)	74 (37-200)	0 (0-0)	824 (491-1694)
2007–08	6 (3-17)	22 (11-48)	4 (1-11)	0 (0-0)	24 (14-52)
2008–09	14 (7-35)	91 (62-147)	15 (7-32)	0 (0-0)	163 (113-256)
2009–10	30 (20-52)	90 (68-123)	8 (4-16)	0 (0-0)	151 (117-207)
2010–11	46 (22-125)	201 (134-354)	5 (1-27)	0 (0-0)	494 (339-822)
2011–12	37 (20-83)	172 (124-250)	15 (7-36)	0 (0-1)	327 (240-469)
2012–13	48 (22-125)	231 (158-387)	8 (2-39)	0 (0-0)	420 (299-649)
2013–14	44 (22-116)	388 (289-547)	26 (13-78)	0 (0-2)	631 (483-927)
2014–15	79 (47-159)	420 (332-562)	20 (9-50)	0 (0-6)	802 (636-1160)
2015–16	108 (58-231)	332 (239-496)	1 (0-19)	0 (0-3)	813 (599-1255)
2016–17	80 (45-176)	363 (276-519)	41 (21-97)	0 (0-12)	874 (666-1290)

Table A5: continued

(b) QMS species

Fishing year	AUCK		CHAT		COOK		EAST		NORTH	
2002–03	1	(0-3)	78	(45-146)	13	(4-48)	0	(0-2)	0	(0-3)
2003–04	66	(35-147)	695	(564-875)	711	(511-997)	17	(3-84)	17	(4-80)
2004–05	4	(2-12)	524	(399-719)	470	(327-689)	4	(1-23)	4	(1-23)
2005–06	2	(1-11)	771	(599-1025)	469	(256-876)	5	(1-28)	14	(3-64)
2006–07	5	(1-26)	290	(219-417)	534	(388-790)	6	(1-32)	11	(2-59)
2007–08	1	(0-5)	314	(231-436)	605	(422-897)	3	(1-23)	8	(2-40)
2008–09	5	(1-31)	300	(209-441)	845	(563-1329)	7	(1-44)	12	(2-64)
2009–10	2	(0-7)	194	(151-248)	196	(150-257)	3	(1-17)	12	(3-53)
2010–11	2	(0-15)	690	(464-1101)	440	(258-815)	8	(1-49)	14	(4-62)
2011–12	1	(0-5)	845	(635-1149)	378	(270-538)	8	(2-37)	17	(4-84)
2012–13	4	(1-20)	232	(176-328)	173	(120-260)	8	(1-39)	22	(5-109)
2013–14	13	(6-38)	463	(357-629)	292	(211-415)	12	(5-30)	17	(7-45)
2014–15	19	(9-51)	364	(284-485)	106	(82-141)	6	(2-18)	12	(7-25)
2015–16	6	(2-16)	360	(285-471)	184	(136-251)	15	(3-64)	21	(10-44)
2016–17	14	(6-45)	616	(454-861)	217	(152-318)	27	(12-59)	38	(19-84)

Fishing year	PUYS		STEW		SUBA		WCNI		WCSI	
2002–03	3	(1-11)	15	(9-28)	5	(3-12)	0	(0-1)	115	(81-173)
2003–04	60	(31-121)	1148	(778-1695)	428	(278-664)	2	(0-28)	371	(309-448)
2004–05	55	(33-98)	102	(68-165)	34	(20-60)	0	(0-4)	152	(120-194)
2005–06	45	(23-95)	194	(144-292)	15	(8-38)	5	(1-50)	399	(313-526)
2006–07	81	(32-220)	592	(438-851)	92	(57-174)	3	(0-35)	447	(326-632)
2007–08	38	(14-109)	94	(66-145)	17	(10-36)	3	(0-37)	211	(158-298)
2008–09	18	(8-54)	497	(340-816)	76	(41-171)	4	(0-51)	255	(187-377)
2009–10	20	(11-38)	203	(154-275)	16	(9-34)	0	(0-6)	82	(63-110)
2010–11	13	(5-37)	174	(113-302)	10	(4-41)	0	(0-14)	208	(139-344)
2011–12	13	(6-29)	99	(74-139)	7	(4-18)	3	(0-40)	682	(540-895)
2012–13	21	(11-53)	381	(290-544)	28	(15-71)	3	(0-35)	555	(447-737)
2013–14	13	(6-31)	545	(420-747)	56	(33-118)	2	(0-24)	363	(302-458)
2014–15	21	(12-43)	634	(499-834)	38	(21-86)	1	(0-16)	753	(640-919)
2015–16	29	(17-50)	213	(165-289)	7	(3-18)	1	(0-11)	515	(439-614)
2016–17	54	(29-116)	492	(378-685)	52	(30-110)	6	(1-50)	590	(499-736)

Table A5: continued

(c) Non-QMS fish species

Fishing year	AUCK	CHAT	COOK	EAST	NORTH
2002–03	139 (94-233)	10527 (8891-12620)	2382 (1681-3378)	82 (31-217)	97 (23-426)
2003–04	10 (5-22)	3771 (3130-4618)	63 (41-103)	32 (7-136)	34 (8-136)
2004–05	25 (12-66)	1379 (1123-1708)	218 (144-343)	30 (7-144)	28 (6-128)
2005–06	7 (3-29)	1385 (1122-1747)	94 (39-239)	19 (5-87)	57 (13-235)
2006–07	3 (1-12)	1560 (1238-2004)	79 (56-114)	28 (10-81)	30 (7-129)
2007–08	2 (1-4)	4377 (3625-5279)	98 (70-138)	19 (4-83)	35 (9-146)
2008–09	1 (0-3)	7950 (6546-9804)	76 (49-120)	32 (8-135)	38 (10-151)
2009–10	1 (0-5)	2817 (2311-3471)	145 (108-201)	70 (24-216)	85 (25-280)
2010–11	1 (0-6)	2767 (2259-3457)	20 (13-32)	36 (11-130)	48 (18-129)
2011–12	1 (0-4)	1035 (829-1318)	98 (72-138)	43 (14-144)	58 (14-240)
2012–13	1 (0-4)	1486 (1240-1824)	194 (146-268)	50 (13-208)	108 (26-442)
2013–14	3 (1-6)	940 (763-1187)	203 (154-275)	44 (24-79)	81 (46-143)
2014–15	6 (3-13)	1816 (1522-2202)	121 (99-152)	23 (15-38)	63 (44-91)
2015–16	2 (1-5)	619 (493-800)	96 (68-140)	65 (18-240)	96 (51-187)
2016–17	3 (1-10)	879 (677-1171)	33 (24-46)	44 (26-75)	72 (45-115)

Fishing year	PUYS	STEW	SUBA	WCNI	WCSI
2002–03	874 (483-1671)	1747 (1421-2205)	650 (503-875)	20 (3-133)	2566 (2161-3110)
2003–04	204 (125-378)	329 (246-461)	102 (71-157)	6 (1-43)	1468 (1195-1835)
2004–05	434 (220-888)	876 (635-1252)	306 (207-475)	4 (1-27)	810 (663-1015)
2005–06	1763 (990-3284)	535 (402-748)	57 (32-122)	24 (5-121)	1777 (1442-2247)
2006–07	122 (65-242)	397 (303-534)	80 (54-131)	14 (4-54)	1732 (1334-2334)
2007–08	213 (89-527)	309 (244-402)	61 (43-93)	24 (5-114)	1116 (916-1379)
2008–09	57 (31-115)	427 (335-564)	71 (49-111)	22 (4-108)	1146 (915-1454)
2009–10	235 (141-425)	181 (143-235)	16 (10-31)	6 (1-37)	760 (595-1002)
2010–11	69 (39-129)	294 (234-383)	10 (5-24)	5 (1-26)	795 (633-1027)
2011–12	331 (203-601)	266 (211-346)	24 (14-46)	6 (2-19)	707 (555-903)
2012–13	252 (155-440)	420 (349-520)	22 (13-45)	20 (4-91)	1034 (868-1273)
2013–14	100 (58-190)	451 (372-564)	37 (24-64)	12 (2-63)	890 (754-1078)
2014–15	130 (84-211)	525 (441-636)	27 (17-49)	9 (2-51)	1036 (888-1222)
2015–16	321 (198-561)	195 (153-261)	2 (1-8)	11 (2-56)	631 (515-811)
2016–17	151 (91-258)	286 (230-359)	32 (20-58)	15 (4-56)	710 (603-854)

Table A5: continued

(d) Non-QMS invertebrate species

Fishing year	AUCK	CHAT	COOK	EAST	NORTH
2002–03	7 (5-13)	280 (227-350)	2 (1-6)	1 (0-5)	0 (0-2)
2003–04	2 (1-6)	306 (242-392)	0 (0-1)	1 (0-3)	0 (0-1)
2004–05	4 (2-9)	96 (76-122)	0 (0-1)	0 (0-1)	0 (0-1)
2005–06	1 (0-4)	182 (143-234)	2 (1-5)	1 (0-2)	1 (0-2)
2006–07	0 (0-1)	76 (61-97)	1 (1-3)	1 (0-3)	0 (0-1)
2007–08	1 (0-2)	82 (66-106)	2 (1-6)	0 (0-2)	0 (0-1)
2008–09	0 (0-0)	79 (64-101)	1 (0-3)	0 (0-2)	0 (0-1)
2009–10	0 (0-1)	49 (41-58)	1 (0-1)	1 (0-2)	0 (0-1)
2010–11	0 (0-1)	60 (47-78)	1 (0-1)	1 (0-3)	0 (0-2)
2011–12	0 (0-0)	15 (12-20)	0 (0-1)	0 (0-1)	0 (0-1)
2012–13	0 (0-1)	21 (18-25)	1 (1-2)	1 (0-2)	0 (0-2)
2013–14	1 (0-1)	13 (10-16)	1 (1-3)	1 (0-2)	0 (0-1)
2014–15	1 (1-2)	28 (24-33)	1 (1-1)	1 (0-1)	1 (0-1)
2015–16	0 (0-1)	20 (16-26)	1 (0-2)	1 (0-2)	0 (0-1)
2016–17	1 (0-2)	17 (14-22)	0 (0-1)	1 (0-1)	1 (0-1)

Fishing year	PUYS	STEW	SUBA	WCNI	WCSI
2002–03	9 (4-22)	106 (83-136)	36 (28-50)	0 (0-0)	52 (41-69)
2003–04	4 (2-7)	85 (65-117)	26 (18-40)	0 (0-0)	35 (26-46)
2004–05	5 (2-10)	133 (98-185)	46 (32-70)	0 (0-0)	12 (9-18)
2005–06	17 (8-37)	78 (58-110)	8 (5-16)	0 (0-1)	41 (30-54)
2006–07	10 (6-20)	49 (38-67)	9 (6-15)	0 (0-0)	26 (19-38)
2007–08	8 (3-18)	74 (58-95)	14 (10-22)	0 (0-1)	48 (38-61)
2008–09	2 (1-4)	38 (30-50)	6 (4-10)	0 (0-0)	28 (21-37)
2009–10	4 (3-6)	36 (30-43)	3 (2-5)	0 (0-0)	7 (6-9)
2010–11	4 (2-7)	39 (31-51)	2 (1-4)	0 (0-0)	23 (18-31)
2011–12	2 (1-4)	30 (24-38)	3 (2-5)	0 (0-0)	13 (10-17)
2012–13	2 (2-4)	43 (37-50)	3 (2-4)	0 (0-0)	14 (12-17)
2013–14	2 (1-3)	48 (41-57)	4 (3-6)	0 (0-0)	21 (18-25)
2014–15	1 (1-2)	70 (60-81)	4 (3-6)	0 (0-0)	34 (30-39)
2015–16	5 (3-9)	32 (26-40)	1 (0-1)	0 (0-0)	27 (22-34)
2016–17	2 (1-4)	41 (34-49)	5 (3-7)	0 (0-0)	21 (18-26)

Table A5: continued

(e) ALL species

Fishing year	AUCK	CHAT	COOK	EAST	NORTH
2002–03	205 (133-364)	14762 (12323-18033)	1982 (1425-2798)	71 (29-178)	70 (19-275)
2003–04	71 (40-167)	9658 (7888-11894)	1330 (949-1859)	57 (15-210)	72 (19-266)
2004–05	57 (28-147)	3348 (2756-4158)	651 (489-883)	26 (8-92)	32 (8-135)
2005–06	29 (11-112)	4042 (3341-4989)	659 (385-1147)	24 (6-96)	86 (23-340)
2006–07	30 (9-149)	3089 (2396-4230)	652 (490-909)	32 (11-90)	63 (17-239)
2007–08	3 (1-8)	7160 (5924-8868)	838 (630-1122)	23 (6-92)	55 (15-211)
2008–09	3 (1-11)	12681 (9917-16575)	943 (685-1338)	40 (11-153)	67 (17-260)
2009–10	3 (1-13)	3848 (3212-4673)	333 (275-404)	33 (12-94)	71 (24-207)
2010–11	3 (1-18)	5611 (4193-7853)	690 (466-1070)	55 (16-175)	93 (32-294)
2011–12	3 (1-16)	3039 (2388-3930)	643 (478-876)	39 (13-131)	98 (27-396)
2012–13	4 (2-12)	1718 (1414-2204)	346 (268-459)	37 (11-142)	116 (32-389)
2013–14	9 (5-20)	1801 (1457-2341)	550 (431-700)	71 (39-133)	104 (58-193)
2014–15	20 (11-46)	2776 (2334-3339)	213 (183-250)	11 (7-17)	75 (52-112)
2015–16	6 (3-22)	984 (793-1300)	366 (276-487)	70 (23-239)	138 (77-260)
2016–17	22 (9-83)	924 (703-1300)	303 (225-423)	104 (58-197)	158 (91-286)

Fishing year	PUYS	STEW	SUBA	WCNI	WCSI
2002–03	784 (437-1513)	2853 (2277-3654)	1002 (753-1420)	13 (3-81)	3250 (2716-3906)
2003–04	276 (167-516)	2528 (1880-3518)	773 (535-1247)	10 (2-69)	2882 (2409-3543)
2004–05	681 (409-1175)	2179 (1576-3104)	765 (517-1183)	3 (0-16)	1509 (1270-1839)
2005–06	2074 (1252-3605)	2008 (1558-2783)	221 (130-471)	30 (6-151)	2676 (2227-3285)
2006–07	484 (249-1017)	4774 (3545-6808)	949 (609-1847)	19 (5-86)	3740 (2865-5079)
2007–08	622 (271-1434)	594 (469-769)	115 (79-187)	32 (7-139)	2167 (1764-2743)
2008–09	152 (77-357)	1384 (1028-1949)	222 (137-419)	32 (7-158)	2402 (1892-3272)
2009–10	267 (167-445)	512 (422-639)	47 (30-84)	4 (1-22)	659 (539-821)
2010–11	199 (98-455)	724 (527-1060)	23 (10-75)	8 (1-54)	2302 (1723-3191)
2011–12	417 (235-812)	1019 (775-1377)	90 (49-203)	10 (3-33)	3606 (2932-4646)
2012–13	378 (220-753)	1288 (1048-1671)	67 (40-155)	18 (4-82)	2727 (2286-3396)
2013–14	249 (138-529)	1525 (1233-1933)	121 (77-235)	14 (3-74)	2491 (2110-3038)
2014–15	275 (177-450)	1987 (1685-2361)	102 (63-188)	8 (2-39)	2681 (2355-3096)
2015–16	515 (302-945)	876 (679-1195)	9 (4-31)	12 (3-65)	2106 (1746-2644)
2016–17	460 (253-927)	2006 (1554-2772)	223 (128-491)	26 (6-122)	2802 (2308-3580)

Table A6:. Total annual bycatch estimates (t) (with estimated 95% CIs in parenthesis) for selected categories and main bycatch species for the target hoki, hake, ling, silver warehou, white warehou trawl fishery. The slope of a regression through the data points is shown (in bold if significant) in the bottom row for each species group/code (see Table A1 for species code definitions).

Fishing year	Morids		Schedule 6		Rattails (all)		Slickheads		Sharks		BAR		BOE		BYX	
1990–91	1047	(965-1141)	972	(792-1384)	2428	(2192-2698)	4	(2-10)	3748	(3378-4276)	353	(197-783)	120	(49-454)	24	(18-34)
1991–92	1082	(997-1176)	1687	(1391-2257)	3956	(3600-4386)	2	(1-4)	4994	(4547-5577)	385	(248-648)	474	(336-732)	23	(18-31)
1992–93	1264	(1065-1535)	1114	(930-1382)	5938	(4954-7176)	1	(0-67)	3905	(3407-4516)	275	(142-688)	187	(98-426)	27	(20-36)
1993–94	597	(532-673)	1911	(1634-2285)	1685	(1536-1856)	3	(1-9)	3982	(3609-4436)	132	(94-234)	333	(182-715)	88	(66-126)
1994–95	1253	(1084-1494)	4163	(3278-6106)	4851	(4216-5650)	2	(0-33)	6776	(5823-8790)	2054	(1167-3878)	302	(138-811)	50	(39-65)
1995–96	2475	(1915-3508)	10366	(7645-15034)	10225	(8806-12116)	0	(0-1906)	18670	(14221-26155)	935	(563-1744)	93	(30-576)	66	(45-102)
1996–97	1259	(955-1773)	4380	(2747-9826)	19355	(16566-22826)	1	(0-23)	9093	(6417-16538)	856	(319-3237)	66	(8-5258)	40	(27-58)
1997–98	1392	(1235-1598)	5647	(5020-6403)	16479	(15170-17953)	5	(1-46)	11498	(10486-12706)	135	(76-325)	1636	(1052-2823)	209	(155-292)
1998–99	1075	(977-1190)	5201	(4584-5936)	10330	(9568-11120)	3	(1-7)	9975	(9233-10885)	144	(96-232)	258	(170-450)	18	(10-35)
1999–2000	1018	(929-1121)	6532	(5590-7768)	10828	(9772-12038)	16	(10-30)	12451	(11427-13565)	138	(87-243)	872	(420-2443)	16	(10-27)
2000–01	841	(770-923)	4997	(4381-5728)	14100	(12895-15493)	2	(1-6)	9980	(9286-10781)	302	(189-570)	362	(143-1469)	28	(15-64)
2001–02	1654	(1514-1824)	4350	(3833-5020)	15512	(14053-17221)	31	(20-53)	10228	(9524-11084)	145	(87-262)	251	(153-469)	2	(1-5)
2002–03	858	(780-944)	3940	(3393-4659)	13269	(12119-14647)	29	(18-51)	9009	(8331-9813)	332	(199-659)	552	(221-1956)	31	(21-50)
2003–04	993	(901-1104)	3516	(3085-4067)	11235	(9925-12813)	18	(7-77)	8865	(8021-9882)	292	(151-755)	2373	(746-12893)	6	(4-12)
2004–05	766	(689-852)	2316	(2029-2682)	10851	(9772-12071)	12	(5-45)	5872	(5366-6423)	1236	(635-3385)	125	(51-457)	4	(1-14)
2005–06	711	(640-796)	2436	(2099-2875)	9635	(8589-10913)	13	(9-19)	6480	(5827-7262)	138	(92-221)	548	(265-1455)	3	(1-18)
2006–07	710	(637-792)	2051	(1787-2400)	8236	(7406-9206)	6	(3-19)	4418	(4031-4856)	199	(114-399)	427	(216-1073)	16	(6-59)
2007–08	1097	(974-1245)	2455	(2124-2863)	9540	(8488-10883)	40	(32-50)	7046	(6402-7784)	276	(147-588)	756	(419-1708)	27	(10-113)
2008–09	568	(507-641)	2742	(2403-3161)	9864	(8676-11357)	32	(24-45)	4968	(4558-5444)	34	(20-71)	142	(56-587)	14	(6-41)
2009–10	473	(405-556)	2365	(2094-2695)	14647	(12756-17203)	5	(3-10)	5126	(4693-5643)	205	(116-472)	981	(474-2678)	26	(11-73)
2010–11	522	(452-613)	3058	(2666-3585)	8202	(7271-9304)	3	(2-8)	5105	(4647-5629)	1112	(588-2836)	12	(5-45)	16	(7-46)
2011–12	483	(427-552)	3001	(2687-3383)	6375	(5728-7144)	6	(4-13)	5903	(5428-6475)	87	(58-146)	1297	(695-3407)	23	(14-44)
2012–13	615	(558-682)	2511	(2275-2804)	10463	(9509-11641)	6	(4-9)	5226	(4852-5628)	639	(344-1853)	673	(308-2038)	25	(18-37)
2013–14	1004	(904-1135)	4040	(3640-4530)	8013	(7345-8786)	13	(9-18)	7152	(6689-7690)	624	(367-1417)	1517	(807-4016)	50	(36-73)
2014–15	1161	(1040-1308)	4455	(4028-5003)	14511	(12844-16596)	14	(11-18)	8556	(7811-9360)	509	(344-817)	593	(232-2257)	118	(90-163)
2015–16	711	(636-807)	2544	(2303-2811)	13205	(11773-14933)	11	(8-17)	5412	(5032-5859)	320	(217-543)	343	(155-1099)	33	(26-46)
2016–17	806	(717-922)	4022	(3615-4489)	14599	(12963-16670)	13	(9-20)	6362	(5941-6887)	1290	(687-3464)	733	(354-1765)	75	(55-111)
Slope	**-0.025**		0.008		0.034		**0.089**		-0.005		0.004		0.035		-0.004	

Table A6: continued

Fishing year	GIZ	GSH	GSP	JAV	JMA	LDO	ORH	RCO
1990–91	321 (266-394)	556 (480-647)	264 (203-358)	1320 (1106-1593)	1440 (948-2572)	349 (310-397)	218 (123-498)	129 (101-171)
1991–92	277 (246-314)	709 (629-799)	436 (319-614)	1441 (1272-1645)	775 (491-1449)	388 (351-428)	59 (38-94)	273 (206-395)
1992–93	270 (215-342)	754 (628-923)	112 (56-263)	2926 (2356-3649)	82 (44-223)	319 (268-389)	45 (21-109)	111 (88-146)
1993–94	79 (65-97)	559 (487-670)	196 (136-291)	614 (552-690)	428 (333-599)	366 (327-414)	254 (74-1574)	190 (144-261)
1994–95	132 (103-181)	740 (620-920)	124 (80-210)	2102 (1818-2449)	3865 (2458-7982)	331 (285-386)	48 (22-148)	615 (436-949)
1995–96	461 (365-593)	925 (719-1403)	10 (1-473)	2949 (2447-3628)	2036 (1238-3885)	391 (335-463)	9 (2-255)	849 (576-1459)
1996–97	288 (205-429)	1455 (998-2279)	12 (2-593)	8083 (6620-10010)	876 (487-1934)	554 (464-673)	280 (20-297995)	118 (76-255)
1997–98	276 (243-326)	1442 (1312-1579)	26 (3-397)	9135 (8293-10094)	360 (232-694)	535 (496-582)	13 (7-27)	139 (98-278)
1998–99	338 (304-382)	643 (542-780)	606 (425-919)	4633 (4265-5075)	233 (160-388)	809 (743-877)	38 (14-182)	186 (127-297)
1999–2000	202 (176-234)	436 (335-592)	1254 (1018-1572)	6320 (5652-7112)	125 (76-273)	379 (347-411)	165 (105-271)	70 (52-97)
2000–01	526 (474-590)	623 (447-935)	1980 (1590-2493)	7442 (6727-8346)	24 (16-46)	792 (730-859)	31 (15-86)	86 (68-109)
2001–02	402 (366-442)	306 (238-412)	1932 (1573-2429)	8989 (8046-10118)	15 (10-28)	792 (732-862)	64 (39-121)	121 (96-160)
2002–03	365 (330-408)	322 (238-455)	1939 (1576-2413)	7501 (6854-8333)	45 (30-88)	946 (862-1040)	236 (143-470)	127 (104-158)
2003–04	357 (310-412)	258 (189-365)	1556 (1347-1833)	5913 (5162-6813)	86 (54-172)	610 (556-672)	69 (35-164)	185 (156-222)
2004–05	300 (275-329)	262 (201-354)	869 (661-1152)	7109 (6425-8019)	68 (40-145)	465 (422-520)	62 (16-589)	194 (149-257)
2005–06	344 (301-390)	180 (125-281)	955 (740-1312)	5476 (4804-6292)	24 (16-58)	448 (407-496)	22 (12-47)	151 (118-207)
2006–07	220 (200-242)	155 (105-246)	822 (633-1116)	5659 (5029-6424)	18 (10-38)	442 (396-495)	72 (28-285)	164 (131-211)
2007–08	263 (230-299)	255 (174-405)	1438 (1151-1838)	5483 (4807-6265)	113 (53-504)	304 (278-334)	160 (93-301)	64 (51-84)
2008–09	156 (135-181)	305 (206-475)	988 (810-1245)	5852 (5126-6784)	20 (8-90)	294 (263-331)	83 (37-285)	34 (27-43)
2009–10	297 (259-340)	574 (423-833)	690 (491-984)	7666 (6619-9012)	15 (8-32)	335 (306-370)	13 (6-35)	67 (52-90)
2010–11	240 (214-270)	591 (401-952)	972 (754-1306)	4614 (4069-5293)	13 (6-41)	359 (327-400)	7 (2-45)	188 (138-271)
2011–12	193 (167-227)	607 (437-945)	776 (612-1019)	2987 (2674-3343)	51 (31-119)	328 (300-360)	3 (1-10)	195 (149-264)
2012–13	283 (260-308)	418 (311-616)	747 (567-1025)	4807 (4336-5435)	21 (14-39)	551 (505-603)	8 (3-24)	172 (141-217)
2013–14	314 (286-346)	477 (366-674)	1084 (855-1401)	4099 (3703-4572)	14 (10-22)	555 (512-602)	8 (5-14)	275 (225-346)
2014–15	619 (555-692)	581 (430-848)	1151 (928-1469)	7443 (6526-8638)	62 (46-95)	833 (758-924)	9 (6-16)	164 (141-195)
2015–16	371 (331-419)	842 (619-1223)	1298 (1006-1767)	7138 (6357-8166)	45 (34-66)	681 (625-752)	11 (4-43)	227 (184-303)
2016–17	327 (293-370)	560 (403-885)	923 (679-1294)	7483 (6642-8547)	29 (20-64)	664 (598-739)	6 (3-12)	251 (203-320)
Slope	0.012	-0.021	**0.105**	**0.044**	**-0.158**	0.011	**-0.102**	-0.010

Table A6: continued

Fishing year	RIB		RSO		SBW		SND		SPD		SPE		SQU	
1990–91	788	(724-861)	155	(124-204)	6	(1-129)	355	(296-432)	787	(592-1389)	258	(228-297)	186	(167-208)
1991–92	806	(731-881)	102	(85-126)	40	(25-70)	402	(340-486)	1451	(1141-2109)	349	(307-398)	248	(221-279)
1992–93	986	(818-1223)	153	(124-197)	2	(1-2)	307	(225-429)	769	(625-1006)	350	(287-429)	148	(126-176)
1993–94	235	(209-266)	230	(188-320)	1	(0-3)	314	(251-403)	1672	(1386-2050)	255	(227-291)	188	(164-218)
1994–95	418	(366-485)	41	(30-60)	36	(18-106)	164	(129-215)	3931	(3015-6432)	373	(323-437)	348	(310-392)
1995–96	367	(305-453)	76	(49-158)	1	(0-6)	173	(115-287)	10471	(7363-16075)	569	(457-717)	206	(177-245)
1996–97	994	(748-1358)	38	(20-98)	7	(3-33)	181	(125-289)	3894	(2116-10743)	505	(382-709)	177	(150-209)
1997–98	984	(879-1107)	92	(61-145)	39	(19-99)	318	(254-414)	4587	(4003-5343)	691	(619-779)	220	(192-263)
1998–99	805	(740-884)	16	(8-36)	32	(13-125)	193	(153-247)	4378	(3830-5087)	783	(718-859)	209	(188-232)
1999–2000	910	(826-1012)	276	(158-560)	34	(24-54)	780	(643-970)	6137	(5124-7557)	846	(729-1000)	150	(131-173)
2000–01	692	(627-772)	54	(36-102)	83	(51-149)	363	(292-462)	4064	(3507-4781)	1120	(999-1250)	501	(445-565)
2001–02	1375	(1255-1508)	97	(71-157)	65	(23-327)	851	(697-1065)	3782	(3286-4438)	1355	(1191-1556)	548	(497-609)
2002–03	584	(530-649)	296	(243-368)	336	(185-804)	343	(277-430)	3261	(2794-3875)	1521	(1347-1739)	506	(445-584)
2003–04	674	(601-757)	543	(448-719)	247	(135-572)	276	(231-339)	2925	(2497-3471)	1049	(894-1244)	381	(337-430)
2004–05	431	(388-480)	205	(161-284)	21	(4-452)	283	(243-335)	2057	(1736-2479)	686	(613-767)	327	(291-369)
2005–06	493	(438-555)	141	(110-192)	2	(1-3)	455	(390-546)	2052	(1666-2579)	487	(424-564)	394	(346-449)
2006–07	421	(375-475)	29	(22-40)	13	(7-27)	231	(190-286)	1843	(1577-2192)	415	(363-477)	488	(424-565)
2007–08	991	(869-1138)	24	(16-45)	940	(508-2215)	551	(474-654)	2124	(1801-2596)	370	(327-419)	262	(235-292)
2008–09	554	(484-637)	71	(53-108)	837	(416-2267)	350	(296-421)	2353	(1997-2758)	338	(289-401)	281	(244-324)
2009–10	328	(285-386)	49	(37-73)	45	(15-243)	183	(148-228)	1925	(1695-2239)	567	(491-664)	381	(338-437)
2010–11	299	(258-349)	140	(108-194)	236	(111-819)	252	(199-322)	2767	(2312-3397)	873	(734-1059)	606	(516-735)
2011–12	305	(267-353)	42	(31-63)	54	(27-152)	149	(118-191)	2713	(2396-3113)	466	(410-534)	341	(302-387)
2012–13	378	(341-423)	164	(127-246)	28	(19-51)	274	(229-342)	1957	(1726-2256)	672	(599-776)	563	(504-649)
2013–14	591	(530-662)	236	(186-312)	232	(147-460)	338	(283-414)	3841	(3346-4504)	399	(365-439)	604	(534-683)
2014–15	981	(847-1155)	173	(145-212)	175	(115-302)	211	(173-258)	3596	(3112-4243)	975	(874-1095)	1117	(1004-1258)
2015–16	415	(370-467)	281	(217-407)	135	(79-303)	346	(288-426)	2114	(1851-2438)	846	(760-955)	722	(628-837)
2016–17	486	(426-570)	689	(580-859)	143	(86-306)	217	(179-266)	3764	(3320-4328)	582	(526-650)	815	(706-952)
Slope	-0.017		0.026		**0.140**		-0.006		0.009		0.018		**0.054**	

Table A7: Total annual bycatch estimates (t) (with estimated 95% CIs in parenthesis) for selected categories and main bycatch species, by area for the target hoki, hake, ling, silver warehou, white warehou trawl fishery. Species are ordered by decreasing total catch. See Table A1 for species code definitions.

Morid cods

Fishing year	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI	
1990–91	5	(3-8)	308	(278-343)	13	(5-33)	1	(0-3)	0	(0-0)	84	(63-110)	442	(391-504)	76	(64-91)	0	(0-0)	113	(98-131)
1991–92	5	(3-8)	355	(310-413)	9	(3-24)	1	(0-2)	0	(0-0)	118	(100-140)	407	(364-458)	45	(37-54)	0	(0-1)	139	(118-166)
1992–93	5	(3-9)	564	(413-777)	9	(4-24)	1	(0-5)	0	(0-2)	42	(28-70)	238	(196-291)	9	(6-14)	0	(0-3)	387	(317-489)
1993–94	6	(4-9)	129	(110-151)	35	(18-70)	5	(2-16)	0	(0-1)	48	(30-78)	106	(87-132)	7	(5-10)	0	(0-1)	256	(222-300)
1994–95	8	(5-13)	394	(329-477)	91	(35-249)	5	(2-15)	1	(0-4)	74	(37-149)	204	(160-262)	7	(4-12)	2	(0-7)	451	(382-538)
1995–96	8	(5-16)	556	(433-726)	827	(399-1727)	29	(10-85)	8	(3-20)	171	(96-313)	181	(133-249)	6	(4-14)	0	(0-3)	642	(526-825)
1996–97	16	(9-30)	335	(262-438)	235	(86-619)	24	(8-70)	7	(2-22)	61	(34-111)	331	(215-520)	8	(4-16)	0	(0-2)	205	(160-269)
1997–98	41	(31-55)	559	(491-638)	83	(57-121)	19	(11-32)	7	(3-18)	90	(35-236)	343	(285-416)	28	(20-38)	1	(0-3)	209	(175-255)
1998–99	15	(11-21)	357	(320-396)	85	(65-110)	8	(3-20)	4	(1-12)	114	(69-186)	232	(202-263)	42	(34-51)	0	(0-2)	215	(181-257)
1999–2000	24	(19-30)	433	(380-497)	46	(33-66)	5	(2-12)	2	(1-7)	81	(52-130)	225	(200-255)	65	(56-77)	1	(0-3)	128	(108-152)
2000–01	17	(14-22)	393	(350-448)	25	(19-33)	4	(1-12)	1	(0-3)	62	(42-90)	151	(131-174)	48	(40-57)	0	(0-2)	136	(114-160)
2001–02	38	(29-50)	446	(395-509)	38	(26-58)	5	(2-16)	4	(1-11)	91	(57-147)	358	(310-411)	161	(138-190)	1	(0-4)	506	(440-586)
2002–03	18	(14-23)	435	(382-500)	18	(12-25)	9	(4-19)	1	(0-4)	37	(23-57)	115	(98-134)	76	(64-90)	0	(0-1)	146	(128-169)
2003–04	11	(8-15)	544	(478-630)	23	(16-33)	5	(2-15)	2	(1-6)	24	(15-37)	108	(88-132)	51	(41-63)	0	(0-1)	225	(197-259)
2004–05	15	(11-22)	242	(213-274)	42	(30-59)	4	(1-12)	2	(0-5)	53	(34-85)	145	(116-180)	43	(34-56)	0	(0-1)	214	(186-251)
2005–06	2	(1-4)	210	(181-244)	22	(12-38)	2	(1-6)	2	(1-7)	59	(38-93)	113	(92-139)	6	(4-10)	1	(0-3)	291	(254-338)
2006–07	2	(1-5)	267	(232-308)	29	(21-41)	2	(1-6)	2	(1-5)	23	(15-37)	162	(135-197)	17	(12-24)	0	(0-2)	199	(167-242)
2007–08	7	(4-13)	374	(320-444)	43	(30-62)	4	(1-12)	3	(1-9)	51	(25-100)	133	(110-164)	24	(18-35)	1	(0-6)	449	(372-550)
2008–09	3	(2-6)	254	(217-303)	18	(13-27)	3	(1-7)	1	(0-3)	6	(3-10)	86	(73-102)	13	(9-18)	0	(0-2)	179	(147-220)
2009–10	1	(0-4)	210	(171-260)	25	(16-40)	4	(1-12)	4	(1-11)	17	(9-32)	110	(88-140)	7	(4-15)	0	(0-1)	90	(69-119)
2010–11	3	(2-7)	230	(192-281)	8	(4-13)	5	(2-13)	2	(1-5)	27	(16-49)	63	(51-82)	9	(6-15)	0	(0-1)	170	(134-220)
2011–12	3	(1-6)	195	(167-232)	16	(11-26)	3	(1-11)	2	(1-7)	42	(26-68)	114	(92-143)	7	(4-13)	0	(0-2)	94	(76-118)
2012–13	3	(1-6)	240	(208-281)	34	(23-51)	5	(2-14)	4	(1-12)	33	(21-53)	121	(103-144)	14	(10-21)	0	(0-2)	157	(134-189)
2013–14	13	(8-24)	275	(233-332)	55	(37-84)	6	(3-14)	3	(2-7)	55	(33-95)	247	(209-304)	32	(23-52)	0	(0-3)	308	(260-374)
2014–15	11	(7-20)	419	(350-507)	38	(28-58)	8	(3-20)	3	(2-5)	45	(28-81)	213	(178-263)	16	(11-29)	0	(0-3)	398	(337-480)
2015–16	5	(3-11)	258	(221-303)	13	(8-20)	5	(2-14)	3	(1-6)	121	(81-188)	114	(93-143)	6	(3-12)	0	(0-1)	181	(153-216)
2016–17	5	(3-11)	302	(253-366)	9	(5-16)	7	(3-14)	8	(4-17)	67	(41-115)	115	(94-145)	12	(8-19)	0	(0-2)	276	(235-330)

Table A7: continued

Schedule 6 species

Fishing year	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI	
1990–91	1	(0-2)	304	(245-384)	156	(46-565)	1	(0-6)	0	(0-0)	40	(26-64)	57	(44-74)	10	(7-14)	0	(0-3)	387	(320-471)
1991–92	3	(1-7)	428	(321-578)	184	(53-677)	1	(0-6)	0	(0-0)	33	(24-48)	254	(206-316)	27	(19-42)	2	(0-13)	718	(586-900)
1992–93	4	(2-8)	274	(197-376)	161	(74-352)	2	(0-8)	1	(0-4)	25	(14-45)	209	(169-260)	8	(4-13)	6	(1-28)	412	(344-509)
1993–94	10	(6-21)	177	(142-225)	292	(161-532)	12	(3-55)	0	(0-3)	37	(19-73)	210	(159-277)	12	(7-25)	2	(0-15)	1136	(969-1349)
1994–95	11	(6-24)	660	(508-885)	713	(192-2595)	9	(2-40)	3	(1-18)	24	(10-63)	318	(232-446)	10	(5-23)	14	(3-72)	2313	(1891-2850)
1995–96	12	(6-27)	1483	(1174-1882)	6011	(3502-10512)	69	(17-271)	25	(7-85)	106	(54-214)	289	(207-430)	10	(5-21)	8	(1-45)	2252	(1881-2800)
1996–97	15	(7-34)	636	(510-808)	2035	(571-7353)	75	(19-301)	32	(8-129)	219	(104-490)	321	(181-582)	8	(3-19)	6	(1-32)	936	(768-1144)
1997–98	42	(31-58)	1077	(954-1236)	1665	(1312-2144)	146	(90-236)	32	(12-86)	102	(28-362)	355	(285-447)	30	(21-46)	15	(3-62)	2125	(1839-2473)
1998–99	16	(10-28)	1267	(1088-1480)	1698	(1334-2161)	45	(14-149)	27	(7-103)	250	(133-493)	257	(208-328)	49	(36-74)	12	(2-70)	1521	(1291-1803)
1999–2000	33	(23-53)	1856	(1545-2258)	2791	(2090-3785)	26	(8-86)	16	(4-66)	77	(44-146)	313	(252-396)	90	(68-126)	22	(6-85)	1261	(1050-1525)
2000–01	58	(39-92)	1291	(1095-1523)	1445	(1100-1916)	32	(8-147)	7	(2-31)	120	(79-190)	537	(428-682)	166	(127-227)	16	(3-87)	1272	(1066-1543)
2001–02	79	(54-127)	1435	(1202-1735)	689	(484-1010)	18	(4-78)	14	(3-59)	62	(38-105)	778	(616-994)	347	(269-466)	9	(2-47)	882	(754-1049)
2002–03	44	(31-68)	1164	(988-1395)	1448	(1064-1985)	27	(9-81)	10	(2-42)	93	(53-168)	293	(240-365)	191	(150-245)	5	(1-32)	645	(541-781)
2003–04	32	(21-55)	1366	(1137-1651)	970	(730-1343)	24	(5-92)	12	(3-48)	31	(19-52)	343	(267-448)	158	(118-220)	5	(1-28)	551	(470-646)
2004–05	11	(7-19)	899	(775-1045)	811	(611-1083)	15	(4-55)	6	(2-25)	113	(71-183)	114	(85-155)	34	(24-49)	3	(1-15)	294	(249-348)
2005–06	3	(1-10)	911	(772-1105)	648	(424-969)	9	(2-40)	12	(3-56)	56	(31-104)	226	(177-296)	12	(7-25)	12	(2-58)	516	(431-623)
2006–07	5	(2-13)	720	(606-884)	417	(315-570)	11	(4-37)	8	(2-34)	88	(48-175)	362	(288-462)	37	(24-61)	4	(1-14)	375	(299-470)
2007–08	10	(5-20)	786	(666-953)	822	(609-1111)	11	(3-49)	10	(2-43)	41	(18-95)	190	(153-242)	34	(23-51)	16	(3-81)	502	(410-635)
2008–09	17	(9-37)	1012	(841-1222)	643	(479-875)	21	(6-77)	12	(3-45)	34	(18-66)	440	(359-564)	65	(44-103)	15	(4-70)	448	(354-575)
2009–10	5	(2-17)	1043	(882-1257)	284	(220-373)	19	(5-75)	19	(6-65)	51	(29-99)	393	(323-489)	26	(15-48)	4	(1-23)	492	(403-610)
2010–11	18	(9-41)	1166	(969-1420)	531	(366-785)	37	(10-143)	20	(7-63)	43	(24-82)	344	(270-458)	49	(31-86)	6	(1-37)	803	(655-995)
2011–12	4	(2-11)	1123	(956-1319)	371	(279-488)	19	(5-69)	16	(4-61)	24	(14-43)	191	(155-242)	12	(7-23)	7	(2-25)	1219	(1042-1458)
2012–13	11	(5-28)	838	(725-980)	157	(116-216)	20	(5-81)	20	(5-89)	36	(22-61)	490	(410-602)	55	(37-86)	9	(2-43)	849	(741-1003)
2013–14	53	(32-103)	1440	(1223-1705)	389	(291-534)	29	(15-58)	17	(7-42)	44	(26-80)	1032	(859-1283)	135	(95-217)	7	(2-41)	855	(737-1009)
2014–15	68	(41-129)	1749	(1484-2087)	117	(93-150)	17	(7-41)	12	(7-22)	69	(43-119)	1288	(1069-1578)	97	(61-165)	5	(1-31)	1003	(884-1161)
2015–16	14	(8-29)	1201	(1034-1390)	163	(125-220)	26	(8-98)	25	(12-49)	41	(27-67)	292	(238-370)	16	(9-30)	4	(1-20)	742	(656-853)
2016–17	27	(15-54)	2109	(1821-2454)	204	(150-283)	39	(21-75)	42	(23-76)	55	(33-95)	573	(471-697)	58	(38-95)	15	(4-53)	877	(776-1016)

Rattails (all species combined)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	4 (2-7)	1809 (1603-2044)	3 (1-11)	1 (0-6)	0 (0-0)	70 (47-106)	319 (269-383)	55 (44-70)	0 (0-0)	164 (138-195)
1991–92	7 (5-12)	3137 (2792-3545)	2 (1-6)	1 (0-3)	0 (0-0)	31 (26-39)	621 (562-689)	68 (58-81)	1 (0-4)	85 (70-103)
1992–93	14 (9-23)	4906 (3990-6131)	3 (1-10)	2 (1-10)	1 (0-4)	22 (14-37)	704 (591-842)	26 (18-41)	3 (0-14)	244 (200-297)
1993–94	10 (7-14)	1329 (1199-1478)	20 (11-36)	7 (2-28)	0 (0-1)	9 (5-19)	190 (161-225)	12 (9-17)	1 (0-3)	103 (87-122)
1994–95	19 (12-30)	3894 (3330-4651)	28 (9-95)	6 (2-22)	2 (0-8)	13 (5-34)	480 (391-597)	16 (10-28)	5 (1-24)	361 (299-442)
1995–96	24 (15-44)	8919 (7644-10673)	300 (123-764)	37 (11-134)	8 (2-25)	38 (18-85)	555 (425-727)	20 (12-37)	2 (0-11)	253 (200-321)
1996–97	93 (44-189)	16427 (14056-19482)	184 (53-639)	89 (25-338)	29 (8-111)	35 (13-90)	1936 (970-3692)	49 (22-102)	4 (1-20)	321 (260-400)
1997–98	242 (190-319)	12900 (11734-14203)	102 (66-156)	228 (150-350)	44 (17-115)	128 (37-419)	2022 (1712-2394)	166 (126-228)	12 (2-50)	567 (482-670)
1998–99	34 (26-46)	9047 (8332-9804)	56 (40-80)	17 (6-49)	13 (4-45)	70 (37-134)	521 (465-590)	96 (80-117)	4 (1-19)	455 (402-517)
1999–2000	111 (89-141)	8753 (7777-9936)	27 (17-43)	16 (5-45)	9 (2-33)	69 (41-116)	1047 (930-1179)	303 (260-357)	11 (3-35)	462 (395-547)
2000–01	97 (77-126)	12214 (11090-13550)	24 (16-36)	18 (6-59)	5 (1-17)	72 (45-120)	849 (739-985)	268 (226-323)	6 (1-29)	537 (467-626)
2001–02	228 (179-305)	11030 (9817-12531)	27 (11-72)	13 (4-47)	10 (3-43)	17 (11-27)	2193 (1913-2525)	986 (840-1176)	4 (1-19)	976 (847-1138)
2002–03	128 (103-164)	11030 (9922-12318)	26 (14-45)	61 (28-128)	9 (3-34)	49 (28-84)	834 (728-966)	547 (474-641)	3 (1-15)	562 (496-636)
2003–04	32 (23-46)	10243 (8966-11807)	14 (9-23)	12 (3-43)	6 (2-21)	11 (7-18)	328 (272-397)	153 (125-192)	2 (0-9)	413 (363-471)
2004–05	84 (61-121)	9033 (8028-10186)	22 (13-36)	16 (4-51)	7 (2-28)	53 (30-95)	816 (658-1029)	244 (190-320)	2 (0-11)	560 (492-640)
2005–06	5 (2-11)	8357 (7365-9602)	29 (11-79)	10 (3-37)	14 (4-51)	199 (122-317)	317 (259-390)	17 (11-29)	10 (2-46)	645 (567-755)
2006–07	7 (4-15)	7173 (6382-8116)	22 (16-33)	11 (4-29)	7 (2-26)	29 (18-46)	496 (423-584)	51 (38-71)	5 (1-15)	427 (357-523)
2007–08	32 (21-59)	7881 (6875-9112)	44 (30-66)	13 (4-49)	11 (3-43)	53 (25-121)	621 (528-754)	111 (84-161)	14 (3-64)	737 (615-898)
2008–09	25 (15-46)	8608 (7481-10049)	30 (19-49)	16 (4-58)	8 (2-31)	12 (7-21)	631 (537-751)	93 (70-131)	9 (2-43)	407 (337-488)
2009–10	8 (4-27)	13510 (11645-15992)	72 (51-108)	33 (12-102)	17 (6-55)	24 (14-45)	602 (503-743)	40 (26-71)	3 (1-16)	298 (244-375)
2010–11	25 (16-46)	7063 (6170-8094)	8 (5-14)	19 (6-63)	15 (5-43)	34 (20-57)	452 (381-549)	65 (48-96)	3 (1-15)	503 (421-609)
2011–12	9 (5-17)	5515 (4912-6245)	47 (34-68)	15 (5-45)	13 (4-43)	38 (26-58)	385 (328-461)	24 (16-39)	3 (1-9)	317 (274-367)
2012–13	16 (10-34)	8475 (7543-9615)	100 (73-140)	32 (9-117)	33 (9-122)	65 (43-103)	738 (640-858)	84 (61-124)	10 (3-46)	874 (761-1007)
2013–14	56 (40-91)	5704 (5071-6424)	96 (73-128)	24 (13-44)	28 (16-52)	142 (90-229)	1079 (949-1232)	144 (112-196)	8 (2-36)	717 (636-813)
2014–15	73 (47-128)	11210 (9631-13259)	86 (65-121)	25 (14-49)	28 (17-46)	236 (150-399)	1343 (1147-1615)	103 (70-175)	8 (2-47)	1371 (1198-1585)
2015–16	21 (13-43)	10947 (9627-12603)	41 (29-61)	55 (17-192)	39 (20-80)	390 (262-617)	454 (375-568)	25 (14-47)	8 (1-48)	1163 (1018-1363)
2016–17	29 (18-55)	12628 (11043-14548)	10 (6-17)	23 (12-44)	26 (14-48)	220 (135-393)	620 (513-764)	63 (44-98)	10 (3-48)	942 (823-1100)

Slickheads

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-0)	1 (0-3)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	3 (1-7)
1991–92	0 (0-0)	1 (0-2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (1-2)
1992–93	0 (0-0)	0 (0-8)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-49)
1993–94	0 (0-0)	1 (0-2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	2 (1-7)
1994–95	0 (0-0)	1 (0-9)	0 (0-2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (0-19)
1995–96	0 (0-0)	0 (0-198)	0 (0-111)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-518)
1996–97	0 (0-0)	0 (0-8)	0 (0-4)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-9)
1997–98	0 (0-0)	2 (0-20)	0 (0-3)	0 (0-3)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	2 (0-22)
1998–99	0 (0-0)	1 (0-3)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (1-3)
1999–2000	0 (0-0)	5 (3-11)	1 (0-2)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	9 (5-17)
2000–01	0 (0-0)	1 (0-2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (1-3)
2001–02	0 (0-0)	7 (4-15)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-0)	1 (0-2)	0 (0-1)	0 (0-0)	21 (13-37)
2002–03	0 (0-0)	7 (4-15)	0 (0-2)	0 (0-2)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-1)	0 (0-0)	19 (12-36)
2003–04	0 (0-0)	5 (1-22)	0 (0-3)	0 (0-2)	0 (0-1)	0 (0-0)	0 (0-1)	0 (0-1)	0 (0-0)	12 (5-53)
2004–05	0 (0-0)	3 (1-14)	0 (0-2)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	8 (3-33)
2005–06	0 (0-0)	3 (2-5)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	9 (6-14)
2006–07	0 (0-0)	2 (1-6)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	4 (2-13)
2007–08	0 (0-0)	13 (9-18)	1 (1-3)	0 (0-2)	0 (0-1)	0 (0-0)	1 (0-2)	0 (0-0)	0 (0-1)	23 (19-29)
2008–09	0 (0-0)	12 (8-18)	1 (0-2)	0 (0-3)	0 (0-1)	0 (0-0)	1 (0-1)	0 (0-0)	0 (0-1)	18 (13-25)
2009–10	0 (0-0)	1 (1-4)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	3 (2-7)
2010–11	0 (0-0)	1 (0-2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	2 (1-6)
2011–12	0 (0-0)	1 (1-3)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	5 (3-9)
2012–13	0 (0-0)	1 (1-3)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	4 (3-7)
2013–14	0 (0-0)	3 (2-5)	0 (0-1)	0 (0-2)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	9 (6-13)
2014–15	0 (0-0)	3 (2-5)	0 (0-0)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	10 (8-13)
2015–16	0 (0-0)	2 (1-5)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	8 (5-13)
2016–17	0 (0-0)	2 (1-5)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	10 (7-15)

Table A7: continued

Sharks

Fishing year	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI	
1990–91	11	(7-21)	1710	(1521-1933)	226	(74-670)	4	(1-16)	0	(0-0)	123	(91-169)	933	(818-1075)	161	(134-197)	0	(0-3)	552	(481-631)
1991–92	16	(10-26)	2366	(2078-2716)	200	(66-628)	3	(1-10)	0	(0-0)	106	(89-126)	1311	(1186-1457)	143	(122-174)	4	(1-18)	816	(711-937)
1992–93	23	(15-37)	1912	(1510-2414)	164	(84-313)	4	(1-17)	1	(0-6)	71	(49-106)	1136	(987-1316)	43	(31-62)	10	(2-42)	515	(442-602)
1993–94	41	(29-65)	1140	(998-1308)	406	(252-674)	34	(10-121)	1	(0-4)	85	(51-143)	810	(674-977)	51	(36-76)	5	(1-24)	1378	(1219-1567)
1994–95	38	(25-61)	2040	(1735-2404)	819	(255-2687)	19	(5-70)	5	(1-20)	42	(21-84)	994	(803-1229)	33	(21-57)	24	(6-91)	2713	(2363-3135)
1995–96	50	(31-90)	3704	(3109-4496)	9820	(5681-17113)	158	(48-546)	36	(12-104)	246	(143-445)	1182	(914-1543)	41	(24-79)	13	(3-74)	3239	(2733-3953)
1996–97	73	(42-133)	1929	(1606-2339)	3144	(941-10208)	185	(53-638)	41	(13-134)	430	(230-780)	1545	(1007-2421)	38	(21-77)	11	(2-51)	1544	(1292-1867)
1997–98	188	(150-247)	3575	(3285-3922)	2238	(1778-2792)	287	(196-418)	72	(31-171)	386	(132-1177)	1583	(1348-1868)	132	(102-177)	29	(8-108)	2907	(2547-3300)
1998–99	51	(38-71)	4320	(3948-4739)	1808	(1503-2196)	85	(32-243)	43	(13-144)	637	(385-1110)	771	(676-881)	144	(118-178)	21	(5-94)	2024	(1793-2310)
1999–2000	142	(117-174)	5459	(4891-6109)	3164	(2535-3911)	48	(18-136)	26	(7-88)	166	(111-251)	1325	(1190-1484)	385	(334-449)	30	(11-77)	1651	(1468-1854)
2000–01	165	(135-208)	4648	(4206-5126)	1410	(1161-1712)	80	(28-253)	12	(4-44)	309	(230-418)	1465	(1287-1676)	460	(395-549)	26	(7-99)	1356	(1199-1532)
2001–02	184	(152-229)	5262	(4739-5822)	702	(533-928)	28	(10-81)	22	(7-74)	131	(92-190)	1757	(1572-1974)	787	(694-905)	16	(4-54)	1315	(1181-1463)
2002–03	171	(137-216)	4566	(4124-5094)	1342	(1068-1723)	88	(44-182)	18	(5-63)	205	(138-312)	1103	(974-1277)	727	(631-847)	9	(2-42)	741	(660-835)
2003–04	108	(78-153)	5037	(4422-5790)	1105	(851-1437)	49	(15-170)	23	(6-76)	133	(90-204)	1102	(907-1334)	510	(417-634)	10	(2-44)	748	(663-849)
2004–05	51	(37-74)	3448	(3095-3839)	975	(765-1265)	29	(8-99)	11	(3-39)	247	(173-368)	498	(400-613)	148	(116-192)	4	(1-20)	423	(373-484)
2005–06	8	(4-18)	3990	(3524-4539)	768	(545-1119)	19	(5-70)	23	(7-87)	449	(292-696)	525	(438-637)	29	(19-45)	26	(6-105)	598	(527-689)
2006–07	11	(6-23)	2381	(2114-2704)	428	(338-548)	19	(7-51)	13	(4-45)	164	(105-260)	725	(618-857)	75	(56-104)	12	(4-39)	567	(484-673)
2007–08	37	(26-59)	3948	(3502-4496)	1111	(878-1428)	27	(8-101)	21	(6-66)	170	(85-350)	706	(606-838)	127	(101-166)	37	(10-141)	800	(693-931)
2008–09	39	(27-64)	2336	(2084-2647)	623	(492-794)	37	(11-126)	18	(5-57)	128	(82-197)	999	(876-1149)	149	(116-198)	28	(9-102)	579	(499-672)
2009–10	13	(7-31)	2951	(2617-3340)	285	(233-360)	45	(18-117)	43	(16-121)	220	(142-344)	926	(809-1076)	62	(44-93)	8	(2-37)	538	(463-635)
2010–11	43	(28-71)	2576	(2266-2920)	472	(345-647)	64	(20-195)	28	(11-71)	202	(128-342)	767	(658-911)	111	(83-156)	10	(2-52)	793	(681-924)
2011–12	11	(6-23)	3099	(2770-3516)	427	(335-551)	43	(15-120)	31	(9-109)	248	(171-374)	491	(420-584)	30	(20-47)	15	(5-43)	1474	(1294-1699)
2012–13	23	(14-43)	2501	(2267-2781)	211	(167-269)	43	(13-147)	37	(10-124)	254	(176-386)	973	(859-1105)	111	(86-153)	18	(5-69)	1015	(912-1142)
2013–14	88	(63-131)	3390	(3064-3765)	509	(413-634)	56	(33-96)	15	(9-26)	210	(141-315)	1644	(1468-1853)	220	(177-290)	13	(3-58)	985	(891-1096)
2014–15	102	(71-162)	4789	(4191-5490)	163	(135-201)	21	(11-41)	27	(18-43)	126	(85-194)	1899	(1654-2203)	144	(107-220)	9	(2-43)	1237	(1111-1388)
2015–16	36	(23-62)	3121	(2802-3472)	193	(153-250)	48	(16-148)	48	(28-86)	215	(155-307)	742	(639-880)	42	(27-68)	8	(2-30)	934	(847-1039)
2016–17	51	(36-79)	3628	(3282-4026)	216	(167-283)	55	(35-89)	52	(34-84)	125	(87-185)	1068	(939-1230)	110	(84-152)	17	(6-55)	1026	(935-1133)

Table A7: continued

BAR (Barracouta)

Fishing year	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI	
1990–91	1	(0-12)	24	(12-68)	8	(1-58)	2	(0-23)	0	(0-0)	7	(2-32)	94	(23-429)	14	(3-84)	0	(0-5)	171	(103-325)
1991–92	1	(0-7)	32	(9-130)	6	(1-37)	1	(0-14)	0	(0-0)	4	(2-14)	107	(49-252)	10	(3-36)	0	(0-5)	200	(130-331)
1992–93	0	(0-5)	44	(7-349)	4	(0-30)	1	(0-22)	0	(0-0)	1	(0-8)	38	(14-129)	1	(0-8)	0	(0-11)	153	(84-355)
1993–94	1	(0-6)	16	(7-34)	4	(2-12)	3	(0-23)	0	(0-0)	1	(0-2)	28	(7-109)	1	(0-7)	0	(0-3)	71	(56-91)
1994–95	4	(1-37)	1460	(727-3026)	32	(5-199)	10	(1-111)	0	(0-5)	5	(1-29)	144	(30-773)	4	(0-31)	4	(0-77)	296	(209-435)
1995–96	7	(1-43)	151	(58-415)	47	(8-288)	37	(5-301)	1	(0-16)	5	(1-35)	211	(65-744)	5	(1-35)	1	(0-17)	382	(272-567)
1996–97	4	(0-30)	471	(102-2516)	35	(6-242)	48	(6-401)	1	(0-18)	11	(3-41)	107	(23-514)	2	(0-19)	0	(0-14)	76	(48-135)
1997–98	3	(0-25)	25	(12-57)	5	(2-13)	21	(7-66)	0	(0-3)	1	(0-6)	27	(5-168)	2	(0-19)	0	(0-7)	38	(23-65)
1998–99	1	(0-7)	16	(9-30)	7	(3-16)	4	(1-25)	0	(0-2)	1	(0-4)	26	(11-67)	5	(2-17)	0	(0-5)	76	(48-127)
1999–2000	5	(1-16)	40	(21-88)	2	(1-5)	3	(0-17)	0	(0-1)	1	(0-6)	47	(22-107)	13	(5-35)	0	(0-7)	19	(11-34)
2000–01	6	(2-35)	43	(16-126)	4	(1-13)	7	(1-55)	0	(0-2)	1	(0-9)	82	(38-207)	22	(8-73)	0	(0-8)	114	(68-227)
2001–02	5	(2-17)	12	(3-57)	1	(0-5)	2	(0-19)	0	(0-1)	1	(0-3)	61	(29-129)	25	(12-59)	0	(0-4)	29	(20-46)
2002–03	5	(1-26)	73	(33-198)	7	(2-22)	8	(1-68)	0	(0-3)	1	(0-10)	44	(16-136)	27	(9-94)	0	(0-6)	142	(78-311)
2003–04	3	(0-35)	58	(16-234)	5	(1-22)	9	(1-93)	0	(0-5)	1	(0-11)	48	(9-273)	21	(4-119)	0	(0-9)	110	(69-210)
2004–05	9	(1-109)	129	(29-620)	51	(19-203)	27	(3-329)	0	(0-14)	10	(1-94)	131	(23-979)	33	(4-261)	0	(0-23)	686	(373-1738)
2005–06	0	(0-2)	17	(7-43)	3	(1-21)	2	(0-21)	0	(0-2)	1	(0-8)	24	(9-65)	1	(0-5)	0	(0-12)	77	(54-120)
2006–07	1	(0-9)	22	(8-70)	4	(2-10)	4	(0-34)	0	(0-3)	1	(0-5)	98	(42-251)	8	(2-35)	0	(0-8)	47	(30-85)
2007–08	2	(0-22)	123	(53-327)	4	(1-13)	5	(0-59)	0	(0-5)	1	(0-10)	58	(17-218)	8	(2-52)	1	(0-32)	45	(24-101)
2008–09	0	(0-1)	11	(4-35)	2	(1-5)	1	(0-12)	0	(0-1)	0	(0-1)	6	(3-16)	1	(0-3)	0	(0-5)	9	(5-21)
2009–10	0	(0-3)	86	(37-268)	11	(4-35)	5	(1-67)	0	(0-8)	0	(0-5)	25	(10-82)	1	(0-10)	0	(0-7)	55	(22-163)
2010–11	3	(0-38)	475	(202-1732)	19	(3-137)	39	(4-445)	1	(0-28)	5	(1-48)	108	(42-425)	11	(2-92)	0	(0-37)	324	(156-882)
2011–12	0	(0-1)	54	(30-105)	3	(1-5)	3	(0-22)	0	(0-2)	1	(0-3)	8	(4-16)	0	(0-2)	0	(0-6)	14	(9-22)
2012–13	1	(0-18)	350	(146-1321)	18	(6-79)	13	(1-192)	1	(0-21)	1	(0-19)	113	(50-418)	8	(1-77)	1	(0-41)	55	(25-157)
2013–14	3	(0-24)	367	(166-1097)	10	(4-35)	39	(8-238)	0	(0-7)	1	(0-12)	88	(47-240)	9	(3-47)	0	(0-22)	56	(33-112)
2014–15	6	(1-43)	100	(51-241)	29	(14-69)	15	(2-100)	1	(0-12)	2	(0-15)	173	(98-387)	10	(2-58)	0	(0-16)	129	(83-229)
2015–16	3	(0-22)	118	(64-240)	7	(1-35)	11	(1-96)	0	(0-6)	1	(0-5)	85	(44-205)	3	(0-23)	0	(0-5)	69	(48-107)
2016–17	4	(0-51)	850	(358-2878)	15	(3-80)	13	(2-101)	1	(0-13)	2	(0-16)	145	(62-472)	10	(2-93)	1	(0-34)	160	(84-386)

BOE (Black oreo)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-1)	111 (46-441)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-1)	5 (2-23)	1 (0-5)	0 (0-0)	0 (0-2)
1991–92	0 (0-2)	442 (312-687)	0 (0-5)	0 (0-1)	0 (0-0)	0 (0-2)	26 (17-44)	3 (1-7)	0 (0-0)	0 (0-2)
1992–93	0 (0-1)	177 (93-407)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-1)	9 (5-23)	0 (0-2)	0 (0-0)	0 (0-1)
1993–94	0 (0-3)	317 (173-682)	0 (0-7)	0 (0-3)	0 (0-0)	0 (0-1)	12 (5-35)	0 (0-3)	0 (0-0)	1 (0-4)
1994–95	0 (0-2)	293 (134-794)	0 (0-5)	0 (0-1)	0 (0-0)	0 (0-1)	6 (2-23)	0 (0-1)	0 (0-1)	0 (0-3)
1995–96	0 (0-1)	91 (29-564)	0 (0-2)	0 (0-1)	0 (0-0)	0 (0-0)	2 (0-12)	0 (0-1)	0 (0-0)	0 (0-1)
1996–97	0 (0-1)	63 (7-5109)	0 (0-3)	0 (0-2)	0 (0-0)	0 (0-0)	1 (0-78)	0 (0-0)	0 (0-0)	0 (0-1)
1997–98	3 (1-11)	1591 (1019-2769)	1 (0-17)	0 (0-14)	0 (0-6)	0 (0-2)	27 (14-61)	2 (0-10)	0 (0-2)	1 (0-6)
1998–99	0 (0-1)	252 (166-439)	0 (0-3)	0 (0-1)	0 (0-1)	0 (0-0)	4 (2-9)	1 (0-3)	0 (0-0)	0 (0-1)
1999–2000	1 (0-11)	838 (401-2372)	0 (0-11)	0 (0-4)	0 (0-2)	0 (0-2)	19 (8-68)	5 (1-26)	0 (0-1)	0 (0-4)
2000–01	0 (0-7)	348 (137-1383)	0 (0-4)	0 (0-1)	0 (0-0)	0 (0-1)	7 (2-43)	2 (0-15)	0 (0-0)	0 (0-3)
2001–02	1 (0-3)	239 (144-448)	0 (0-2)	0 (0-1)	0 (0-1)	0 (0-1)	7 (4-18)	3 (1-9)	0 (0-0)	0 (0-1)
2002–03	1 (0-10)	533 (211-1871)	0 (0-4)	0 (0-2)	0 (0-1)	0 (0-2)	7 (2-42)	4 (1-32)	0 (0-0)	0 (0-4)
2003–04	1 (0-30)	2285 (719-12261)	0 (0-22)	0 (0-10)	0 (0-3)	0 (0-4)	27 (6-236)	10 (2-108)	0 (0-0)	1 (0-18)
2004–05	0 (0-2)	121 (49-451)	0 (0-2)	0 (0-1)	0 (0-0)	0 (0-1)	2 (0-11)	0 (0-4)	0 (0-0)	0 (0-1)
2005–06	0 (0-1)	533 (255-1424)	0 (0-6)	0 (0-2)	0 (0-2)	0 (0-2)	10 (3-43)	0 (0-4)	0 (0-1)	0 (0-4)
2006–07	0 (0-1)	411 (205-1050)	0 (0-4)	0 (0-1)	0 (0-1)	0 (0-1)	9 (3-40)	1 (0-6)	0 (0-0)	0 (0-2)
2007–08	0 (0-5)	733 (404-1677)	0 (0-10)	0 (0-2)	0 (0-2)	0 (0-2)	14 (6-51)	2 (0-12)	0 (0-2)	0 (0-4)
2008–09	0 (0-1)	138 (54-572)	0 (0-2)	0 (0-1)	0 (0-0)	0 (0-0)	2 (1-18)	0 (0-3)	0 (0-0)	0 (0-1)
2009–10	0 (0-3)	947 (454-2643)	0 (0-12)	0 (0-3)	0 (0-7)	0 (0-2)	19 (7-92)	1 (0-10)	0 (0-0)	0 (0-6)
2010–11	0 (0-0)	12 (5-44)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)
2011–12	0 (0-5)	1251 (675-3338)	0 (0-14)	0 (0-7)	0 (0-7)	0 (0-4)	25 (8-101)	1 (0-12)	0 (0-2)	1 (0-10)
2012–13	0 (0-4)	643 (294-1951)	0 (0-8)	0 (0-3)	0 (0-3)	0 (0-1)	14 (4-90)	1 (0-14)	0 (0-1)	0 (0-6)
2013–14	1 (0-17)	1435 (758-3861)	0 (0-26)	0 (0-19)	0 (0-8)	0 (0-4)	44 (18-189)	4 (1-40)	0 (0-1)	1 (0-15)
2014–15	0 (0-6)	567 (220-2213)	0 (0-8)	0 (0-4)	0 (0-4)	0 (0-1)	14 (4-84)	0 (0-10)	0 (0-0)	0 (0-6)
2015–16	0 (0-2)	333 (150-1078)	0 (0-4)	0 (0-2)	0 (0-1)	0 (0-1)	4 (1-30)	0 (0-2)	0 (0-0)	0 (0-3)
2016–17	0 (0-6)	705 (339-1730)	0 (0-10)	0 (0-6)	0 (0-5)	0 (0-2)	13 (5-67)	1 (0-11)	0 (0-1)	1 (0-7)

Table A7: continued

BYX (Alfonsino)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-0)	9 (6-13)	1 (1-2)	3 (2-9)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	10 (8-14)
1991–92	0 (0-0)	11 (8-15)	1 (1-2)	3 (1-6)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	8 (6-11)
1992–93	0 (0-0)	12 (9-16)	1 (1-1)	4 (2-9)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	9 (7-12)
1993–94	0 (0-0)	25 (19-37)	3 (2-5)	27 (14-58)	0 (0-0)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-1)	30 (23-40)
1994–95	0 (0-0)	24 (18-32)	2 (1-3)	6 (3-13)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	16 (13-21)
1995–96	0 (0-0)	22 (16-33)	3 (2-5)	29 (15-55)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	10 (7-15)
1996–97	0 (0-0)	10 (8-14)	2 (1-2)	22 (12-37)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	5 (4-7)
1997–98	0 (0-0)	75 (58-101)	6 (4-10)	99 (58-167)	1 (0-2)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-2)	27 (20-36)
1998–99	0 (0-0)	7 (4-13)	0 (0-1)	7 (3-19)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	3 (2-5)
1999–2000	0 (0-0)	7 (4-11)	1 (0-1)	6 (3-13)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	3 (2-4)
2000–01	0 (0-0)	8 (4-18)	1 (0-2)	13 (5-39)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	5 (3-11)
2001–02	0 (0-0)	1 (0-2)	0 (0-0)	1 (0-3)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)
2002–03	0 (0-0)	11 (8-17)	1 (1-2)	13 (7-26)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	6 (4-9)
2003–04	0 (0-0)	2 (1-3)	0 (0-0)	3 (1-7)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (1-2)
2004–05	0 (0-0)	1 (0-4)	0 (0-1)	2 (0-9)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (0-2)
2005–06	0 (0-0)	1 (0-7)	0 (0-1)	1 (0-9)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (0-3)
2006–07	0 (0-0)	6 (2-23)	0 (0-3)	5 (1-31)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	3 (1-9)
2007–08	0 (0-0)	10 (4-51)	1 (0-6)	9 (2-63)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-2)	3 (1-15)
2008–09	0 (0-0)	5 (2-13)	0 (0-2)	6 (2-27)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	2 (1-5)
2009–10	0 (0-0)	9 (4-27)	1 (0-4)	9 (2-46)	0 (0-2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	4 (2-12)
2010–11	0 (0-0)	4 (2-11)	0 (0-2)	9 (3-32)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	2 (1-6)
2011–12	0 (0-0)	7 (4-13)	1 (0-2)	10 (4-25)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	4 (2-7)
2012–13	0 (0-0)	8 (6-12)	1 (1-2)	10 (5-20)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	5 (4-7)
2013–14	0 (0-0)	12 (9-17)	2 (1-3)	26 (14-47)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	9 (7-12)
2014–15	0 (0-0)	38 (29-54)	5 (3-9)	42 (23-83)	1 (0-2)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-1)	28 (22-37)
2015–16	0 (0-0)	10 (8-13)	1 (1-2)	14 (8-25)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	8 (6-9)
2016–17	0 (0-0)	21 (15-30)	2 (1-4)	35 (19-65)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-1)	16 (12-21)

GIZ (Giant stargazer)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-2)	197 (162-242)	0 (0-1)	0 (0-2)	0 (0-0)	33 (19-60)	41 (23-73)	7 (4-13)	0 (0-1)	37 (28-53)
1991–92	1 (0-2)	158 (135-186)	0 (0-0)	0 (0-1)	0 (0-0)	16 (13-19)	73 (62-88)	8 (6-11)	1 (0-3)	18 (14-25)
1992–93	1 (0-2)	165 (119-227)	0 (0-0)	0 (0-1)	0 (0-0)	9 (6-14)	50 (40-64)	2 (1-3)	3 (1-10)	37 (28-50)
1993–94	1 (0-2)	27 (22-33)	0 (0-1)	1 (0-4)	0 (0-0)	6 (3-14)	17 (12-24)	1 (1-2)	1 (0-3)	23 (17-32)
1994–95	1 (0-2)	65 (49-87)	1 (0-2)	1 (0-2)	0 (0-0)	7 (3-23)	19 (12-30)	1 (0-1)	4 (1-13)	32 (21-49)
1995–96	1 (1-3)	369 (287-481)	4 (1-14)	5 (1-17)	1 (0-2)	22 (10-48)	28 (19-43)	1 (0-3)	2 (0-8)	25 (17-38)
1996–97	2 (1-4)	171 (126-244)	4 (1-14)	7 (2-28)	1 (0-4)	13 (5-34)	32 (13-80)	1 (0-3)	2 (0-7)	46 (22-105)
1997–98	6 (4-8)	146 (131-163)	2 (1-6)	14 (8-23)	1 (0-3)	22 (8-60)	46 (37-58)	4 (3-5)	4 (1-12)	29 (22-37)
1998–99	4 (2-6)	187 (167-210)	2 (1-4)	4 (1-10)	1 (0-3)	31 (18-52)	55 (45-68)	10 (7-13)	3 (1-11)	40 (33-50)
1999–2000	3 (2-5)	105 (91-122)	1 (0-3)	1 (0-5)	0 (0-1)	21 (12-38)	31 (25-38)	9 (7-11)	6 (2-15)	22 (17-29)
2000–01	7 (5-10)	344 (303-392)	1 (0-2)	3 (1-9)	0 (0-1)	26 (17-41)	63 (51-77)	20 (16-25)	4 (1-15)	55 (43-70)
2001–02	7 (5-9)	217 (195-242)	0 (0-1)	1 (0-4)	0 (0-1)	11 (8-17)	64 (53-78)	29 (23-36)	3 (1-9)	68 (58-79)
2002–03	4 (3-6)	232 (206-264)	1 (0-2)	3 (1-8)	0 (0-1)	15 (9-25)	28 (23-34)	19 (15-22)	2 (0-5)	59 (50-70)
2003–04	3 (2-5)	207 (177-241)	1 (0-3)	2 (1-8)	0 (0-2)	7 (4-13)	34 (23-50)	16 (10-24)	2 (0-7)	81 (68-98)
2004–05	3 (2-4)	182 (166-201)	1 (0-2)	2 (0-5)	0 (0-1)	8 (5-14)	29 (24-36)	9 (7-11)	1 (0-3)	64 (54-75)
2005–06	1 (0-1)	167 (145-193)	1 (0-3)	1 (0-4)	1 (0-3)	43 (28-66)	39 (31-48)	2 (1-4)	6 (2-20)	80 (67-100)
2006–07	0 (0-1)	148 (132-165)	0 (0-1)	1 (0-3)	0 (0-1)	10 (7-14)	33 (28-39)	3 (2-5)	4 (2-10)	18 (14-22)
2007–08	1 (1-2)	151 (129-175)	1 (0-3)	1 (0-4)	0 (0-1)	11 (6-21)	24 (19-30)	4 (3-6)	6 (2-19)	60 (47-79)
2008–09	1 (0-1)	108 (91-128)	0 (0-1)	1 (0-3)	0 (0-1)	3 (1-5)	19 (16-24)	3 (2-4)	2 (1-6)	18 (13-25)
2009–10	0 (0-1)	225 (192-265)	1 (0-2)	2 (1-5)	1 (0-2)	7 (4-12)	25 (20-31)	2 (1-3)	1 (0-5)	31 (24-40)
2010–11	2 (1-3)	143 (125-165)	0 (0-2)	2 (1-6)	1 (0-2)	9 (6-16)	34 (28-42)	5 (3-7)	1 (0-6)	41 (33-52)
2011–12	0 (0-1)	125 (104-153)	0 (0-1)	1 (0-4)	0 (0-2)	12 (7-21)	20 (16-26)	1 (1-3)	2 (1-5)	29 (22-38)
2012–13	1 (1-3)	145 (131-162)	1 (0-3)	3 (1-9)	1 (0-4)	10 (7-14)	61 (53-71)	7 (5-10)	4 (1-13)	46 (40-54)
2013–14	5 (3-7)	135 (119-154)	1 (0-3)	4 (2-10)	1 (0-2)	23 (16-35)	87 (75-102)	12 (8-16)	3 (1-10)	42 (35-49)
2014–15	8 (5-13)	333 (289-387)	1 (0-4)	5 (2-12)	1 (1-2)	43 (28-66)	143 (121-173)	11 (7-17)	3 (1-12)	66 (56-77)
2015–16	2 (1-4)	180 (157-207)	1 (0-2)	3 (1-10)	1 (1-3)	65 (46-95)	40 (33-51)	2 (1-4)	1 (0-5)	72 (61-84)
2016–17	2 (1-4)	169 (146-197)	0 (0-1)	2 (1-5)	1 (1-2)	43 (28-68)	48 (39-60)	5 (3-8)	2 (1-7)	51 (44-60)

Table A7: continued

GSH (Dark ghost shark)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	3 (1-7)	186 (158-222)	8 (2-26)	1 (0-5)	0 (0-0)	14 (8-26)	274 (225-335)	47 (36-63)	0 (0-0)	19 (13-26)
1991–92	4 (2-7)	333 (283-392)	5 (1-18)	0 (0-2)	0 (0-0)	15 (11-19)	304 (265-348)	33 (26-42)	1 (0-4)	10 (7-14)
1992–93	5 (3-8)	460 (354-603)	6 (2-20)	1 (0-6)	0 (0-2)	6 (4-10)	234 (200-285)	9 (6-13)	2 (0-11)	25 (19-34)
1993–94	11 (7-16)	234 (204-270)	54 (21-142)	8 (2-33)	0 (0-1)	4 (2-9)	202 (168-251)	13 (9-19)	1 (0-5)	24 (18-32)
1994–95	8 (5-13)	409 (348-485)	51 (14-180)	4 (1-17)	1 (0-6)	9 (3-31)	210 (167-267)	7 (5-11)	4 (1-21)	22 (15-32)
1995–96	7 (4-11)	469 (387-577)	225 (82-663)	14 (3-52)	4 (1-13)	8 (2-24)	156 (122-205)	6 (3-10)	1 (0-6)	22 (15-32)
1996–97	29 (15-56)	465 (359-617)	203 (56-736)	30 (8-129)	12 (3-48)	7 (2-21)	612 (349-1088)	15 (7-33)	2 (0-9)	23 (10-52)
1997–98	36 (29-45)	916 (834-1003)	48 (26-86)	33 (17-65)	10 (3-39)	20 (6-67)	303 (260-357)	25 (20-32)	3 (1-15)	34 (23-51)
1998–99	7 (4-15)	380 (307-479)	52 (33-82)	5 (1-23)	5 (1-19)	5 (2-13)	113 (85-154)	20 (13-33)	2 (0-12)	45 (32-67)
1999–2000	9 (5-18)	192 (135-283)	59 (30-119)	3 (1-15)	3 (1-13)	13 (5-36)	88 (64-131)	25 (17-41)	3 (1-16)	27 (17-46)
2000–01	7 (3-20)	367 (247-587)	40 (20-91)	6 (1-35)	2 (0-13)	45 (18-125)	67 (41-117)	21 (11-44)	3 (0-29)	45 (25-93)
2001–02	9 (5-19)	77 (54-115)	21 (10-50)	2 (0-11)	3 (1-12)	14 (6-33)	94 (64-142)	42 (27-69)	2 (0-13)	33 (23-51)
2002–03	12 (6-26)	117 (79-177)	15 (6-39)	2 (0-9)	2 (0-7)	9 (3-25)	78 (51-132)	52 (32-89)	1 (0-7)	26 (16-42)
2003–04	5 (2-12)	100 (69-149)	21 (9-59)	3 (1-16)	2 (1-11)	6 (3-16)	49 (29-89)	23 (12-43)	1 (0-6)	39 (26-61)
2004–05	3 (1-7)	167 (124-232)	17 (8-36)	2 (0-11)	1 (0-7)	7 (3-20)	30 (17-57)	9 (4-19)	0 (0-3)	19 (13-30)
2005–06	0 (0-3)	64 (41-107)	21 (8-61)	1 (0-7)	2 (0-12)	10 (3-32)	38 (22-78)	2 (0-8)	2 (0-19)	29 (17-56)
2006–07	1 (0-4)	48 (30-80)	15 (7-40)	1 (0-7)	1 (0-7)	4 (2-12)	60 (35-115)	6 (2-19)	1 (0-8)	10 (5-23)
2007–08	2 (0-8)	155 (96-274)	25 (11-61)	1 (0-7)	1 (0-8)	4 (1-14)	39 (22-80)	6 (3-22)	3 (0-19)	8 (4-19)
2008–09	2 (0-8)	185 (118-306)	23 (7-75)	3 (0-16)	2 (0-12)	7 (2-22)	48 (30-90)	7 (3-20)	3 (0-23)	11 (5-25)
2009–10	0 (0-3)	448 (311-687)	21 (10-53)	5 (1-27)	7 (2-30)	14 (6-39)	31 (20-53)	2 (1-6)	1 (0-9)	30 (18-57)
2010–11	3 (1-19)	364 (231-651)	26 (8-95)	8 (1-53)	6 (1-30)	10 (3-41)	79 (44-178)	10 (4-43)	1 (0-20)	48 (25-109)
2011–12	1 (0-4)	516 (357-836)	8 (4-22)	3 (1-17)	4 (1-17)	3 (1-9)	38 (24-69)	2 (1-7)	2 (0-11)	23 (14-41)
2012–13	1 (0-8)	242 (166-392)	33 (15-89)	4 (1-29)	7 (1-34)	7 (3-26)	72 (47-128)	7 (3-23)	2 (0-18)	24 (14-47)
2013–14	5 (2-17)	278 (198-431)	26 (14-61)	9 (3-33)	5 (2-15)	6 (3-18)	105 (72-178)	13 (6-35)	1 (0-11)	13 (8-24)
2014–15	5 (2-17)	406 (278-638)	13 (7-32)	4 (1-24)	4 (2-12)	6 (2-18)	98 (66-168)	7 (3-21)	1 (0-10)	23 (14-41)
2015–16	2 (1-9)	668 (462-1014)	13 (6-31)	6 (1-36)	7 (2-24)	10 (5-25)	49 (32-86)	2 (1-9)	1 (0-11)	69 (46-120)
2016–17	2 (0-9)	432 (292-721)	12 (4-39)	5 (2-22)	8 (3-28)	7 (3-22)	46 (29-85)	4 (2-14)	1 (0-12)	31 (20-54)

GSP (Pale ghost shark)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	1 (0-3)	150 (114-203)	0 (0-0)	0 (0-0)	0 (0-0)	1 (1-2)	93 (70-130)	16 (11-24)	0 (0-0)	2 (1-3)
1991–92	2 (1-4)	256 (188-365)	0 (0-0)	0 (0-0)	0 (0-0)	2 (1-3)	157 (112-226)	17 (11-27)	0 (0-0)	1 (1-3)
1992–93	1 (0-3)	70 (35-171)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)	38 (19-91)	1 (0-5)	0 (0-0)	1 (0-2)
1993–94	3 (1-6)	131 (91-193)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-1)	56 (38-88)	4 (2-7)	0 (0-0)	2 (1-3)
1994–95	1 (0-2)	96 (62-166)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	25 (15-43)	1 (0-2)	0 (0-0)	1 (0-1)
1995–96	0 (0-3)	8 (1-395)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-0)	2 (0-77)	0 (0-3)	0 (0-0)	0 (0-2)
1996–97	0 (0-4)	10 (1-450)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-0)	2 (0-108)	0 (0-2)	0 (0-0)	0 (0-1)
1997–98	0 (0-8)	21 (2-323)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-0)	4 (0-65)	0 (0-5)	0 (0-0)	0 (0-1)
1998–99	6 (3-13)	480 (337-724)	1 (0-3)	1 (0-3)	0 (0-1)	1 (0-2)	94 (65-151)	17 (11-31)	0 (0-0)	3 (2-6)
1999–2000	32 (24-44)	820 (663-1028)	3 (2-6)	2 (1-6)	0 (0-2)	4 (2-5)	297 (237-374)	86 (67-112)	0 (0-1)	10 (7-14)
2000–01	48 (35-67)	1350 (1080-1723)	2 (1-5)	3 (1-10)	0 (0-2)	6 (4-9)	419 (329-539)	132 (102-175)	0 (0-2)	18 (13-25)
2001–02	51 (38-72)	1143 (924-1441)	2 (1-4)	2 (1-7)	0 (0-3)	4 (3-6)	484 (391-619)	218 (173-286)	0 (0-1)	24 (18-33)
2002–03	47 (35-66)	1343 (1091-1684)	3 (1-5)	4 (1-11)	0 (0-3)	4 (3-6)	304 (245-384)	200 (159-260)	0 (0-1)	29 (22-39)
2003–04	25 (19-32)	1133 (973-1341)	2 (1-4)	3 (1-9)	0 (0-3)	3 (2-4)	251 (215-299)	118 (100-143)	0 (0-1)	19 (14-24)
2004–05	15 (10-24)	648 (492-862)	1 (1-3)	1 (0-5)	0 (0-1)	3 (2-4)	146 (107-201)	44 (31-64)	0 (0-0)	10 (7-15)
2005–06	3 (1-8)	729 (563-1014)	1 (0-3)	1 (0-4)	0 (0-2)	4 (2-7)	188 (138-267)	10 (6-20)	0 (0-2)	16 (11-24)
2006–07	3 (1-7)	602 (464-820)	1 (0-2)	1 (0-4)	0 (0-2)	2 (1-3)	185 (138-257)	19 (13-31)	0 (0-1)	8 (5-12)
2007–08	15 (9-27)	1036 (823-1336)	5 (2-10)	3 (1-10)	1 (0-5)	5 (3-8)	291 (230-383)	52 (38-78)	1 (0-4)	26 (19-36)
2008–09	8 (5-15)	720 (581-921)	2 (1-5)	3 (1-9)	0 (0-3)	3 (2-4)	204 (164-259)	31 (22-46)	0 (0-2)	14 (10-19)
2009–10	2 (1-7)	515 (365-747)	1 (0-2)	1 (0-6)	0 (0-3)	1 (1-3)	146 (102-223)	10 (5-21)	0 (0-0)	7 (4-12)
2010–11	10 (5-21)	725 (560-996)	1 (0-3)	4 (1-13)	0 (0-4)	3 (2-6)	180 (136-250)	26 (16-45)	0 (0-1)	18 (12-26)
2011–12	4 (2-9)	581 (455-767)	1 (0-2)	2 (1-8)	0 (0-3)	2 (1-4)	162 (124-220)	10 (6-18)	0 (0-1)	14 (10-20)
2012–13	4 (2-12)	513 (385-705)	1 (0-3)	2 (0-7)	0 (0-4)	2 (1-4)	191 (139-270)	21 (13-40)	0 (0-1)	11 (7-17)
2013–14	16 (10-30)	678 (532-896)	3 (2-7)	8 (3-24)	1 (0-5)	4 (2-7)	305 (235-406)	40 (28-64)	0 (0-2)	22 (16-32)
2014–15	17 (11-30)	760 (610-979)	1 (1-3)	4 (1-13)	1 (0-6)	3 (2-6)	311 (243-410)	24 (16-40)	0 (0-1)	25 (19-35)
2015–16	11 (6-24)	992 (766-1358)	1 (1-4)	5 (1-16)	1 (0-7)	5 (3-9)	236 (177-335)	13 (7-26)	0 (0-1)	29 (21-42)
2016–17	9 (4-23)	659 (483-939)	1 (0-2)	4 (1-14)	0 (0-4)	3 (1-6)	199 (139-308)	20 (11-41)	0 (0-2)	23 (15-36)

Table A7: continued

JMA (Jack mackerels)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-6)	108 (50-269)	132 (30-520)	9 (1-71)	0 (0-0)	10 (3-43)	24 (6-118)	3 (0-27)	13 (0-514)	1035 (696-1765)
1991–92	0 (0-5)	67 (23-202)	91 (22-359)	6 (1-54)	0 (0-0)	14 (5-57)	39 (13-139)	3 (0-22)	8 (0-378)	480 (322-822)
1992–93	0 (0-0)	8 (3-26)	10 (2-46)	1 (0-9)	0 (0-1)	0 (0-3)	2 (1-11)	0 (0-0)	3 (0-106)	47 (27-100)
1993–94	0 (0-1)	34 (19-66)	40 (20-84)	8 (2-40)	0 (0-1)	2 (1-6)	6 (2-24)	0 (0-2)	4 (0-98)	316 (247-428)
1994–95	1 (0-13)	734 (360-1802)	355 (89-1415)	28 (5-257)	6 (1-65)	18 (3-116)	63 (15-347)	1 (0-14)	148 (6-3057)	2154 (1442-3641)
1995–96	1 (0-23)	320 (157-716)	349 (104-1146)	87 (14-520)	18 (3-120)	9 (2-61)	68 (18-406)	0 (0-17)	28 (0-893)	940 (598-1709)
1996–97	0 (0-3)	72 (25-227)	144 (32-610)	44 (8-251)	10 (2-59)	5 (1-24)	8 (2-47)	0 (0-2)	3 (0-169)	512 (301-1010)
1997–98	0 (0-3)	22 (12-50)	39 (20-86)	13 (4-51)	3 (1-20)	1 (0-6)	2 (0-15)	0 (0-3)	5 (0-154)	255 (157-475)
1998–99	0 (0-2)	25 (13-52)	31 (18-58)	8 (2-39)	2 (0-13)	1 (0-4)	4 (1-17)	1 (0-6)	3 (0-105)	142 (96-224)
1999–2000	0 (0-2)	29 (11-78)	15 (7-36)	6 (1-31)	1 (0-8)	2 (0-8)	3 (1-11)	1 (0-4)	3 (0-122)	49 (32-86)
2000–01	0 (0-0)	3 (2-7)	3 (2-6)	2 (0-9)	0 (0-1)	0 (0-1)	1 (0-2)	0 (0-1)	0 (0-16)	13 (8-21)
2001–02	0 (0-0)	1 (0-3)	2 (1-4)	1 (0-4)	0 (0-1)	0 (0-0)	0 (0-1)	0 (0-1)	0 (0-9)	9 (6-15)
2002–03	0 (0-1)	5 (3-12)	7 (4-15)	2 (0-13)	0 (0-2)	0 (0-2)	1 (0-3)	0 (0-2)	1 (0-31)	24 (15-42)
2003–04	0 (0-1)	8 (2-30)	10 (4-24)	5 (1-30)	1 (0-5)	0 (0-3)	1 (0-5)	0 (0-2)	0 (0-35)	53 (34-96)
2004–05	0 (0-1)	11 (3-37)	15 (7-37)	4 (1-29)	1 (0-4)	1 (0-6)	1 (0-7)	0 (0-2)	0 (0-33)	27 (17-57)
2005–06	0 (0-0)	2 (1-5)	3 (1-15)	1 (0-4)	0 (0-2)	0 (0-1)	0 (0-2)	0 (0-0)	1 (0-28)	13 (10-18)
2006–07	0 (0-0)	3 (1-11)	4 (2-11)	1 (0-3)	0 (0-2)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-13)	7 (4-13)
2007–08	0 (0-2)	34 (12-126)	14 (6-43)	4 (1-39)	1 (0-17)	0 (0-4)	2 (0-20)	0 (0-4)	5 (0-299)	28 (12-81)
2008–09	0 (0-0)	2 (1-12)	4 (1-18)	1 (0-9)	0 (0-3)	0 (0-1)	0 (0-3)	0 (0-1)	1 (0-51)	7 (3-24)
2009–10	0 (0-0)	1 (0-1)	3 (2-6)	0 (0-3)	0 (0-2)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-8)	9 (4-21)
2010–11	0 (0-0)	1 (0-6)	2 (1-9)	1 (0-8)	0 (0-2)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-9)	6 (3-20)
2011–12	0 (0-0)	12 (5-30)	16 (8-31)	2 (0-15)	1 (0-6)	0 (0-2)	0 (0-3)	0 (0-0)	1 (0-59)	12 (7-24)
2012–13	0 (0-0)	2 (1-5)	9 (6-15)	1 (0-4)	0 (0-2)	0 (0-0)	0 (0-1)	0 (0-0)	1 (0-17)	5 (3-8)
2013–14	0 (0-0)	1 (1-3)	3 (2-4)	2 (1-6)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-8)	5 (4-8)
2014–15	0 (0-0)	7 (4-14)	20 (13-32)	2 (0-7)	1 (0-4)	0 (0-1)	1 (0-3)	0 (0-0)	0 (0-26)	27 (19-41)
2015–16	0 (0-0)	7 (4-13)	9 (5-16)	3 (1-13)	1 (0-2)	0 (0-1)	1 (0-2)	0 (0-0)	0 (0-13)	22 (17-30)
2016–17	0 (0-0)	5 (3-11)	4 (2-9)	3 (1-12)	1 (0-3)	0 (0-1)	0 (0-1)	0 (0-0)	1 (0-36)	12 (8-18)

LDO (Lookdown dory)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-1)	191 (164-223)	0 (0-1)	0 (0-1)	0 (0-0)	13 (8-21)	16 (12-23)	3 (2-4)	0 (0-0)	124 (105-149)
1991–92	0 (0-1)	258 (229-293)	0 (0-0)	0 (0-1)	0 (0-0)	5 (4-6)	27 (22-32)	3 (2-4)	1 (0-3)	93 (79-109)
1992–93	0 (0-0)	231 (185-296)	0 (0-0)	0 (0-1)	0 (0-1)	6 (4-9)	11 (9-14)	0 (0-1)	2 (0-6)	67 (57-80)
1993–94	1 (0-1)	222 (194-257)	1 (0-2)	2 (1-6)	0 (0-1)	4 (2-8)	14 (10-19)	1 (0-2)	1 (0-5)	119 (100-142)
1994–95	0 (0-1)	165 (138-199)	1 (0-3)	1 (0-3)	1 (0-2)	5 (2-10)	11 (8-17)	0 (0-1)	4 (1-12)	140 (115-170)
1995–96	1 (0-1)	294 (247-356)	3 (1-6)	3 (1-8)	3 (1-8)	7 (3-13)	12 (8-18)	0 (0-1)	1 (0-5)	65 (52-82)
1996–97	1 (0-2)	369 (303-456)	5 (2-11)	9 (4-22)	10 (4-25)	9 (4-17)	22 (11-43)	1 (0-1)	2 (0-8)	121 (97-154)
1997–98	3 (2-4)	374 (345-407)	2 (1-4)	7 (3-15)	7 (3-16)	11 (5-23)	22 (17-29)	2 (1-3)	3 (1-12)	101 (86-118)
1998–99	2 (1-3)	611 (561-668)	2 (1-5)	4 (1-9)	7 (3-17)	14 (8-24)	29 (23-37)	5 (4-7)	4 (1-13)	126 (109-146)
1999–2000	2 (1-3)	265 (239-292)	1 (0-2)	1 (1-3)	2 (1-6)	5 (4-8)	19 (16-22)	5 (4-7)	5 (2-12)	71 (63-81)
2000–01	3 (2-4)	624 (568-681)	1 (0-2)	3 (1-8)	2 (1-5)	14 (10-20)	26 (22-31)	8 (7-10)	4 (1-13)	105 (92-120)
2001–02	3 (2-4)	506 (461-560)	1 (0-2)	2 (1-5)	5 (2-12)	13 (9-19)	29 (24-36)	13 (11-17)	4 (1-11)	213 (190-239)
2002–03	3 (2-4)	733 (660-816)	1 (0-2)	2 (1-6)	3 (1-8)	8 (5-14)	20 (17-25)	13 (10-17)	2 (0-7)	158 (138-181)
2003–04	2 (1-2)	458 (409-512)	1 (0-2)	3 (1-7)	4 (2-9)	6 (4-9)	15 (12-19)	7 (6-9)	2 (0-7)	111 (99-124)
2004–05	2 (1-3)	361 (322-409)	1 (0-2)	2 (1-4)	2 (1-5)	9 (5-14)	18 (12-25)	5 (3-8)	1 (0-4)	65 (55-76)
2005–06	0 (0-1)	261 (232-294)	1 (0-2)	1 (0-3)	4 (2-11)	16 (11-26)	13 (10-17)	1 (0-1)	5 (1-16)	143 (126-164)
2006–07	0 (0-1)	326 (287-370)	0 (0-1)	1 (0-4)	3 (1-7)	8 (5-12)	23 (18-29)	2 (1-4)	2 (0-7)	75 (62-92)
2007–08	1 (0-1)	187 (168-208)	1 (0-2)	1 (0-3)	2 (1-6)	5 (3-9)	11 (10-14)	2 (2-3)	5 (1-14)	87 (76-100)
2008–09	1 (0-1)	165 (143-191)	1 (0-2)	2 (1-5)	3 (1-8)	6 (4-10)	13 (11-16)	2 (1-3)	5 (1-17)	94 (80-112)
2009–10	0 (0-0)	236 (212-265)	1 (1-2)	2 (1-5)	7 (3-16)	8 (6-13)	14 (12-17)	1 (1-2)	2 (0-6)	62 (54-72)
2010–11	1 (0-1)	186 (167-210)	1 (0-1)	3 (1-8)	4 (2-10)	9 (6-13)	11 (9-14)	2 (1-2)	2 (0-7)	139 (120-162)
2011–12	0 (0-0)	232 (209-258)	0 (0-1)	1 (1-4)	4 (2-9)	6 (4-9)	9 (7-11)	1 (0-1)	3 (1-7)	72 (62-82)
2012–13	0 (0-1)	312 (278-350)	1 (1-2)	3 (1-9)	9 (4-22)	7 (5-10)	19 (16-24)	2 (1-3)	5 (1-17)	188 (166-216)
2013–14	1 (1-2)	315 (283-351)	2 (1-3)	7 (3-17)	8 (4-15)	12 (8-19)	23 (19-27)	3 (2-4)	4 (1-13)	178 (159-200)
2014–15	1 (1-2)	555 (490-632)	1 (0-1)	4 (2-8)	7 (4-12)	8 (6-13)	22 (18-27)	2 (1-3)	3 (1-12)	228 (203-258)
2015–16	1 (0-1)	465 (418-525)	1 (0-2)	4 (1-9)	8 (4-16)	13 (9-19)	12 (10-16)	1 (0-1)	2 (0-8)	173 (152-198)
2016–17	1 (0-1)	467 (410-537)	0 (0-1)	4 (2-9)	8 (4-15)	8 (5-12)	12 (10-16)	1 (1-2)	3 (1-14)	156 (136-179)

Table A7: continued

ORH (Orange roughy)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-1)	172 (96-420)	1 (0-16)	0 (0-13)	0 (0-0)	5 (2-20)	9 (4-25)	1 (0-6)	0 (0-0)	19 (9-49)
1991–92	0 (0-0)	51 (32-82)	0 (0-2)	0 (0-2)	0 (0-0)	2 (1-3)	3 (1-4)	0 (0-1)	0 (0-1)	3 (2-5)
1992–93	0 (0-0)	38 (17-94)	0 (0-1)	0 (0-3)	0 (0-1)	0 (0-2)	2 (1-5)	0 (0-0)	0 (0-2)	3 (2-9)
1993–94	0 (0-3)	183 (54-1210)	4 (0-77)	3 (0-130)	0 (0-1)	1 (0-23)	5 (1-52)	0 (0-3)	0 (0-4)	21 (6-183)
1994–95	0 (0-0)	41 (18-133)	2 (0-9)	0 (0-6)	0 (0-1)	0 (0-1)	1 (0-3)	0 (0-0)	0 (0-2)	3 (1-8)
1995–96	0 (0-0)	7 (1-191)	1 (0-22)	0 (0-6)	0 (0-1)	0 (0-1)	0 (0-2)	0 (0-0)	0 (0-0)	0 (0-10)
1996–97	0 (0-4)	194 (14-208750)	13 (0-7715)	5 (0-3144)	1 (0-415)	1 (0-302)	2 (0-1400)	0 (0-2)	0 (0-3)	6 (0-4056)
1997–98	0 (0-0)	11 (6-23)	0 (0-2)	0 (0-4)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)
1998–99	0 (0-0)	33 (11-163)	1 (0-9)	0 (0-10)	0 (0-3)	0 (0-2)	0 (0-3)	0 (0-1)	0 (0-1)	1 (0-9)
1999–2000	0 (0-1)	138 (87-227)	5 (1-22)	2 (0-22)	1 (0-5)	2 (1-4)	3 (2-7)	1 (0-3)	0 (0-4)	8 (5-15)
2000–01	0 (0-0)	26 (12-74)	0 (0-3)	0 (0-5)	0 (0-1)	0 (0-1)	0 (0-2)	0 (0-1)	0 (0-1)	2 (1-6)
2001–02	0 (0-1)	53 (32-102)	1 (0-5)	0 (0-7)	0 (0-3)	0 (0-2)	1 (1-4)	1 (0-2)	0 (0-1)	5 (3-11)
2002–03	0 (0-2)	198 (117-403)	3 (1-20)	2 (0-37)	1 (0-6)	1 (0-7)	3 (1-8)	2 (1-6)	0 (0-2)	18 (10-40)
2003–04	0 (0-0)	57 (29-141)	1 (0-7)	1 (0-13)	0 (0-3)	0 (0-2)	1 (0-3)	0 (0-2)	0 (0-1)	5 (2-12)
2004–05	0 (0-1)	50 (12-515)	0 (0-18)	0 (0-17)	0 (0-4)	0 (0-8)	0 (0-8)	0 (0-2)	0 (0-1)	4 (1-46)
2005–06	0 (0-0)	18 (9-39)	0 (0-2)	0 (0-2)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-1)	2 (1-5)
2006–07	0 (0-0)	60 (23-243)	0 (0-8)	0 (0-11)	0 (0-4)	0 (0-4)	1 (0-7)	0 (0-1)	0 (0-3)	4 (1-20)
2007–08	0 (0-1)	132 (76-254)	4 (1-21)	1 (0-18)	1 (0-8)	1 (0-5)	2 (1-7)	0 (0-2)	0 (0-9)	12 (7-25)
2008–09	0 (0-1)	69 (28-247)	1 (0-15)	1 (0-18)	0 (0-6)	0 (0-4)	1 (0-6)	0 (0-1)	0 (0-5)	5 (2-24)
2009–10	0 (0-0)	11 (5-29)	0 (0-2)	0 (0-3)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-0)	1 (0-3)
2010–11	0 (0-0)	6 (2-38)	0 (0-1)	0 (0-3)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-0)	1 (0-4)
2011–12	0 (0-0)	2 (1-8)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-1)
2012–13	0 (0-0)	6 (2-20)	0 (0-1)	0 (0-2)	0 (0-1)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	1 (0-3)
2013–14	0 (0-0)	6 (4-10)	0 (0-1)	0 (0-3)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (0-1)
2014–15	0 (0-0)	7 (4-13)	0 (0-1)	0 (0-2)	0 (0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (1-2)
2015–16	0 (0-0)	9 (3-37)	0 (0-1)	0 (0-3)	0 (0-2)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-0)	1 (0-5)
2016–17	0 (0-0)	5 (2-9)	0 (0-0)	0 (0-2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1 (0-2)

RCO (Red cod)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-0)	42 (31-59)	7 (1-37)	0 (0-1)	0 (0-0)	42 (28-65)	8 (5-12)	1 (1-2)	0 (0-0)	24 (19-31)
1991–92	1 (0-3)	67 (33-135)	12 (2-75)	0 (0-2)	0 (0-0)	65 (46-104)	62 (43-94)	6 (3-13)	0 (0-1)	49 (35-73)
1992–93	0 (0-1)	5 (2-10)	4 (1-24)	0 (0-1)	0 (0-1)	15 (9-24)	26 (19-36)	1 (0-2)	0 (0-1)	56 (44-74)
1993–94	2 (1-7)	4 (2-9)	16 (5-50)	1 (0-8)	0 (0-1)	23 (13-46)	48 (26-91)	3 (1-7)	0 (0-1)	86 (68-109)
1994–95	2 (1-6)	251 (155-429)	60 (11-318)	2 (0-12)	2 (0-10)	37 (15-89)	60 (26-137)	2 (1-6)	1 (0-7)	169 (136-214)
1995–96	2 (1-4)	38 (24-66)	399 (170-1016)	8 (1-45)	6 (2-25)	84 (41-176)	39 (21-73)	1 (1-3)	0 (0-3)	249 (199-319)
1996–97	1 (0-2)	9 (6-14)	30 (5-158)	2 (0-15)	3 (0-17)	15 (8-29)	15 (8-30)	0 (0-1)	0 (0-1)	36 (27-48)
1997–98	1 (0-3)	22 (15-33)	21 (13-33)	5 (2-10)	5 (1-21)	31 (6-155)	8 (3-20)	1 (0-2)	0 (0-1)	40 (30-55)
1998–99	1 (0-2)	20 (15-28)	36 (26-54)	1 (0-6)	3 (0-15)	94 (44-199)	12 (8-19)	2 (1-4)	0 (0-1)	12 (8-20)
1999–2000	1 (0-1)	17 (11-27)	9 (6-13)	0 (0-2)	1 (0-4)	27 (15-47)	6 (4-8)	2 (1-3)	0 (0-1)	6 (5-9)
2000–01	2 (1-4)	14 (9-23)	10 (7-15)	1 (0-4)	0 (0-3)	16 (10-28)	17 (12-25)	5 (3-9)	0 (0-1)	18 (13-25)
2001–02	4 (2-6)	2 (2-4)	8 (5-12)	0 (0-3)	1 (0-7)	34 (20-59)	35 (24-53)	16 (11-24)	0 (0-1)	19 (15-24)
2002–03	3 (2-6)	40 (28-57)	8 (5-12)	1 (0-3)	1 (0-6)	11 (6-20)	22 (16-32)	14 (10-21)	0 (0-0)	25 (20-33)
2003–04	1 (1-2)	89 (69-116)	10 (7-15)	1 (0-7)	2 (0-10)	16 (9-28)	10 (6-16)	5 (3-8)	0 (0-1)	48 (40-58)
2004–05	4 (2-9)	12 (7-20)	22 (14-36)	1 (0-8)	1 (0-10)	33 (17-70)	38 (22-65)	11 (6-21)	0 (0-1)	65 (49-86)
2005–06	0 (0-1)	5 (4-8)	8 (4-15)	0 (0-3)	2 (0-10)	55 (31-106)	31 (23-43)	2 (1-4)	0 (0-2)	44 (36-55)
2006–07	1 (0-3)	11 (7-19)	19 (14-29)	1 (0-4)	2 (0-10)	16 (8-31)	68 (50-97)	7 (4-13)	0 (0-1)	36 (27-48)
2007–08	1 (0-2)	14 (9-21)	9 (6-14)	0 (0-2)	1 (0-6)	9 (4-23)	13 (10-18)	2 (1-4)	0 (0-1)	12 (9-17)
2008–09	0 (0-1)	6 (4-8)	4 (3-6)	0 (0-2)	1 (0-3)	2 (1-5)	10 (8-14)	1 (1-3)	0 (0-1)	8 (6-10)
2009–10	0 (0-1)	22 (15-33)	9 (6-15)	1 (0-4)	2 (0-8)	10 (5-23)	14 (10-20)	1 (0-2)	0 (0-0)	6 (4-10)
2010–11	2 (1-7)	79 (51-130)	5 (2-9)	2 (0-13)	2 (0-9)	32 (14-82)	36 (24-60)	5 (2-13)	0 (0-1)	16 (11-26)
2011–12	0 (0-2)	90 (61-138)	12 (8-18)	1 (0-9)	3 (1-22)	40 (21-79)	25 (18-36)	1 (1-4)	0 (0-2)	14 (11-20)
2012–13	1 (0-4)	39 (28-56)	14 (9-22)	2 (0-10)	4 (1-24)	32 (18-59)	53 (40-71)	6 (3-11)	0 (0-2)	16 (12-21)
2013–14	6 (3-14)	58 (40-88)	21 (14-33)	1 (0-4)	2 (1-6)	28 (16-61)	119 (90-164)	15 (9-31)	0 (0-2)	16 (13-21)
2014–15	4 (2-8)	31 (23-41)	11 (8-15)	1 (0-4)	2 (1-3)	22 (13-38)	68 (54-86)	5 (3-10)	0 (0-1)	19 (16-23)
2015–16	2 (1-6)	44 (31-64)	9 (5-15)	1 (0-7)	3 (1-7)	85 (52-156)	44 (32-63)	2 (1-7)	0 (0-1)	33 (27-42)
2016–17	2 (1-6)	71 (49-103)	7 (4-12)	4 (2-11)	10 (5-22)	63 (36-117)	50 (38-69)	5 (3-10)	0 (0-2)	31 (25-39)

RIB (Ribaldo)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	4 (2-6)	264 (236-296)	2 (1-6)	1 (0-3)	0 (0-0)	32 (21-50)	338 (299-382)	58 (49-69)	0 (0-0)	87 (72-105)
1991–92	4 (2-6)	303 (262-345)	2 (1-4)	0 (0-2)	0 (0-0)	49 (41-60)	308 (274-347)	34 (27-41)	0 (0-2)	103 (82-132)
1992–93	3 (2-6)	503 (363-685)	1 (0-5)	1 (0-4)	0 (0-0)	12 (7-19)	161 (134-197)	6 (4-10)	0 (0-5)	294 (232-384)
1993–94	3 (2-4)	83 (73-95)	6 (3-12)	2 (1-6)	0 (0-0)	4 (2-8)	52 (43-62)	3 (2-5)	0 (0-1)	81 (65-99)
1994–95	4 (3-6)	156 (135-183)	15 (6-38)	2 (1-5)	0 (0-0)	7 (3-17)	98 (81-119)	3 (2-5)	1 (0-4)	128 (102-164)
1995–96	2 (1-4)	209 (170-256)	30 (12-75)	4 (1-11)	0 (0-1)	8 (4-17)	55 (42-72)	2 (1-4)	0 (0-1)	53 (40-71)
1996–97	17 (10-31)	296 (236-388)	88 (36-218)	19 (7-56)	1 (0-5)	17 (8-37)	364 (219-597)	9 (5-19)	0 (0-3)	162 (106-249)
1997–98	30 (22-39)	488 (433-551)	32 (13-74)	14 (7-29)	1 (0-3)	21 (9-50)	247 (206-296)	20 (15-27)	1 (0-4)	123 (97-158)
1998–99	12 (9-17)	353 (319-394)	23 (11-46)	5 (2-16)	1 (0-2)	9 (5-18)	187 (166-213)	34 (28-41)	0 (0-3)	176 (148-213)
1999–2000	21 (17-27)	437 (382-503)	24 (10-56)	4 (1-11)	0 (0-2)	14 (8-26)	200 (178-225)	58 (50-68)	1 (0-4)	145 (120-176)
2000–01	13 (10-17)	378 (336-431)	7 (3-16)	4 (1-10)	0 (0-1)	27 (17-45)	112 (97-131)	36 (30-43)	0 (0-3)	112 (91-138)
2001–02	28 (22-35)	378 (339-429)	11 (5-28)	4 (1-12)	1 (0-3)	15 (7-32)	261 (228-302)	118 (101-138)	1 (0-4)	556 (479-644)
2002–03	12 (9-15)	289 (255-329)	7 (3-16)	5 (2-10)	0 (0-1)	14 (7-25)	78 (66-92)	51 (44-62)	0 (0-1)	126 (106-150)
2003–04	8 (6-12)	345 (299-402)	10 (4-25)	4 (1-11)	0 (0-2)	11 (6-20)	83 (67-102)	39 (31-49)	0 (0-2)	170 (143-202)
2004–05	10 (7-13)	180 (160-200)	7 (3-16)	2 (1-6)	0 (0-1)	7 (4-13)	93 (76-112)	28 (22-36)	0 (0-1)	104 (86-125)
2005–06	1 (0-2)	183 (158-214)	7 (3-17)	1 (0-4)	0 (0-1)	18 (11-29)	69 (55-88)	4 (2-7)	1 (0-3)	207 (174-247)
2006–07	1 (1-2)	194 (170-224)	3 (2-8)	1 (0-4)	0 (0-1)	8 (5-14)	70 (58-84)	7 (5-10)	0 (0-2)	132 (106-165)
2007–08	6 (4-10)	304 (261-355)	18 (9-38)	3 (1-11)	0 (0-3)	18 (9-36)	110 (91-136)	20 (14-28)	1 (0-9)	504 (414-622)
2008–09	3 (1-5)	228 (192-271)	7 (3-15)	3 (1-8)	0 (0-1)	4 (2-7)	67 (56-81)	10 (7-14)	1 (0-4)	228 (182-286)
2009–10	1 (0-3)	129 (107-157)	6 (3-12)	2 (1-7)	0 (0-2)	4 (2-7)	66 (54-85)	4 (3-8)	0 (0-1)	113 (87-148)
2010–11	1 (1-3)	113 (95-135)	3 (1-8)	2 (1-7)	0 (0-1)	5 (3-9)	27 (21-35)	4 (3-6)	0 (0-1)	141 (112-179)
2011–12	1 (1-3)	97 (84-113)	2 (1-4)	2 (1-6)	0 (0-1)	5 (3-9)	53 (44-65)	3 (2-6)	0 (0-2)	139 (110-178)
2012–13	1 (1-3)	158 (138-184)	7 (4-14)	3 (1-8)	0 (0-2)	6 (3-10)	64 (54-78)	7 (5-11)	0 (0-2)	129 (108-156)
2013–14	5 (3-8)	152 (134-176)	12 (7-23)	7 (3-19)	0 (0-3)	13 (8-21)	87 (74-105)	12 (8-17)	0 (0-3)	299 (255-352)
2014–15	7 (4-16)	369 (299-462)	11 (6-23)	5 (2-14)	1 (0-3)	10 (6-21)	129 (99-172)	10 (6-19)	0 (0-4)	430 (350-549)
2015–16	2 (1-5)	170 (147-198)	3 (1-8)	2 (1-7)	0 (0-2)	20 (13-32)	50 (40-63)	3 (2-5)	0 (0-1)	161 (134-194)
2016–17	2 (1-5)	197 (160-243)	2 (1-6)	3 (1-9)	0 (0-2)	6 (3-11)	48 (37-64)	5 (3-9)	0 (0-2)	220 (183-273)

RSO (Gemfish)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-0)	4 (2-7)	2 (0-8)	6 (1-27)	0 (0-0)	8 (4-21)	5 (2-12)	1 (0-3)	0 (0-2)	125 (101-161)
1991–92	0 (0-1)	2 (1-4)	1 (0-4)	3 (1-10)	0 (0-0)	3 (2-5)	18 (12-27)	2 (1-4)	1 (0-3)	71 (58-87)
1992–93	0 (0-1)	2 (1-10)	1 (0-6)	7 (2-34)	1 (0-6)	3 (2-7)	15 (10-24)	0 (0-2)	2 (0-14)	114 (93-141)
1993–94	0 (0-1)	2 (1-4)	3 (1-10)	25 (6-105)	0 (0-3)	4 (1-11)	4 (2-10)	0 (0-1)	1 (0-5)	187 (159-222)
1994–95	0 (0-0)	0 (0-1)	1 (0-2)	4 (1-16)	1 (0-4)	1 (0-3)	1 (0-2)	0 (0-0)	1 (0-5)	31 (24-40)
1995–96	0 (0-0)	1 (0-4)	2 (1-8)	25 (6-99)	4 (1-10)	2 (1-5)	1 (0-4)	0 (0-0)	0 (0-2)	38 (30-49)
1996–97	0 (0-0)	0 (0-1)	1 (0-2)	18 (4-74)	3 (1-6)	1 (0-2)	0 (0-1)	0 (0-0)	0 (0-1)	14 (10-20)
1997–98	0 (0-0)	0 (0-1)	0 (0-2)	77 (48-126)	4 (2-13)	1 (0-3)	0 (0-1)	0 (0-0)	0 (0-3)	6 (3-11)
1998–99	0 (0-0)	0 (0-1)	0 (0-1)	8 (2-24)	2 (0-8)	0 (0-2)	0 (0-1)	0 (0-0)	0 (0-1)	4 (3-7)
1999–2000	1 (0-4)	3 (1-14)	4 (1-23)	68 (17-290)	20 (4-94)	35 (12-123)	7 (2-29)	2 (0-10)	5 (1-36)	104 (66-183)
2000–01	0 (0-1)	1 (0-3)	1 (0-2)	15 (4-60)	2 (0-7)	2 (1-4)	1 (1-4)	0 (0-1)	1 (0-5)	28 (21-38)
2001–02	0 (0-1)	2 (1-6)	1 (0-4)	17 (4-64)	7 (2-27)	5 (3-11)	3 (1-7)	1 (1-3)	1 (0-8)	55 (44-69)
2002–03	1 (0-2)	9 (5-18)	3 (1-10)	31 (14-67)	7 (2-28)	6 (2-15)	7 (4-12)	4 (2-8)	1 (0-6)	220 (183-267)
2003–04	1 (0-5)	8 (3-19)	7 (2-24)	49 (12-186)	13 (3-50)	11 (5-24)	11 (4-37)	5 (2-17)	2 (0-12)	421 (359-499)
2004–05	0 (0-1)	3 (1-8)	3 (1-9)	21 (5-82)	5 (1-20)	5 (2-14)	3 (1-9)	1 (0-3)	1 (0-4)	157 (126-194)
2005–06	0 (0-0)	1 (1-4)	1 (0-6)	10 (3-37)	7 (2-29)	4 (2-12)	3 (1-6)	0 (0-1)	2 (0-12)	106 (85-135)
2006–07	0 (0-0)	1 (0-1)	0 (0-1)	5 (2-9)	3 (1-10)	1 (0-2)	1 (1-2)	0 (0-0)	3 (1-8)	15 (11-18)
2007–08	0 (0-0)	1 (0-1)	0 (0-1)	5 (1-21)	2 (1-10)	1 (0-3)	1 (0-2)	0 (0-0)	1 (0-6)	11 (8-15)
2008–09	0 (0-0)	1 (0-2)	1 (0-4)	11 (3-42)	3 (1-14)	1 (1-3)	2 (1-3)	0 (0-1)	1 (0-4)	48 (38-61)
2009–10	0 (0-0)	1 (1-2)	1 (1-2)	11 (3-31)	6 (2-15)	3 (1-6)	2 (1-3)	0 (0-0)	0 (0-2)	24 (19-30)
2010–11	0 (0-0)	2 (1-3)	1 (0-3)	17 (5-59)	6 (2-17)	4 (2-8)	2 (1-4)	0 (0-1)	1 (0-5)	103 (82-131)
2011–12	0 (0-0)	0 (0-1)	0 (0-1)	7 (2-21)	4 (1-14)	1 (0-2)	1 (0-1)	0 (0-0)	1 (0-2)	28 (21-36)
2012–13	0 (0-0)	1 (1-3)	3 (1-5)	23 (7-90)	14 (4-54)	3 (2-6)	3 (2-4)	0 (0-1)	3 (1-11)	108 (91-132)
2013–14	0 (0-1)	1 (0-3)	2 (1-5)	33 (14-74)	10 (5-22)	3 (1-7)	3 (2-6)	0 (0-2)	1 (0-9)	177 (139-235)
2014–15	0 (0-1)	2 (1-4)	3 (2-5)	19 (10-38)	12 (7-22)	4 (2-9)	5 (3-9)	0 (0-1)	1 (0-7)	122 (101-153)
2015–16	0 (0-1)	4 (2-7)	3 (1-8)	47 (13-154)	56 (28-121)	7 (3-13)	5 (3-10)	0 (0-1)	1 (0-5)	150 (127-182)
2016–17	1 (0-2)	26 (15-49)	5 (2-12)	121 (66-256)	29 (16-56)	8 (4-16)	14 (9-22)	1 (1-4)	5 (1-22)	468 (395-566)

Table A7: continued

SBW (Southern blue whiting)

Fishing year	AUCK		CHAT		COOK	EAST	NORTH	PUYS	STEW		SUBA		WCNI	WCSI
1990–91	0	(0-1)	0	(0-4)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	4	(1-92)	1	(0-14)	0 (0-0)	0 (0-0)
1991–92	0	(0-2)	2	(1-5)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	33	(20-59)	3	(2-8)	0 (0-0)	0 (0-0)
1992–93	0	(0-0)	0	(0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1	(1-2)	0	(0-0)	0 (0-0)	0 (0-0)
1993–94	0	(0-0)	0	(0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1	(0-3)	0	(0-0)	0 (0-0)	0 (0-0)
1994–95	1	(0-5)	5	(2-15)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	28	(14-82)	1	(0-5)	0 (0-0)	0 (0-0)
1995–96	0	(0-0)	0	(0-1)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1	(0-4)	0	(0-0)	0 (0-0)	0 (0-0)
1996–97	0	(0-1)	1	(0-5)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	6	(2-26)	0	(0-1)	0 (0-0)	0 (0-0)
1997–98	3	(1-11)	5	(2-14)	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	27	(13-72)	2	(1-8)	0 (0-0)	0 (0-0)
1998–99	1	(0-11)	5	(2-20)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	21	(8-92)	3	(1-23)	0 (0-0)	0 (0-0)
1999–2000	2	(1-5)	3	(2-6)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	22	(15-36)	6	(4-12)	0 (0-0)	0 (0-0)
2000–01	5	(3-15)	8	(5-15)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	52	(32-99)	16	(8-33)	0 (0-0)	0 (0-0)
2001–02	3	(1-27)	4	(1-23)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	37	(13-216)	16	(5-90)	0 (0-0)	0 (0-0)
2002–03	22	(8-86)	36	(18-94)	0 (0-1)	0 (0-1)	0 (0-0)	0 (0-1)	162	(82-434)	104	(52-312)	0 (0-0)	0 (0-1)
2003–04	12	(4-43)	32	(16-78)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-1)	134	(72-315)	61	(31-173)	0 (0-0)	0 (0-1)
2004–05	1	(0-21)	2	(0-49)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	12	(2-283)	3	(0-78)	0 (0-0)	0 (0-0)
2005–06	0	(0-0)	0	(0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	1	(1-3)	0	(0-0)	0 (0-0)	0 (0-0)
2006–07	0	(0-1)	1	(1-3)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	10	(5-22)	1	(0-3)	0 (0-0)	0 (0-0)
2007–08	25	(6-189)	124	(63-327)	0 (0-5)	0 (0-5)	0 (0-2)	0 (0-6)	631	(332-1592)	99	(37-373)	0 (0-5)	0 (0-3)
2008–09	13	(2-161)	109	(48-415)	0 (0-3)	0 (0-5)	0 (0-2)	0 (0-4)	581	(273-1722)	70	(23-375)	0 (0-4)	0 (0-3)
2009–10	0	(0-6)	5	(1-35)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	35	(11-208)	1	(0-19)	0 (0-0)	0 (0-0)
2010–11	5	(1-63)	33	(13-127)	0 (0-1)	0 (0-3)	0 (0-1)	0 (0-2)	160	(69-608)	18	(5-124)	0 (0-0)	0 (0-1)
2011–12	0	(0-6)	7	(3-24)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	41	(20-123)	2	(0-15)	0 (0-0)	0 (0-0)
2012–13	0	(0-3)	3	(2-7)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	22	(14-42)	2	(1-7)	0 (0-0)	0 (0-0)
2013–14	7	(2-37)	24	(13-58)	0 (0-1)	0 (0-4)	0 (0-1)	0 (0-1)	169	(105-363)	20	(9-75)	0 (0-0)	0 (0-1)
2014–15	6	(2-24)	22	(13-44)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-1)	132	(85-241)	9	(4-33)	0 (0-0)	0 (0-1)
2015–16	3	(1-24)	25	(13-62)	0 (0-1)	0 (0-1)	0 (0-1)	0 (0-1)	96	(53-239)	4	(1-23)	0 (0-0)	0 (0-1)
2016–17	4	(1-20)	20	(11-51)	0 (0-1)	0 (0-2)	0 (0-1)	0 (0-1)	103	(59-242)	9	(3-43)	0 (0-0)	0 (0-1)

Table A7: continued

SND (Shovelnose dogfish)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-0)	273 (224-339)	5 (2-15)	1 (0-5)	0 (0-0)	37 (21-64)	6 (4-10)	1 (1-2)	0 (0-0)	29 (21-40)
1991–92	0 (0-1)	334 (277-411)	4 (1-11)	1 (0-3)	0 (0-0)	17 (14-22)	14 (10-20)	1 (1-3)	0 (0-2)	29 (21-39)
1992–93	0 (0-0)	269 (193-387)	2 (1-7)	1 (0-4)	0 (0-0)	6 (3-12)	5 (3-8)	0 (0-0)	0 (0-3)	22 (16-32)
1993–94	0 (0-1)	182 (146-235)	19 (7-54)	11 (3-39)	0 (0-0)	16 (6-41)	9 (5-17)	1 (0-2)	0 (0-4)	68 (48-98)
1994–95	0 (0-0)	93 (74-121)	13 (5-38)	2 (1-9)	0 (0-1)	9 (3-25)	4 (2-7)	0 (0-0)	1 (0-5)	37 (27-52)
1995–96	0 (0-0)	102 (67-171)	27 (9-83)	7 (2-25)	0 (0-2)	9 (3-25)	2 (1-6)	0 (0-0)	0 (0-2)	19 (11-36)
1996–97	0 (0-1)	86 (62-123)	33 (12-101)	15 (4-51)	0 (0-3)	16 (6-39)	3 (1-8)	0 (0-0)	0 (0-2)	20 (13-32)
1997–98	0 (0-2)	223 (179-279)	21 (8-55)	15 (6-33)	0 (0-3)	18 (6-56)	4 (2-11)	0 (0-1)	1 (0-4)	27 (18-44)
1998–99	0 (0-0)	131 (103-170)	13 (6-29)	4 (1-16)	0 (0-2)	9 (4-20)	2 (1-4)	0 (0-1)	0 (0-2)	28 (18-47)
1999–2000	1 (1-3)	641 (522-799)	23 (11-51)	8 (2-26)	0 (0-3)	50 (24-102)	13 (8-21)	4 (2-7)	2 (0-7)	28 (20-43)
2000–01	1 (0-2)	249 (199-319)	12 (6-27)	8 (2-30)	0 (0-1)	45 (22-92)	8 (4-14)	2 (1-5)	1 (0-6)	30 (19-48)
2001–02	1 (1-4)	699 (565-884)	14 (5-41)	8 (2-31)	0 (0-4)	31 (11-89)	13 (7-25)	6 (3-12)	1 (0-8)	66 (51-92)
2002–03	0 (0-1)	278 (221-353)	5 (2-12)	9 (3-27)	0 (0-1)	15 (7-35)	2 (1-3)	1 (1-2)	0 (0-2)	28 (20-40)
2003–04	0 (0-1)	207 (171-256)	6 (3-14)	5 (1-17)	0 (0-1)	12 (6-23)	3 (1-5)	1 (1-3)	0 (0-2)	39 (28-54)
2004–05	1 (0-1)	230 (196-271)	13 (7-24)	4 (1-13)	0 (0-1)	11 (5-24)	5 (3-10)	2 (1-3)	0 (0-1)	15 (12-19)
2005–06	0 (0-1)	263 (223-314)	15 (6-36)	5 (1-20)	1 (0-5)	91 (57-148)	9 (6-15)	0 (0-1)	2 (0-11)	64 (51-80)
2006–07	0 (0-0)	182 (148-231)	7 (4-13)	2 (1-7)	0 (0-1)	8 (4-18)	4 (2-6)	0 (0-1)	0 (0-2)	25 (18-34)
2007–08	0 (0-1)	395 (342-468)	31 (16-58)	7 (2-25)	1 (0-4)	36 (17-74)	7 (5-10)	1 (1-2)	3 (1-14)	62 (47-82)
2008–09	0 (0-0)	289 (243-351)	8 (4-16)	5 (2-18)	0 (0-2)	8 (3-18)	3 (2-5)	0 (0-1)	1 (0-7)	30 (22-41)
2009–10	0 (0-0)	144 (114-182)	10 (6-17)	4 (1-13)	0 (0-3)	7 (3-19)	3 (2-4)	0 (0-1)	0 (0-2)	12 (8-18)
2010–11	0 (0-1)	169 (132-221)	6 (2-18)	7 (2-26)	0 (0-2)	11 (5-26)	2 (1-5)	0 (0-1)	0 (0-3)	50 (34-73)
2011–12	0 (0-0)	118 (90-158)	3 (1-7)	3 (1-9)	0 (0-2)	8 (4-17)	1 (1-3)	0 (0-0)	0 (0-3)	13 (9-20)
2012–13	0 (0-1)	187 (151-236)	8 (4-18)	7 (2-25)	1 (0-5)	16 (9-38)	5 (3-9)	1 (0-2)	1 (0-6)	43 (32-59)
2013–14	0 (0-1)	232 (187-292)	15 (9-27)	14 (5-41)	0 (0-4)	17 (9-36)	6 (4-10)	1 (0-2)	1 (0-5)	46 (35-63)
2014–15	0 (0-1)	128 (101-165)	8 (5-15)	7 (2-21)	0 (0-3)	12 (6-24)	6 (3-9)	0 (0-1)	0 (0-4)	44 (35-58)
2015–16	0 (0-1)	241 (195-304)	8 (3-19)	8 (2-29)	0 (0-4)	17 (10-31)	5 (3-9)	0 (0-1)	0 (0-3)	61 (46-83)
2016–17	0 (0-1)	151 (121-192)	5 (2-12)	6 (2-20)	0 (0-3)	10 (5-19)	5 (3-8)	0 (0-1)	0 (0-4)	35 (27-46)

SPD (Spiny dogfish)

Fishing year	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI	
1990–91	1	(0-2)	247	(184-336)	177	(45-754)	0	(0-1)	0	(0-0)	22	(13-38)	51	(38-70)	9	(6-14)	0	(0-0)	265	(209-353)
1991–92	2	(1-7)	355	(242-527)	212	(56-835)	0	(0-1)	0	(0-0)	19	(13-30)	221	(176-287)	24	(16-40)	0	(0-2)	576	(457-756)
1992–93	2	(1-6)	181	(120-276)	157	(76-335)	0	(0-1)	0	(0-0)	12	(5-26)	134	(106-173)	5	(3-10)	0	(0-2)	269	(216-337)
1993–94	9	(5-21)	146	(112-191)	320	(166-591)	1	(0-6)	0	(0-0)	23	(11-51)	207	(155-287)	12	(6-25)	0	(0-2)	939	(787-1146)
1994–95	11	(6-28)	705	(532-965)	811	(215-3175)	1	(0-6)	0	(0-3)	15	(5-38)	322	(230-458)	10	(5-25)	1	(0-11)	1976	(1615-2513)
1995–96	12	(6-29)	1180	(910-1574)	6765	(3755-12055)	6	(1-41)	1	(0-15)	66	(29-163)	302	(198-466)	10	(4-27)	0	(0-8)	2092	(1684-2704)
1996–97	11	(4-32)	497	(375-662)	2268	(561-9008)	6	(1-32)	1	(0-11)	166	(73-420)	241	(111-554)	6	(2-17)	0	(0-4)	668	(523-871)
1997–98	39	(26-61)	853	(734-1001)	1559	(1185-2053)	12	(4-39)	2	(0-8)	59	(16-237)	334	(261-436)	29	(19-46)	1	(0-12)	1660	(1395-2006)
1998–99	15	(9-29)	1175	(1002-1387)	1579	(1224-2062)	3	(1-19)	1	(0-12)	196	(100-396)	240	(183-315)	47	(32-70)	1	(0-10)	1090	(912-1318)
1999–2000	33	(21-58)	1729	(1413-2151)	3062	(2226-4365)	2	(0-14)	1	(0-8)	60	(32-126)	314	(246-420)	91	(65-130)	1	(0-14)	814	(656-1039)
2000–01	50	(32-85)	1126	(928-1376)	1453	(1106-1959)	3	(0-17)	0	(0-3)	80	(47-139)	468	(365-609)	143	(105-204)	1	(0-9)	718	(591-894)
2001–02	76	(50-123)	1260	(1048-1536)	757	(522-1074)	1	(0-10)	1	(0-6)	37	(22-67)	748	(588-978)	334	(251-450)	0	(0-7)	545	(457-674)
2002–03	39	(27-60)	904	(755-1098)	1403	(1041-1929)	2	(0-13)	0	(0-5)	61	(33-109)	258	(205-331)	167	(130-219)	0	(0-4)	399	(332-490)
2003–04	28	(17-52)	1111	(907-1381)	985	(721-1356)	2	(0-15)	1	(0-7)	24	(14-46)	301	(228-410)	138	(101-198)	0	(0-6)	307	(256-376)
2004–05	10	(6-19)	746	(627-900)	890	(652-1206)	1	(0-7)	0	(0-3)	94	(57-159)	98	(70-139)	29	(20-45)	0	(0-2)	177	(147-218)
2005–06	3	(1-10)	706	(577-883)	735	(464-1193)	1	(0-5)	1	(0-6)	36	(17-80)	215	(162-299)	11	(5-26)	1	(0-12)	318	(252-411)
2006–07	4	(2-16)	614	(499-768)	479	(352-670)	1	(0-7)	0	(0-5)	58	(31-119)	347	(270-463)	35	(22-66)	0	(0-6)	281	(216-378)
2007–08	7	(4-16)	679	(549-863)	873	(642-1236)	1	(0-7)	1	(0-6)	31	(12-82)	145	(113-199)	26	(17-43)	1	(0-14)	338	(264-449)
2008–09	15	(8-36)	925	(746-1168)	669	(493-949)	2	(0-13)	1	(0-8)	20	(10-42)	406	(323-530)	58	(38-109)	1	(0-14)	224	(172-299)
2009–10	4	(2-15)	817	(676-1019)	297	(224-404)	2	(0-11)	1	(0-12)	25	(13-49)	351	(282-454)	22	(13-44)	0	(0-5)	389	(307-505)
2010–11	15	(7-41)	1140	(917-1481)	606	(395-966)	4	(1-25)	2	(0-13)	28	(14-62)	296	(224-424)	41	(25-87)	0	(0-9)	593	(454-796)
2011–12	3	(1-9)	1098	(926-1326)	393	(292-542)	2	(0-14)	1	(0-11)	13	(8-25)	151	(118-194)	9	(5-18)	1	(0-10)	1028	(856-1269)
2012–13	8	(3-24)	702	(579-865)	174	(123-258)	2	(0-13)	2	(0-12)	22	(12-46)	367	(294-479)	40	(25-78)	1	(0-11)	614	(507-773)
2013–14	47	(25-108)	1519	(1226-1920)	486	(340-709)	5	(1-18)	2	(0-16)	18	(9-41)	953	(763-1275)	122	(79-220)	1	(0-12)	644	(528-828)
2014–15	54	(30-138)	1375	(1104-1755)	131	(98-182)	2	(0-10)	2	(0-14)	45	(24-95)	1079	(858-1446)	79	(46-179)	0	(0-9)	793	(663-972)
2015–16	9	(4-24)	1195	(995-1453)	182	(131-259)	2	(0-12)	1	(0-8)	20	(11-37)	200	(155-274)	11	(5-27)	0	(0-3)	478	(403-582)
2016–17	19	(10-45)	2221	(1866-2704)	218	(151-316)	3	(1-11)	2	(0-10)	30	(17-60)	423	(330-554)	43	(26-84)	1	(0-9)	779	(662-936)

Table A7: continued

SPE (Sea perch)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-0)	210 (184-244)	0 (0-1)	2 (0-6)	0 (0-0)	8 (4-19)	3 (2-7)	1 (0-1)	0 (0-0)	32 (25-42)
1991–92	0 (0-0)	312 (274-359)	0 (0-1)	1 (0-3)	0 (0-0)	3 (2-4)	5 (4-8)	1 (0-1)	0 (0-1)	26 (21-33)
1992–93	0 (0-0)	316 (256-391)	0 (0-1)	1 (0-5)	0 (0-1)	1 (1-2)	1 (1-2)	0 (0-0)	0 (0-2)	28 (23-34)
1993–94	0 (0-0)	188 (168-213)	2 (1-8)	9 (3-30)	0 (0-1)	1 (0-3)	2 (1-3)	0 (0-0)	0 (0-1)	50 (42-59)
1994–95	0 (0-0)	285 (246-335)	6 (2-18)	6 (2-21)	2 (0-6)	3 (1-8)	2 (1-4)	0 (0-0)	1 (0-5)	66 (50-86)
1995–96	0 (0-0)	480 (385-601)	14 (4-46)	26 (8-88)	6 (2-16)	3 (1-8)	3 (1-6)	0 (0-0)	0 (0-2)	28 (21-38)
1996–97	0 (0-0)	331 (263-431)	15 (4-53)	45 (12-166)	13 (4-45)	2 (1-8)	2 (0-5)	0 (0-0)	0 (0-2)	78 (45-143)
1997–98	0 (0-1)	456 (413-502)	11 (4-30)	131 (93-184)	20 (9-48)	7 (2-21)	3 (2-5)	0 (0-1)	1 (0-5)	56 (46-68)
1998–99	0 (0-0)	681 (622-746)	4 (2-8)	15 (6-37)	7 (2-23)	2 (1-6)	3 (1-5)	0 (0-1)	1 (0-2)	66 (56-79)
1999–2000	0 (0-1)	714 (610-846)	9 (3-29)	18 (7-54)	9 (3-32)	8 (4-20)	3 (2-7)	1 (0-2)	3 (1-11)	72 (57-92)
2000–01	1 (0-2)	984 (875-1105)	5 (2-13)	21 (6-65)	4 (1-13)	6 (3-11)	9 (5-16)	3 (2-5)	1 (0-6)	81 (68-97)
2001–02	1 (0-2)	984 (850-1163)	6 (2-19)	16 (5-57)	11 (3-39)	5 (2-11)	10 (6-17)	5 (3-9)	1 (0-5)	304 (253-372)
2002–03	1 (1-3)	1335 (1173-1539)	8 (2-26)	47 (23-98)	10 (3-32)	16 (8-33)	8 (5-13)	5 (3-9)	1 (0-4)	80 (68-94)
2003–04	0 (0-1)	930 (788-1106)	5 (1-18)	19 (6-64)	8 (2-26)	6 (3-11)	3 (1-7)	1 (1-4)	1 (0-3)	69 (57-84)
2004–05	0 (0-1)	606 (541-679)	4 (2-11)	10 (3-32)	4 (1-12)	6 (3-11)	2 (1-4)	1 (0-1)	0 (0-1)	49 (42-59)
2005–06	0 (0-0)	374 (321-438)	3 (1-11)	5 (1-18)	6 (2-23)	9 (3-26)	1 (1-3)	0 (0-0)	1 (0-5)	81 (68-98)
2006–07	0 (0-0)	351 (305-407)	2 (1-4)	8 (3-22)	4 (1-13)	3 (2-6)	4 (2-6)	0 (0-1)	1 (0-3)	38 (30-50)
2007–08	0 (0-0)	271 (235-311)	5 (2-12)	5 (2-17)	4 (1-12)	2 (1-5)	2 (1-3)	0 (0-1)	1 (0-5)	77 (64-93)
2008–09	0 (0-0)	227 (192-272)	4 (1-15)	12 (4-41)	5 (2-18)	5 (3-10)	2 (2-4)	0 (0-1)	2 (0-6)	74 (59-94)
2009–10	0 (0-0)	458 (390-543)	5 (2-12)	17 (5-49)	7 (3-20)	6 (4-11)	4 (3-6)	0 (0-1)	0 (0-2)	63 (51-78)
2010–11	0 (0-1)	634 (524-780)	6 (2-24)	31 (9-103)	17 (5-50)	21 (11-45)	6 (4-11)	1 (0-2)	1 (0-7)	141 (110-186)
2011–12	0 (0-0)	357 (314-411)	2 (1-5)	14 (4-42)	9 (3-30)	6 (3-10)	5 (4-8)	0 (0-1)	1 (0-3)	67 (56-82)
2012–13	0 (0-0)	494 (439-563)	7 (2-21)	20 (6-64)	16 (4-54)	7 (4-12)	6 (4-9)	1 (0-1)	2 (0-7)	114 (97-138)
2013–14	0 (0-1)	263 (235-295)	7 (3-14)	7 (3-12)	4 (2-7)	5 (3-8)	9 (7-11)	1 (1-2)	1 (0-2)	101 (90-115)
2014–15	0 (0-1)	768 (674-878)	4 (2-7)	14 (8-24)	15 (10-22)	2 (1-4)	6 (5-8)	0 (0-1)	1 (0-3)	163 (143-189)
2015–16	0 (0-1)	668 (593-765)	4 (2-13)	21 (7-64)	12 (7-22)	5 (3-8)	8 (6-12)	0 (0-1)	0 (0-2)	121 (105-141)
2016–17	0 (0-0)	415 (365-473)	1 (0-3)	14 (8-25)	17 (10-28)	3 (2-5)	2 (2-4)	0 (0-1)	0 (0-2)	127 (112-146)

Table A7: continued

SQU (Arrow squid)

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI
1990–91	0 (0-0)	33 (27-40)	1 (0-2)	0 (0-0)	0 (0-0)	24 (18-32)	20 (15-27)	3 (2-5)	0 (0-0)	104 (93-119)
1991–92	1 (0-1)	51 (39-67)	1 (0-2)	0 (0-0)	0 (0-0)	31 (26-38)	62 (52-74)	7 (5-9)	0 (0-0)	95 (82-111)
1992–93	1 (0-2)	23 (17-31)	0 (0-1)	0 (0-0)	0 (0-0)	17 (11-30)	41 (32-52)	1 (1-3)	0 (0-0)	63 (52-76)
1993–94	2 (1-3)	20 (15-26)	2 (1-4)	1 (0-2)	0 (0-0)	8 (5-13)	33 (25-46)	2 (1-4)	0 (0-0)	120 (102-142)
1994–95	2 (1-3)	77 (64-91)	3 (1-9)	1 (0-2)	0 (0-1)	14 (9-22)	44 (32-60)	1 (1-3)	0 (0-1)	203 (179-233)
1995–96	2 (1-4)	54 (42-69)	5 (2-12)	2 (1-5)	1 (0-3)	20 (13-34)	57 (43-75)	2 (1-4)	0 (0-0)	61 (51-73)
1996–97	2 (1-3)	31 (24-39)	5 (2-11)	2 (1-6)	2 (1-5)	17 (11-26)	47 (33-67)	1 (1-2)	0 (0-0)	68 (59-79)
1997–98	6 (4-8)	75 (66-84)	4 (3-5)	3 (2-4)	2 (1-4)	23 (9-54)	49 (36-67)	4 (3-6)	0 (0-0)	54 (47-62)
1998–99	2 (1-3)	68 (59-77)	3 (2-4)	1 (0-2)	1 (0-3)	11 (6-19)	26 (22-32)	5 (4-6)	0 (0-0)	91 (78-106)
1999–2000	3 (2-5)	40 (33-48)	2 (1-3)	0 (0-1)	1 (0-2)	17 (10-29)	32 (26-38)	9 (7-12)	0 (0-0)	45 (38-55)
2000–01	8 (6-12)	139 (116-166)	2 (1-4)	2 (1-5)	1 (0-3)	57 (39-83)	75 (62-91)	23 (18-30)	0 (0-1)	189 (162-224)
2001–02	14 (10-18)	65 (56-77)	2 (1-4)	1 (0-3)	2 (1-4)	22 (15-31)	131 (110-154)	59 (48-72)	0 (0-1)	252 (224-287)
2002–03	15 (11-22)	87 (72-108)	2 (1-4)	1 (0-4)	1 (0-4)	17 (11-27)	98 (79-126)	64 (51-83)	0 (0-0)	217 (182-258)
2003–04	4 (2-6)	65 (54-79)	2 (1-3)	1 (0-3)	1 (0-3)	13 (8-22)	37 (29-49)	17 (13-23)	0 (0-0)	239 (207-276)
2004–05	11 (7-15)	59 (51-69)	3 (2-5)	1 (0-3)	1 (0-3)	17 (11-25)	103 (83-128)	31 (24-40)	0 (0-0)	100 (88-114)
2005–06	2 (1-5)	74 (62-89)	2 (1-4)	1 (0-2)	2 (1-6)	53 (34-84)	125 (100-157)	7 (4-12)	0 (0-1)	126 (108-147)
2006–07	2 (1-6)	113 (93-143)	3 (2-5)	1 (1-4)	2 (1-6)	27 (16-44)	168 (135-213)	17 (11-28)	0 (0-1)	148 (122-181)
2007–08	3 (2-5)	60 (52-69)	3 (2-5)	1 (0-2)	1 (0-4)	18 (10-33)	65 (56-77)	12 (9-16)	0 (0-1)	96 (82-111)
2008–09	3 (2-7)	55 (44-71)	2 (1-4)	1 (0-4)	1 (1-5)	19 (12-31)	87 (71-107)	13 (9-20)	0 (0-1)	96 (79-120)
2009–10	2 (1-4)	111 (93-136)	3 (2-4)	2 (1-5)	4 (1-11)	24 (15-39)	122 (101-148)	8 (5-14)	0 (0-0)	103 (86-125)
2010–11	8 (4-19)	144 (114-185)	4 (2-8)	4 (1-12)	4 (2-12)	60 (34-112)	153 (119-211)	21 (13-40)	0 (0-1)	198 (157-258)
2011–12	2 (1-4)	61 (50-76)	2 (1-3)	1 (0-3)	2 (1-7)	23 (15-37)	77 (63-96)	5 (3-9)	0 (0-1)	166 (142-196)
2012–13	6 (2-14)	62 (52-76)	3 (2-6)	2 (1-6)	4 (2-13)	28 (18-49)	260 (217-326)	29 (19-48)	0 (0-1)	163 (139-194)
2013–14	14 (8-26)	47 (39-58)	4 (2-7)	3 (1-6)	3 (1-6)	47 (30-78)	265 (222-325)	35 (24-54)	0 (0-1)	179 (155-209)
2014–15	28 (17-49)	111 (92-134)	3 (2-5)	3 (1-5)	6 (4-11)	42 (27-68)	515 (433-628)	39 (26-65)	0 (0-1)	363 (319-425)
2015–16	13 (6-29)	102 (84-126)	3 (2-6)	3 (1-9)	5 (2-10)	68 (43-114)	273 (216-359)	15 (8-33)	0 (0-1)	231 (197-273)
2016–17	13 (7-33)	119 (96-151)	3 (2-6)	4 (2-9)	8 (4-16)	65 (38-124)	293 (233-384)	29 (18-53)	0 (0-1)	268 (226-324)

Table A8: Total annual discard estimates (t) and estimated 95% CIs for selected categories and main bycatch species for the target hoki, hake, ling, silver warehou, white warehou trawl fishery. The slope of a regression through the data points is shown (in bold if significant) in the bottom row for each species code (see Table A1 for species code definitions).

Fishing year	Morids	Schedule 6	Rattails (all)	Slickheads	Sharks	BAR	BOE	BYX	GIZ	GSH	GSP
2002–03	10 (7-15)	3281 (2741-3977)	6785 (5378-8854)	11 (6-24)	4754 (4294-5325)	27 (4-454)	0 (0-4)	2 (1-4)	0 (0-2)	41 (20-113)	9 (5-20)
2003–04	23 (8-99)	2652 (2226-3235)	3072 (2244-4400)	12 (4-51)	4111 (3648-4686)	25 (4-435)	0 (0-2)	1 (0-6)	0 (0-1)	14 (4-82)	1 (0-3)
2004–05	13 (5-48)	957 (793-1188)	1537 (957-2659)	1 (0-8)	1729 (1528-1975)	3 (1-13)	0 (0-2)	0 (0-5)	0 (0-2)	17 (8-46)	5 (2-23)
2005–06	7 (3-15)	1530 (1222-2003)	3624 (2461-5581)	16 (11-26)	3171 (2748-3697)	2 (0-37)	0 (0-1)	1 (0-9)	0 (0-2)	11 (2-106)	1 (0-10)
2006–07	6 (3-13)	1532 (1249-1903)	2211 (1703-2974)	7 (3-19)	2717 (2310-3226)	1 (0-14)	0 (0-2)	0 (0-3)	1 (0-7)	8 (2-40)	1 (0-19)
2007–08	15 (11-22)	1055 (844-1378)	2213 (1816-2752)	39 (31-51)	2386 (2043-2789)	103 (34-491)	0 (0-2)	1 (0-4)	1 (0-2)	11 (6-26)	4 (2-10)
2008–09	24 (17-35)	1617 (1303-2061)	4627 (3856-5692)	34 (22-53)	2858 (2508-3286)	6 (2-37)	0 (0-1)	0 (0-2)	0 (0-2)	38 (14-170)	3 (1-6)
2009–10	5 (4-7)	668 (566-801)	3335 (2701-4251)	3 (2-6)	1254 (1116-1419)	3 (2-6)	0 (0-2)	0 (0-6)	0 (0-2)	86 (43-238)	2 (1-4)
2010–11	11 (8-14)	1481 (1115-2087)	3509 (2773-4605)	4 (2-10)	1924 (1587-2366)	12 (8-21)	0 (0-1)	1 (0-4)	1 (1-2)	141 (60-562)	5 (3-11)
2011–12	9 (7-12)	1724 (1450-2095)	1483 (1211-1864)	8 (4-17)	2621 (2296-3006)	5 (3-9)	0 (0-1)	2 (1-5)	1 (0-1)	25 (15-50)	1 (1-2)
2012–13	10 (9-12)	1433 (1211-1739)	2358 (2024-2807)	3 (2-5)	2286 (2043-2564)	18 (11-40)	0 (0-3)	2 (1-4)	2 (2-3)	12 (7-24)	2 (1-3)
2013–14	10 (9-12)	1817 (1547-2171)	1837 (1583-2180)	5 (3-8)	2423 (2175-2748)	9 (6-14)	1 (0-20)	5 (2-16)	2 (1-2)	18 (11-34)	3 (2-4)
2014–15	26 (23-30)	1894 (1605-2327)	3088 (2697-3578)	6 (5-9)	2550 (2270-2870)	25 (16-48)	1 (0-21)	2 (1-3)	5 (3-6)	23 (15-43)	12 (9-14)
2015–16	35 (28-43)	1068 (912-1262)	1364 (1113-1733)	4 (3-8)	1764 (1580-2003)	14 (9-27)	1 (0-9)	2 (1-4)	8 (6-11)	58 (35-124)	19 (13-29)
2016–17	24 (21-27)	2000 (1663-2462)	1449 (1192-1837)	6 (4-10)	2145 (1893-2441)	20 (13-34)	0 (0-6)	2 (1-2)	7 (6-10)	22 (15-36)	8 (6-10)
Slope	0.047	-0.015	-0.056	-0.051	-0.038	0.051	0.123	0.137	**0.328**	0.042	0.091

Table A8: Continued

Fishing year	JAV	JMA	LDO	ORH	RCO	RIB	RSO	SBW	SND	SPD	SPE	SQU
2002–03	(3291-5604)	0 (0-4)	67 (54-82)	0 (0-0)	3 (2-6)	4 (3-6)	2 (1-3)	0 (0-2)	218 (175-278)	2958 (2454-3677)	13 (9-20)	8 (5-15)
2003–04	(1005-2096)	0 (0-3)	72 (58-93)	0 (0-0)	3 (1-17)	5 (2-12)	0 (0-1)	0 (0-2)	232 (193-277)	2360 (2016-2822)	6 (3-11)	10 (5-21)
2004–05	(450-1459)	0 (0-1)	3 (1-7)	0 (0-1)	1 (1-3)	4 (1-31)	0 (0-6)	3 (0-36)	158 (131-187)	869 (708-1092)	4 (2-7)	6 (3-17)
2005–06	(1711-4066)	0 (0-4)	0 (0-2)	0 (0-1)	2 (0-25)	3 (2-8)	0 (0-5)	0 (0-2)	432 (357-535)	1345 (1094-1730)	2 (1-7)	1 (0-26)
2006–07	(912-1766)	0 (0-1)	11 (6-19)	0 (0-1)	1 (1-2)	0 (0-5)	1 (0-10)	0 (0-2)	223 (175-290)	1507 (1250-1915)	3 (2-7)	21 (12-43)
2007–08	(1155-2092)	2 (1-5)	1 (0-1)	0 (0-1)	2 (1-3)	1 (1-2)	1 (0-2)	3 (0-24)	223 (177-282)	1035 (816-1353)	1 (0-1)	11 (6-24)
2008–09	(2176-3363)	0 (0-1)	0 (0-1)	0 (0-0)	1 (0-1)	1 (1-4)	1 (0-8)	0 (0-1)	258 (202-348)	1611 (1302-2046)	4 (2-7)	17 (13-23)
2009–10	(1142-1781)	0 (0-1)	3 (2-6)	0 (0-0)	1 (1-2)	1 (0-2)	0 (0-3)	0 (0-0)	70 (53-95)	657 (554-790)	4 (3-8)	16 (14-20)
2010–11	(1501-2750)	0 (0-1)	1 (1-2)	0 (0-1)	3 (2-4)	1 (1-2)	0 (0-1)	0 (0-0)	21 (12-40)	1551 (1156-2237)	3 (2-5)	28 (21-37)
2011–12	(501-791)	1 (0-5)	1 (0-1)	0 (0-1)	4 (3-5)	3 (2-5)	0 (0-1)	0 (0-1)	81 (59-111)	1717 (1428-2092)	3 (2-6)	11 (9-13)
2012–13	(843-1200)	0 (0-1)	2 (2-3)	0 (0-0)	3 (2-3)	5 (4-6)	1 (0-1)	0 (0-0)	84 (66-113)	1397 (1180-1711)	10 (7-13)	21 (18-26)
2013–14	(705-1053)	0 (0-1)	3 (2-4)	0 (0-0)	3 (3-4)	4 (3-5)	1 (1-3)	2 (1-6)	71 (54-97)	1873 (1568-2293)	9 (7-12)	27 (23-32)
2014–15	(1391-1922)	1 (0-1)	16 (13-20)	1 (0-2)	4 (4-5)	17 (14-20)	2 (1-3)	7 (4-19)	84 (66-107)	1792 (1476-2293)	21 (17-26)	49 (41-58)
2015–16	(518-809)	1 (0-1)	27 (21-36)	0 (0-0)	6 (5-7)	25 (19-36)	14 (10-21)	0 (0-1)	110 (83-151)	1010 (850-1223)	31 (25-40)	39 (31-51)
2016–17	(637-1127)	1 (0-1)	13 (10-16)	0 (0-1)	7 (6-9)	11 (10-14)	13 (10-19)	3 (1-7)	99 (73-140)	2145 (1705-2798)	23 (18-29)	25 (20-33)
Slope	-0.071	0.143	0.006	0.041	0.087	0.139	0.214	0.119	-0.099	-0.006	0.120	**0.144**

8 APPENDIX B: QMS species list

Table B 1: Complete list of QMS species codes as at 01 October 2016, ordered from most recent to oldest addition, and alphabetically within each year of entry, along with: year of entry into the QMS; broad taxonomic group (Algae, Fish, Invertebrate); common and scientific names; and total observed catch (t) in the hoki, hake, ling, silver warehou, white warehou fishery between 2002–03 and 2016–17. * listed under Schedule 6 of the Fisheries Act 1996 (stocks which may be returned to the sea or other waters).

Species code	QMS year of entry	Group	Common name	Scientific name	Observed catch (t)
KBB*	2010	Algae	Bladder kelp	*Macrocystis pyrifera*	0.0
PTO*	2010	Fish	Patagonian toothfish	*Dissostichus eleginoides*	0.0
RBT	2009	Fish	Redbait	*Emmelichthys nitidus*	436.4
PRK*	2007	Inv.	Prawn killer	*Ibacus alticrenatus*	2.3
KWH*	2006	Inv.	Knobbed whelk	*Austrofucus glans*	0.2
PZL	2006	Inv.	King clam	*Panopea zelandica*	0.0
OYS*	2005	Inv.	Oysters dredge	*Ostrea chilensis*	0.0
PPI*	2005	Inv.	Pipi	*Paphies australis*	0.0
TUA	2005	Inv.	Tuatua	*Paphies subtriangulata*	0.0
BIG	2004	Fish	Bigeye tuna	*Thunnus obesus*	0.0
BWS*	2004	Fish	Blue shark	*Prionace glauca*	0.0
BYA*	2004	Inv.	Frilled venus shell	*Bassina yatei*	0.0
CHC*	2004	Inv.	Red crab	*Chaceon bicolor*	0.0
DAN*	2004	Inv.	Ringed dosinia	*Dosinia anus*	0.0
DSU*	2004	Inv.	Silky dosinia	*Dosinia subrosea*	0.0
GLM*	2004	Inv.	Green-lipped mussel	*Perna canaliculus*	0.0
GSC*	2004	Inv.	Giant spider crab	*Jacquinotia edwardsii*	43.8
HOR	2004	Inv.	Horse mussel	*Atrina zelandica*	16.4
KAH	2004	Fish.	Kahawai	*Arripis trutta, A. xylabion*	0.0
ATT	2004	Fish	Kahawai	*Arripis trutta*	0.0
KIC*	2004	Inv.	King crab	*Lithodes murrayi, Neolithodes brodiei*	1.8
LDO	2004	Fish	Lookdown dory	*Cyttus traversi*	1436.3
LFE*	2004	Fish	Long-finned eel	*Anguilla dieffenbachii*	0.0
MAK*	2004	Fish	Mako shark	*Isurus oxyrinchus*	14.7
MDI*	2004	Inv.	Trough shell	*Mactra discors*	0.0
MMI*	2004	Inv.	Large trough shell	*Mactra murchisoni*	0.0
MOO	2004	Fish	Moonfish	*Lampris guttatus*	0.0
PAR	2004	Fish	Parore	*Girella tricuspidata*	0.0
PDO*	2004	Inv.	Southern tuatua	*Paphies donacina*	0.0
POR	2004	Fish	Porae	*Nemadactylus douglasii*	0.0
POS*	2004	Fish	Porbeagle shark	*Lamna nasus*	119.4
RBM	2004	Fish	Rays bream	*Brama brama*	355.3
RSN	2004	Fish	Red snapper	*Centroberyx affinis*	0.0
SAE*	2004	Inv.	Triangle shell	*Spisula aequilatera*	0.0
SCC*	2004	Inv.	Sea cucumber	*Stichopus mollis*	0.2
SCI	2004	Inv.	Scampi	*Metanephrops challengeri*	36.9
SPD*	2004	Fish	Spiny dogfish	*Squalus acanthias*	8923.7
STN*	2004	Fish	Southern bluefin tuna	*Thunnus maccoyii*	39.8
SWO*	2004	Fish	Broadbill swordfish	*Xiphias gladius*	57.3
TOR	2004	Fish	Pacific bluefin tuna	*Thunnus orientalis*	0.0
YFN	2004	Fish	Yellowfin tuna	*Thunnus albacares*	0.0
KIN*	2003	Fish	Kingfish	*Seriola lalandi*	0.0
LEA	2003	Fish	Leatherjacket	*Meuschenia scaber*	0.0
RSK*	2003	Fish	Rough skate	*Zearaja nasuta*	271.0
SFE*	2003	Fish	Short-finned eel	*Anguilla australis, Anguilla reinhardtii*	0.0
SSK*	2003	Fish	Smooth skate	*Dipturus innominatus*	795.7
ANC	2002	Fish	Anchovy	*Engraulis australis*	0.0
BUT	2002	Fish	Butterfish	*Odax pullus*	0.0
COC*	2002	Inv.	Cockle	*Austrovenus stutchburyi*	0.0
EMA	2002	Fish	Blue mackerel	*Scomber australasicus*	22.3
GAR	2002	Fish	Garfish	*Hyporhamphus ihi*	0.0
PAD*	2002	Inv.	Paddle crab	*Ovalipes catharus*	0.2
PIL	2002	Fish	Pilchard	*Sardinops sagax*	0.0
QSC*	2002	Inv.	Queen scallop	*Zygochlamys delicatula*	6.3
SPR	2002	Fish	Sprats	*Sprattus antipodum, S. muelleri*	0.0
SUR*	2002	Inv.	Kina	*Evechinus chloroticus*	0.2
ANG	2000	Fish	Anguillidae	Anguillidae	0.0
GSP	1999	Fish	Pale ghost shark	*Hydrolagus bemisi*	2009.6
SBW	1999	Fish	Southern blue whiting	*Micromesistius australis*	1052.5

Table B 1: continued

Species code	QMS year of entry	Group	Common name	Scientific name	Observed catch (t)
CDL	1998	Fish	Cardinalfish	Epigonidae	224.2
EPT	1998	Fish	Deepsea cardinalfish	*Epigonus telescopus*	0.0
FRO	1998	Fish	Frostfish	*Lepidopus caudatus*	2630.8
GSH	1998	Fish	Ghost shark	*Hydrolagus novaezealandiae*	1500.2
OYU	1998	Inv.	NA		0.0
RBY	1998	Fish	Rubyfish	*Plagiogeneion rubiginosum*	22.9
RIB	1998	Fish	Ribaldo	*Mora moro*	1756.4
SPE	1998	Fish	Sea perch	*Helicolenus* spp.	1708.8
TRU	1998	Fish	Trumpeter	*Latris lineata*	0.0
WWA	1998	Fish	White warehou	*Seriolella caerulea*	8474.7
YEM	1998	Fish	Yellow-eyed mullet	*Aldrichetta forsteri*	0.0
SCA*	1992	Inv.	Scallop	*Pecten novaezelandiae*	0.3
CRA*	1990	Inv.	Rock lobster	*Jasus edwardsii*	0.0
PHC	1990	Inv.	Packhorse rock lobster	*Jasus verreauxi*	0.0
JMA	1987	Fish	Jack mackerel	*Trachurus declivis, T. murphyi, T. nz*	520.6
JMD	1987	Fish	Greenback jack mackerel	*Trachurus declivis*	0.0
JMN	1987	Fish	Yellowtail jack mackerel	*Trachurus novaezelandiae*	0.0
JMM	1987	Fish	Slender jack mackerel	*Trachurus murphyi*	0.0
PAU	1987	Inv.	Black paua & yellowfoot paua	*Haliotis iris & H. australis*	0.0
SQU	1987	Inv.	Arrow squid	*Nototodarus sloanii & N. gouldi*	3268.1
NOS	1987	Inv.	NZ southern arrow squid	*Nototodarus sloanii*	0.0
NOG	1987	Inv.	NZ northern arrow squid	*Nototodarus gouldi*	0.0
ASQ	1987	Inv.	NA		0.0
BAR	1986	Fish	Barracouta	*Thyrsites atun*	2989.8
BCO	1986	Fish	Blue cod	*Parapercis colias*	19.0
BNS	1986	Fish	Bluenose	*Hyperoglyphe antarctica*	196.2
BYX	1986	Fish	Alfonsino & long-finned beryx	*Beryx splendens & B. decadactylus*	208.3
ELE	1986	Fish	Elephant fish	*Callorhinchus milii*	0.0
FLA	1986	Fish	Flats		0.0
ESO	1986	Fish	N.Z. sole	*Peltorhamphus novaezeelandiae*	0.0
LSO	1986	Fish	Lemon sole	*Pelotretis flavilatus*	0.0
SFL	1986	Fish	Sand flounder	*Rhombosolea plebeia*	0.0
TUR	1986	Fish	Turbot	*Colistium nudipinnis*	0.0
YBF	1986	Fish	Yellowbelly flounder	*Rhombosolea leporina*	0.0
BFL	1986	Fish	Black flounder	*Rhombosolea retiaria*	0.0
GFL	1986	Fish	Greenback flounder	*Rhombosolea tapirina*	0.0
BRI	1986	Fish	Brill	*Colistium guntheri*	0.0
GMU	1986	Fish	Grey mullet	*Mugil cephalus*	0.0
GUR	1986	Fish	Gurnard	*Chelidonichthys kumu*	22.3
HAK	1986	Fish	Hake	*Merluccius australis*	42414.2
HOK	1986	Fish	Hoki	*Macruronus novaezelandiae*	462579.5
HPB	1986	Fish	Hapuku & bass	*Polyprion oxygeneios & P. americanus*	19.5
BAS	1986	Fish	Bass groper	*Polyprion americanus*	7.8
HAP	1986	Fish	Hapuku	*Polyprion oxygeneios*	139.8
JDO	1986	Fish	John dory	*Zeus faber*	0.0
LIN	1986	Fish	Ling	*Genypterus blacodes*	32949.2
MOK	1986	Fish	Moki	*Latridopsis ciliaris*	0.0
OEO	1986	Fish	Oreos	*P. maculatus, A. niger, & N. rhomboidalis*	0.0
BOE	1986	Fish	Black oreo	*Allocyttus niger*	1325.1
SSO	1986	Fish	Smooth oreo	*Pseudocyttus maculatus*	127.0
SOR	1986	Fish	Spiky oreo	*Neocyttus rhomboidalis*	191.6
WOE	1986	Fish	Warty oreo	*Allocyttus verrucosus*	0.0
ORH	1986	Fish	Orange roughy	*Hoplostethus atlanticus*	142.2
RCO	1986	Fish	Red cod	*Pseudophycis bachus*	909.0
SCH	1986	Fish	School shark	*Galeorhinus galeus*	238.4
SKI	1986	Fish	Gemfish	*Rexea* spp.	0.0
RSO	1986	Fish	Gemfish	*Rexea solandri*	789.0
SNA	1986	Fish	Snapper	*Pagrus auratus*	0.0
SPO*	1986	Fish	Rig	*Mustelus lenticulatus*	0.0
STA	1986	Fish	Giant stargazer	*Kathetostoma* spp.	0.0
GIZ	1986	Fish	Giant stargazer	*Kathetostoma giganteum*	1009.4
SWA	1986	Fish	Silver warehou	*Seriolella punctata*	24380.2
TAR	1986	Fish	Tarakihi	*Nemadactylus macropterus & N.* sp. (king tarakihi)	0.0
NMP	1986	Fish	Tarakihi	*Nemadactylus macropterus*	96.6
TRE	1986	Fish	Trevally	*Pseudocaranx georgianus*	0.0
WAR	1986	Fish	Common warehou	*Seriolella brama*	193.0

## 9   APPENDIX C: Model convergence diagnostics
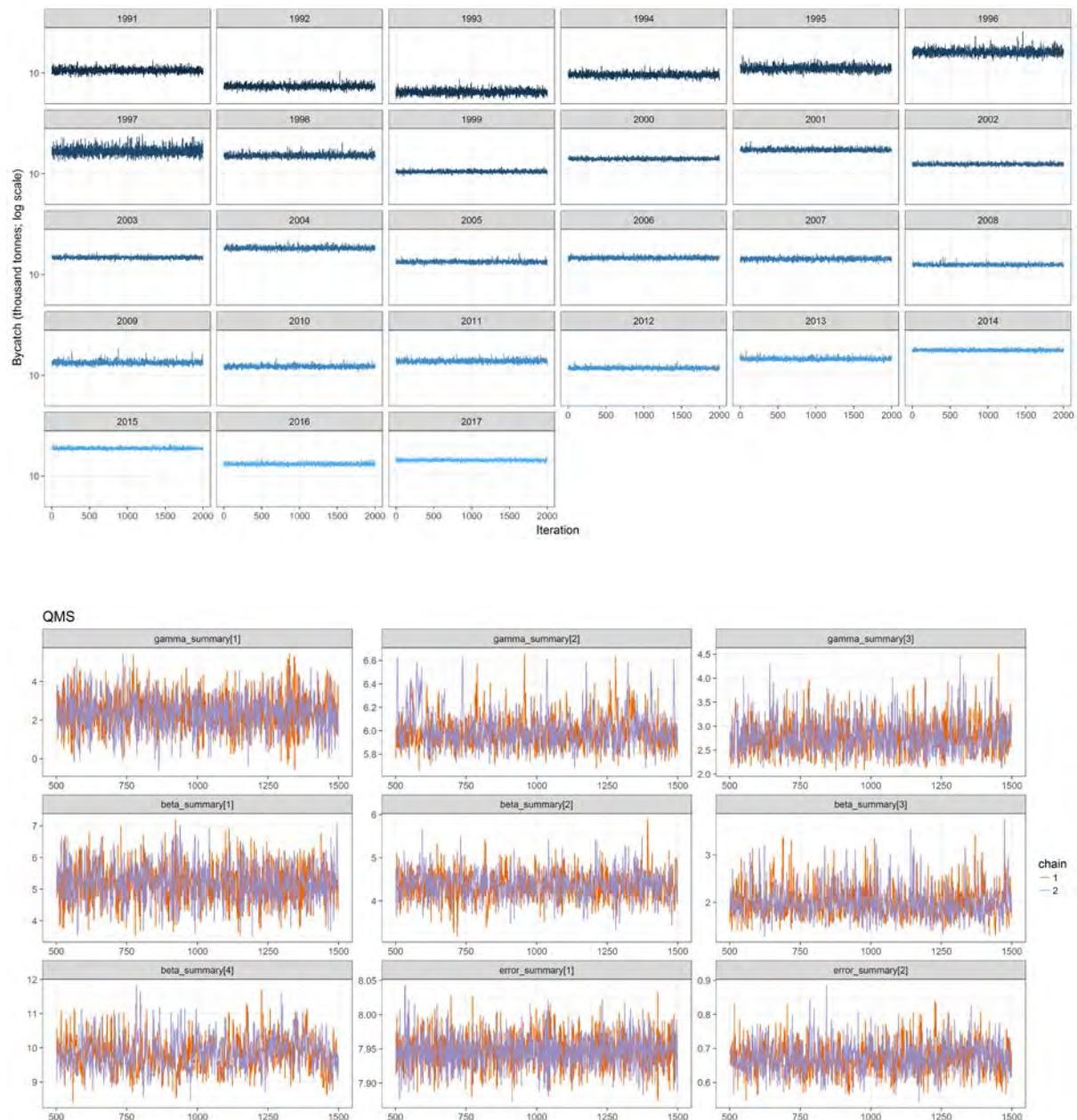
Figure C 1: Convergence diagnostics (MCMC trace plots) for estimation of QMS species bycatch. Top, annual bycatch; bottom, model parameters.
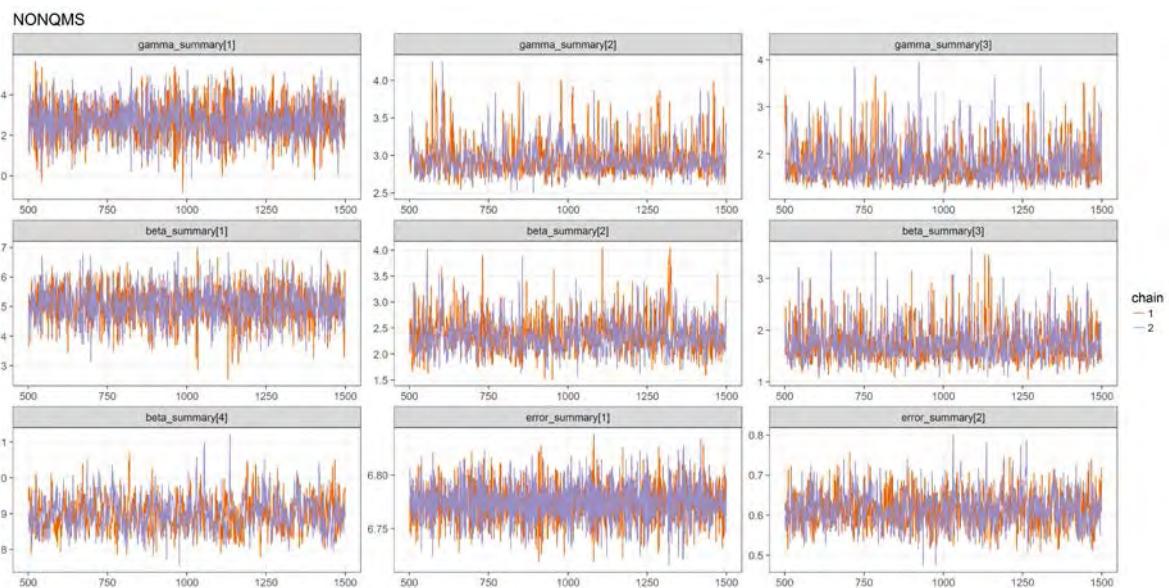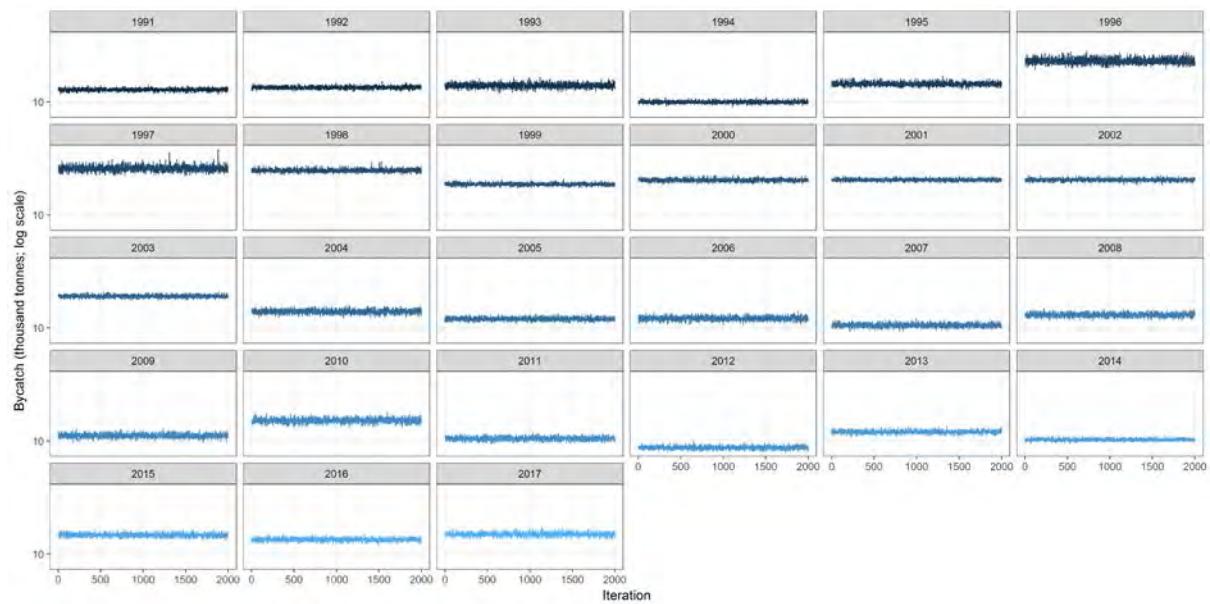
Figure C 2: Convergence diagnostics (MCMC trace plots) for estimation of non-QMS fish species bycatch. Top, annual bycatch; bottom, model parameters.
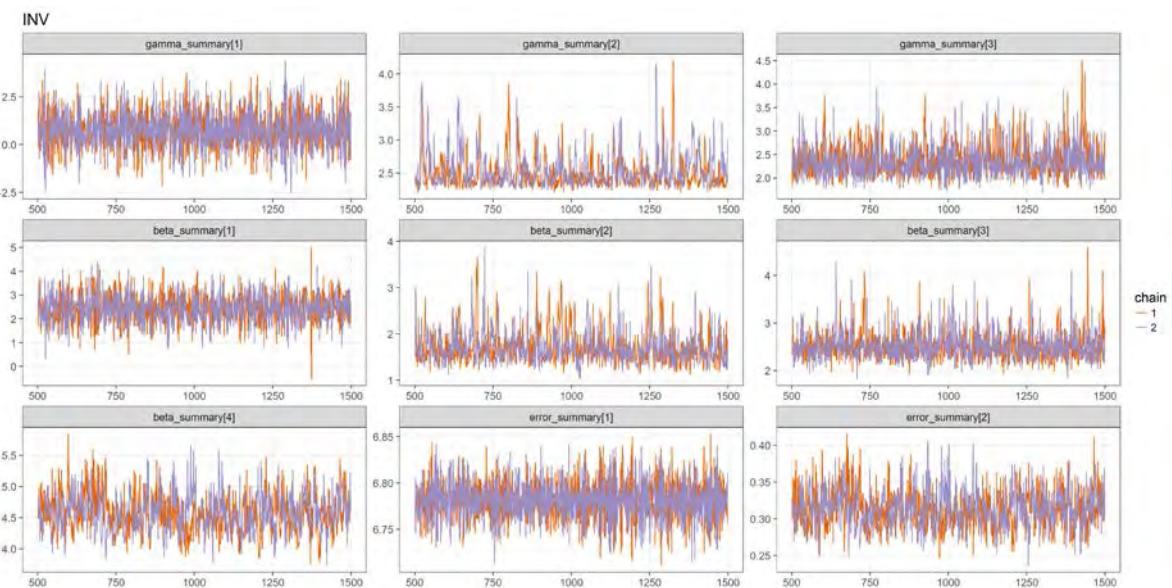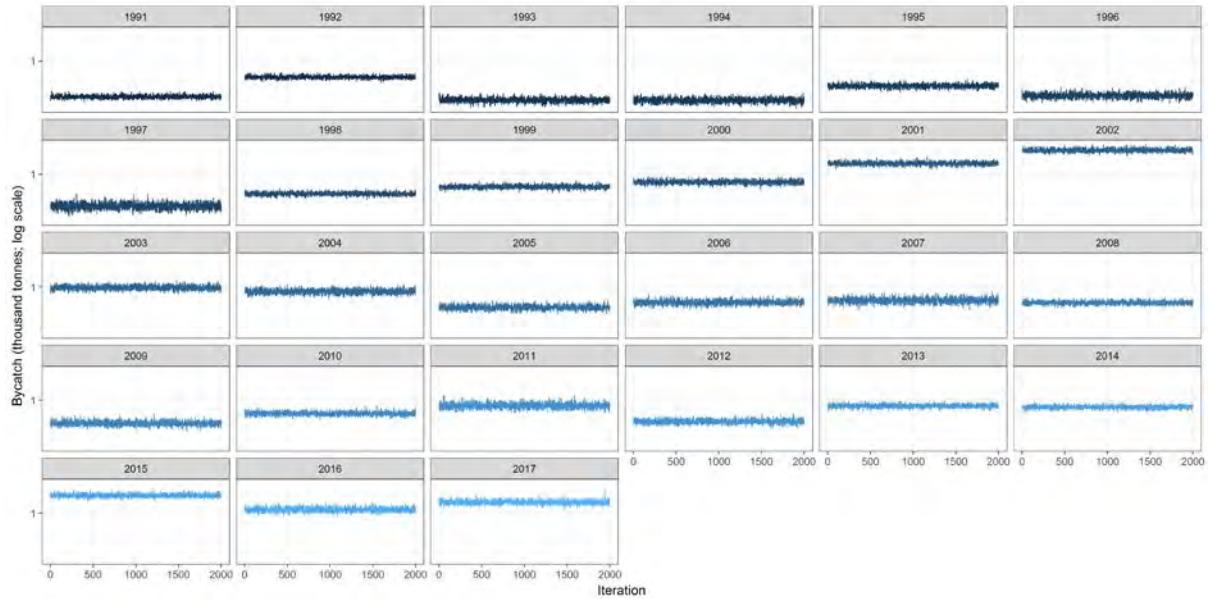
Figure C 3: Convergence diagnostics (MCMC trace plots) for estimation of non-QMS invertebrate species bycatch. Top, annual bycatch; bottom, model parameters.
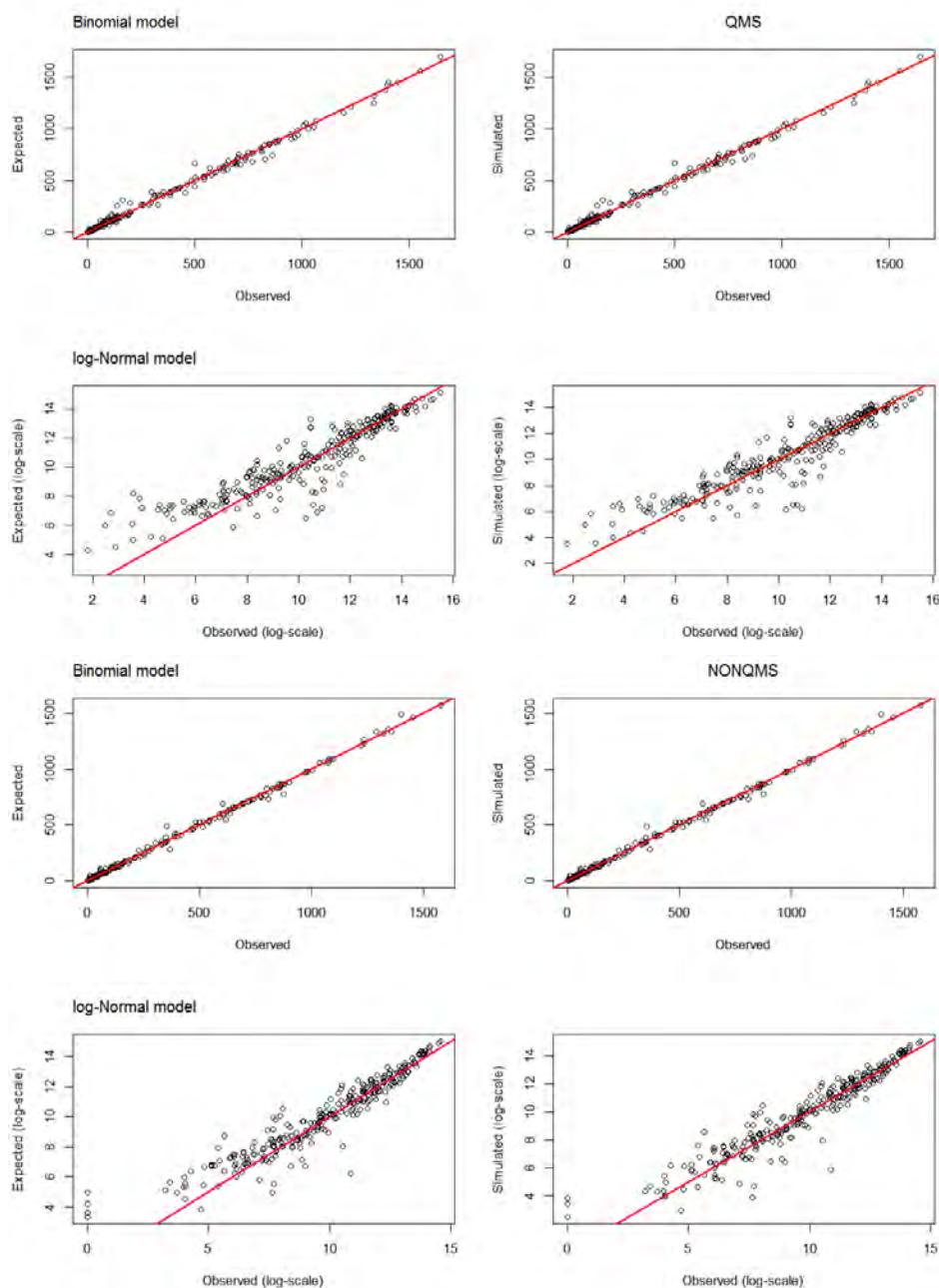
Figure C4. Comparison of the median posterior expected values and simulated predictions with the observer records for bycatch of QMS species (top) and non-QMS fish species (bottom).
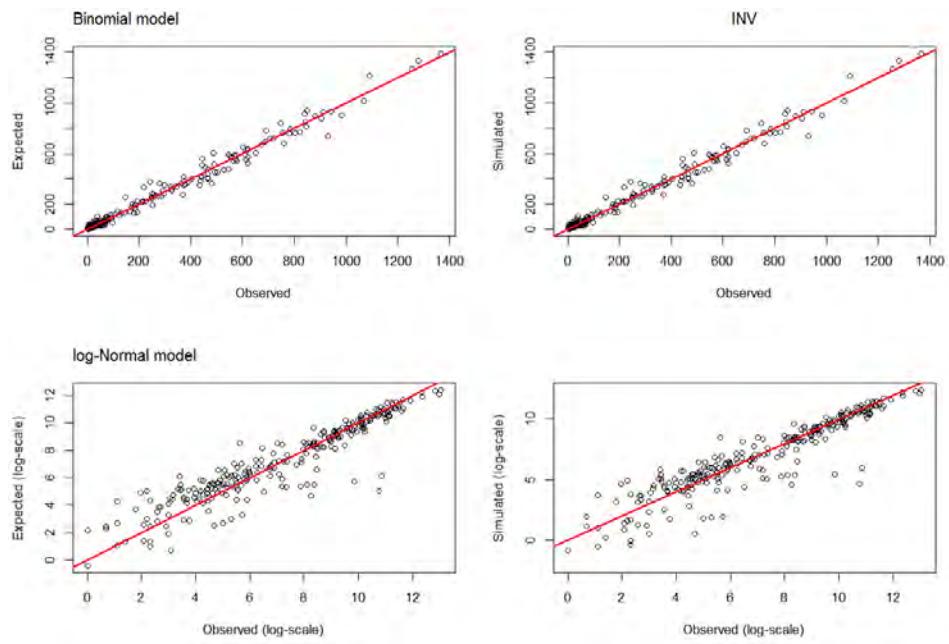
Figure C4 – continued: Non-QMS invertebrate species
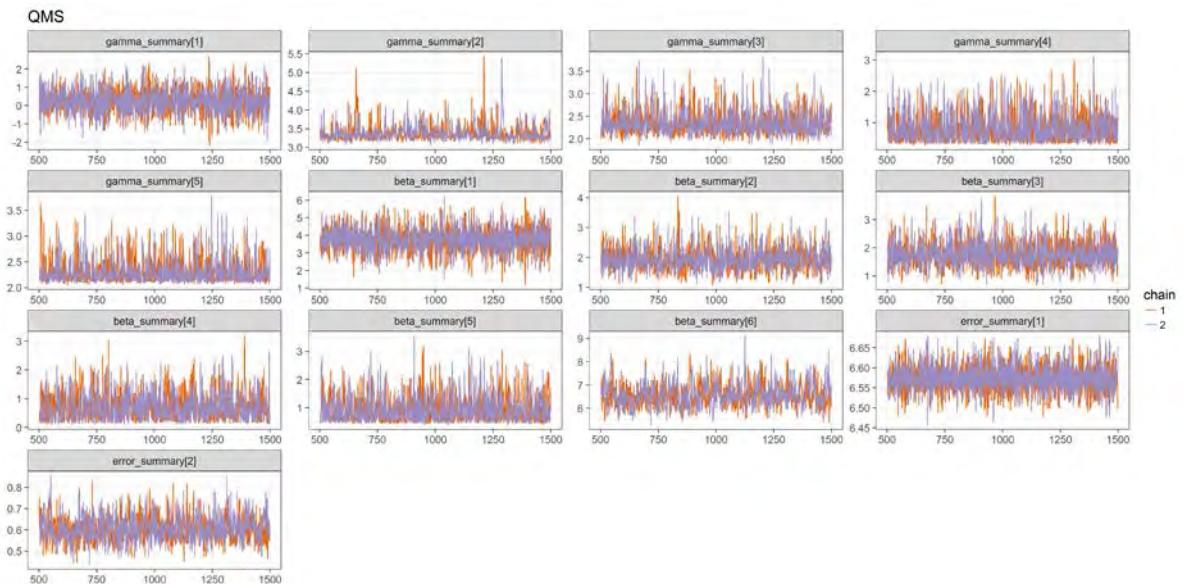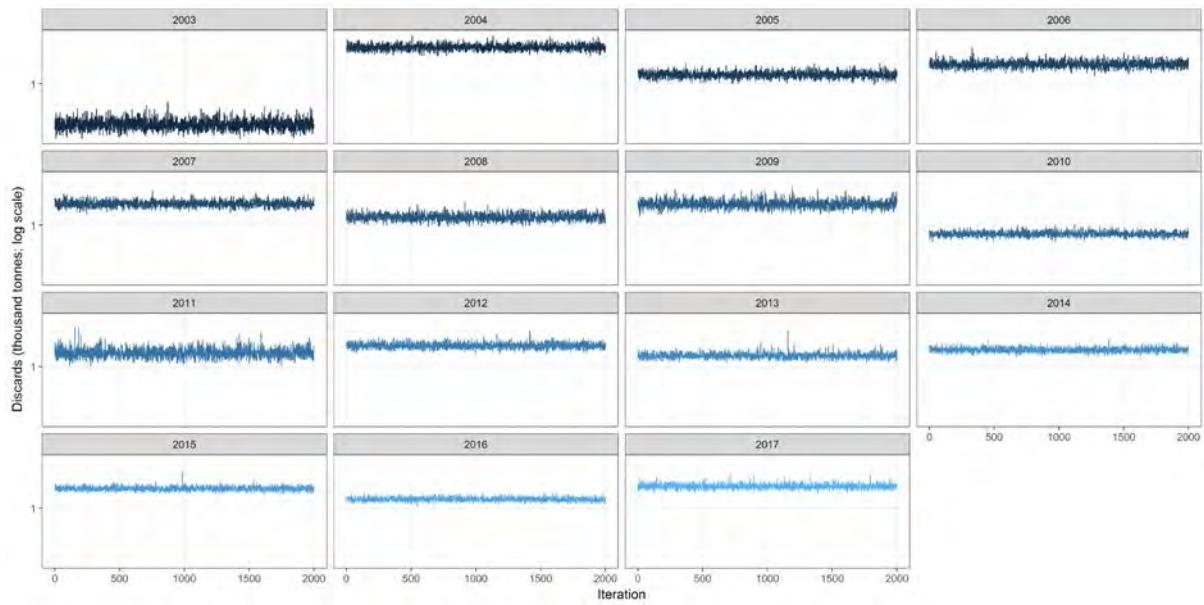
Figure C 5: Convergence diagnostics (MCMC trace plots) for estimation of QMS species discards. Top, annual bycatch; bottom, model parameters.
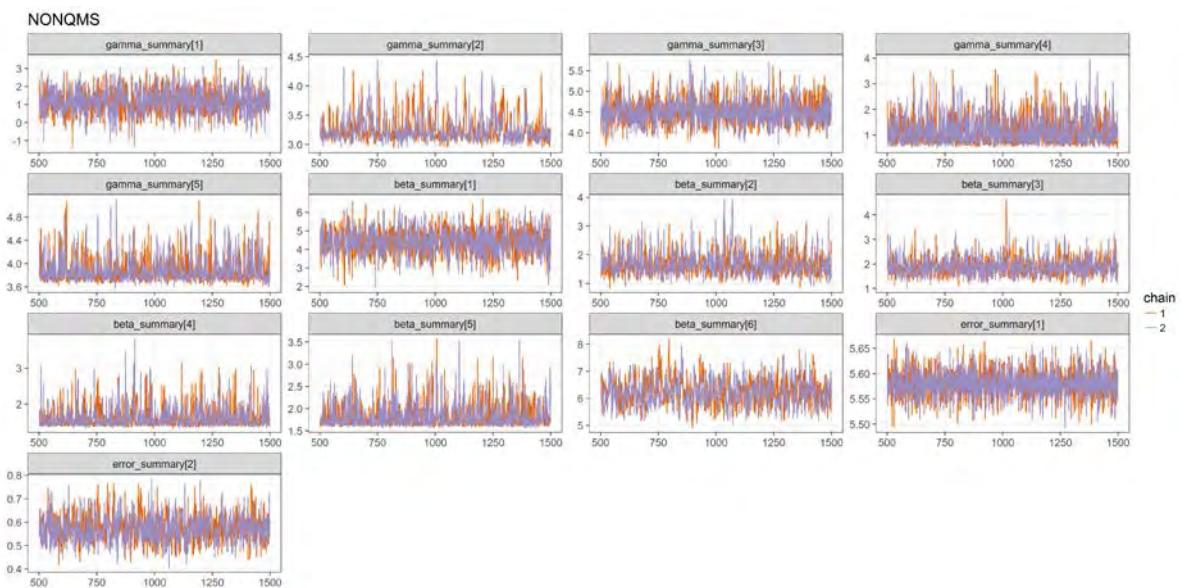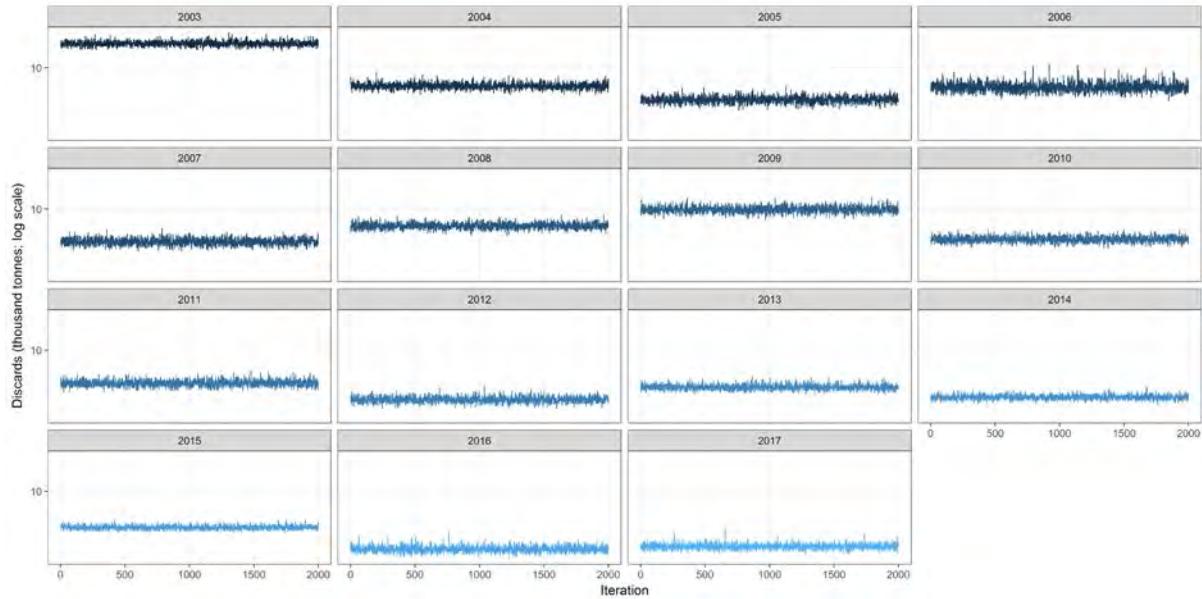
Figure C 6: Convergence diagnostics (MCMC trace plots) for estimation of non-QMS fish species discards. Top, annual bycatch; bottom, model parameters.
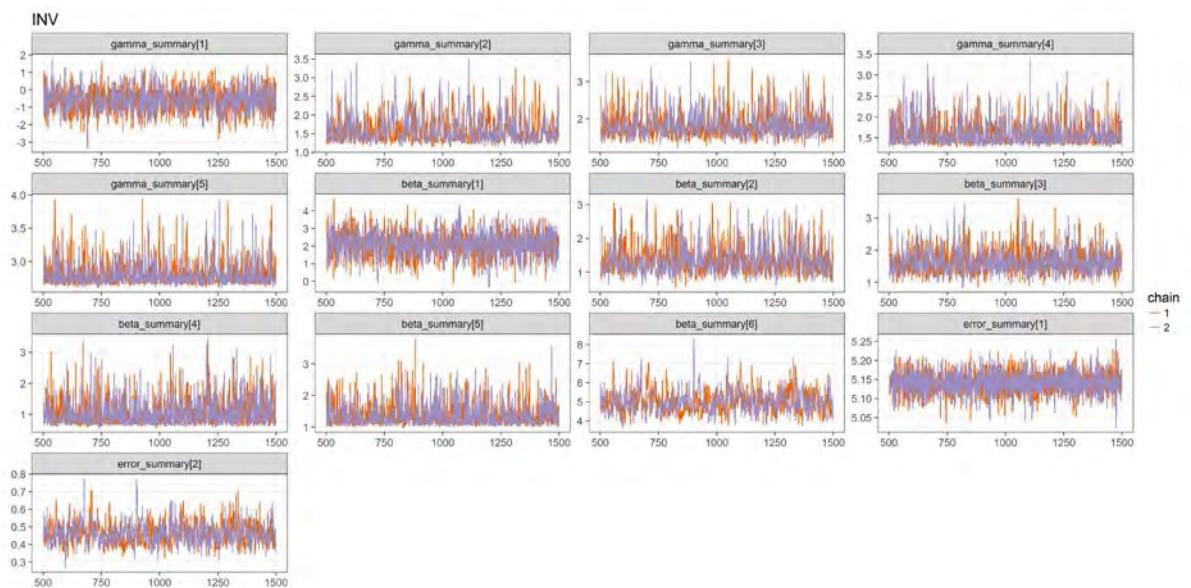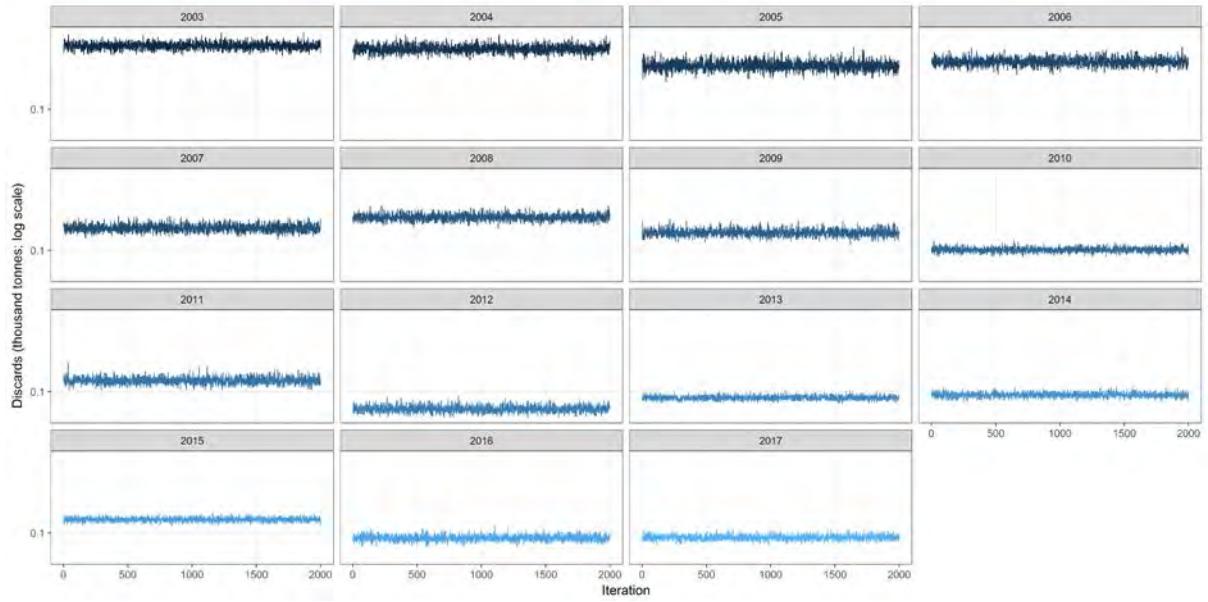
Figure C 7: Convergence diagnostics (MCMC trace plots) for estimation of non-QMS invertebrate species discards. Top, annual bycatch; bottom, model parameters.
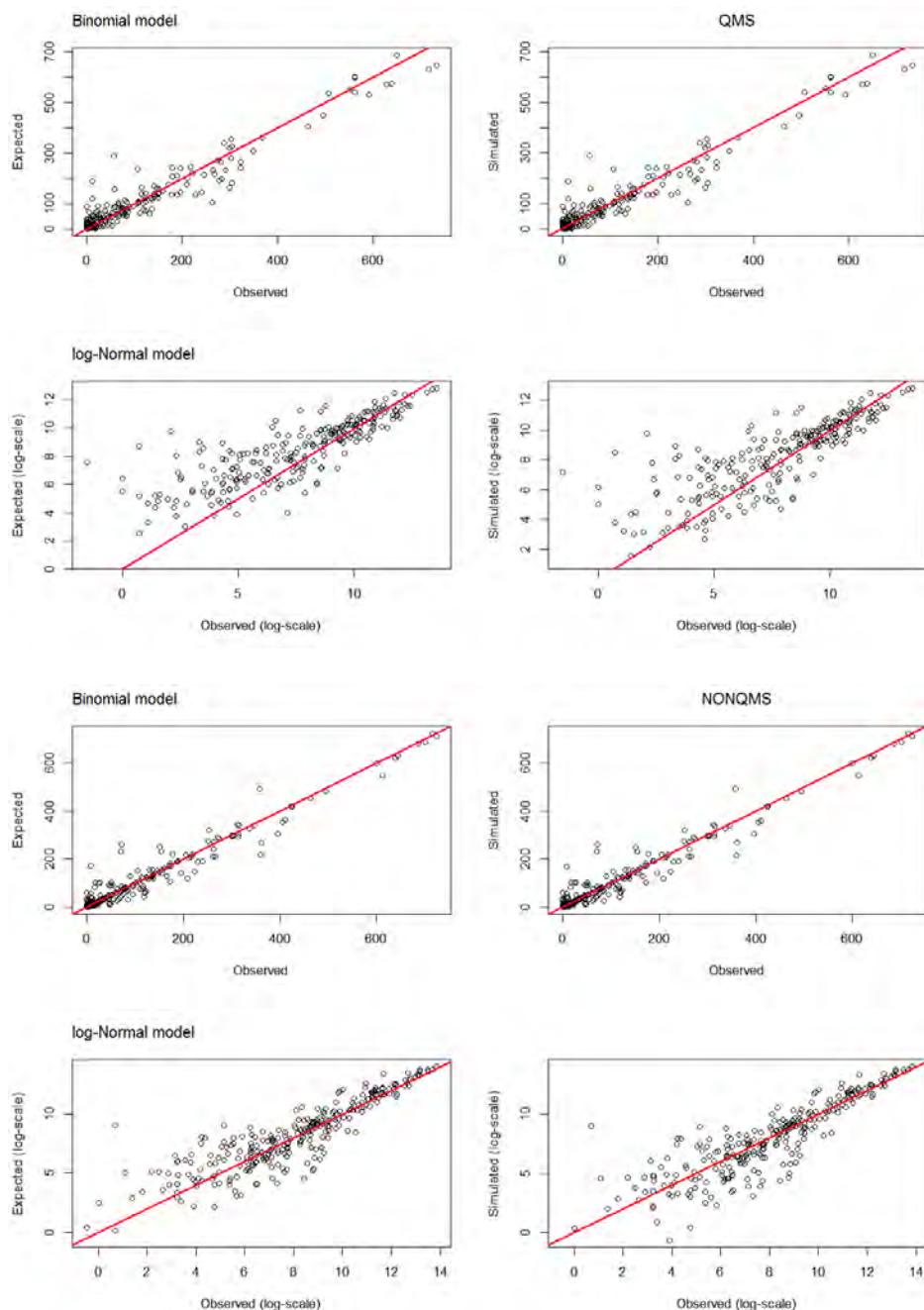
Figure C8. Comparison of the median posterior expected values and simulated predictions with the observer records for discards of QMS species (top) and non-QMS fish species (bottom).
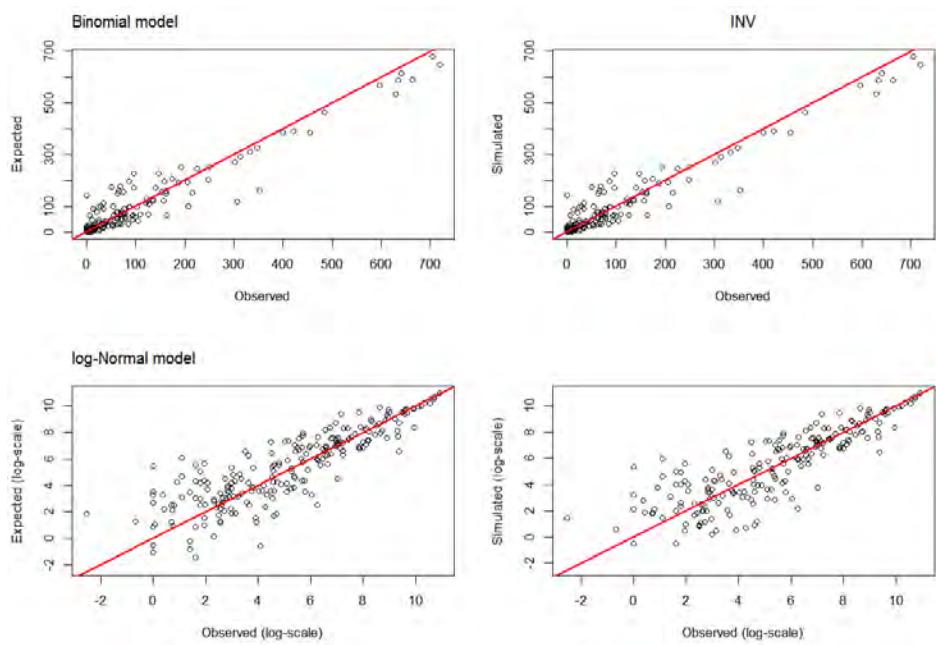
Figure C8 – Continued: Non-QMS invertebrate species