Fisheries New Zealand
Tini a Tangaroa

Non-target fish and invertebrate catch and discards in New Zealand ling longline fisheries from 2002–03 to 2017–18

New Zealand Aquatic Environment and Biodiversity Report No. 241

B. Finucci,
O.F. Anderson,
C.T.T. Edwards

ISSN 1179-6480 (online)
ISBN 978-1-99-002528-0 (online)

May 2020

New Zealand Government

Requests for further copies should be directed to:

Publications Logistics Officer
Ministry for Primary Industries
PO Box 2526
WELLINGTON 6140

Email: brand@mpi.govt.nz
Telephone: 0800 00 83 33
Facsimile: 04-894 0300

This publication is also available on the Ministry for Primary Industries websites at:
http://www.mpi.govt.nz/news-and-resources/publications
http://fs.fish.govt.nz go to Document library/Research reports

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Finucci, B.; Anderson, O.F.; Edwards, C.T.T. (2020). Non-target fish and invertebrate catch and discards in New Zealand ling longline fisheries from 2002–03 to 2017–18.

***New Zealand Aquatic Environment and Biodiversity Report No. 241.* 83 p.**

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 catch and discards in the ling longline fisheries for the fishing years from 2002–03 to 2017–18. These data represented 69 287 sets from a total of 132 vessels (observed and unobserved). 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 target species. Membership of these groups were adjusted in each year, where necessary, to match the year-of-entry of individual species into the QMS system. In addition, separate estimates of annual catch were made for several of the major individual non-target species.

Of those sets where observers were present, ling accounted for about 65% of the total estimated catch in the target fishery since 2002–03. The other main catch species were spiny dogfish (17%), ribaldo (3.3%), rough skate (2.7%), black cod (1.7%), smooth skate (1.5%), sea perch (1.4%), and pale ghost shark (1.2%). Smaller amounts of a range of other (mainly non-QMS) species including various species of cartilaginous fishes, rattails, and other bony fishes were also reported. Starfish were the only invertebrate group in the top 30 non-target taxa, accounting for <0.5% of the catch.

Total annual non-target catch was 1408–4724 t between 2002–03 and 2017–18, varying over time approximately relative to total fishing effort throughout the period. Annual non-target catch comprised predominantly QMS species (1058–3957 t), with the non-QMS species catch ranging from 600 t to 800 t. There were no strong patterns or trends detected in the amounts of non-target catch of any of the groups over time, although some increases were observed after 2014–15.

Total discard estimates varied from 188 t to 2442 t annually. Discards of ling were variable, but for most years were less than 100 t, with a minimum catch of 11 t. Discards of QMS species and non-QMS fish species followed a similar pattern to non-target catch, with increased QMS discards since 2013–14 and non-QMS fish species discards remaining stable with no trend. Discards of non-QMS invertebrate species were low and, for most of the time series, less than 5 t per year.

The discard fraction (kilogram of discards/kilogram of target species catch) showed a declining trend from a peak of 0.98 in 2006–07 to a low of 0.05 in 2012–13, but has since increased (between 0.13 and 0.31) in recent years. The overall discard fraction average was 0.36 across the whole time series, a similar estimate to that previously provided for this fishery. This estimate was low compared with most other fisheries that are monitored, which have ranged between 0.005 (southern blue whiting trawl fishery) and 3.6 (scampi trawl fishery).

1. INTRODUCTION

The Fisheries New Zealand National Deepwater Plan for 2019–20 includes the following Environment Outcome Management Objective 6: Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on associated or dependent and incidentally caught fish species (Fisheries New Zealand 2019a). This project partially addresses this objective by quantifying the level of non-target catch of species or groups of species not managed separately in the Quota Management System (QMS). Summary reports of non-target catch 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.), jack mackerels (*Trachurus* spp.), orange roughy (*Hoplostethus atlanticus*), oreos (Oreosomatidae), and the combined hoki (*Macruronus novaezelandiae*)/hake (*Merluccius australis*)/ling (*Genypterus blacodes*)/silver warehou (*Seriolella punctata*)/white warehou (*Seriolella caerulea*) trawl fishery (Anderson 2012, 2013, Anderson et al. 2017a, Anderson et al. 2017b, Anderson & Edwards 2018, Anderson et al. 2019).

Ling are widely distributed around New Zealand at depths of 200–800 m, especially south of 40° S. Bottom longlining is the method most often used when targeting ling, with much of the effort on pre-spawning and spawning aggregations, especially on the Chatham Rise. Other important line fisheries for ling exist on the west and east coasts of the South Island, off Southland, and on the Bounty Plateau (Anderson et al. 2000, Ballara 1997, Horn 2007). Line methods other than bottom longline account for only 1% of the total line catch, although a fifth of the Cook Strait line catch between 1990 and 2005 was taken on dahn lines, with trot lining sometimes used (Horn 2007). These two methods differ from bottom longlining in the configuration of the hooks, and their use has declined in this fishery (Dunn et al. 2013).

Reported annual landings from the New Zealand ling fishery declined from a peak of 20 000–23 000 t in the second half of the 1990s to 15 000–18 700 t in the four years up to and including 2017–18 (Fisheries New Zealand 2019b). Ling are mainly caught by large trawlers targeting hoki at Puysegur Bank, on the slope of the Stewart-Snares shelf, and in the Auckland Islands area; with a lesser catch from small domestic trawlers operating off the west coast South Island (WCSI) and the east coast of both main islands south of East Cape (Horn et al. 2013). 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). However, with between 16 and 35 million hooks deployed each year in the longline fishery, there remains considerable potential to make substantial catches of both ling and non-target species that are unwanted due to species, size, damage, fish hold storage limitations, or which are lost and moribund due to operational inefficiencies and the actions of predators and scavengers.

Observer and commercial catch-effort data have previously shown that ling account for between 68% and 77% of the total catch in the ling longline fishery, with the principal non-target catch species previously listed as spiny dogfish (*Squalus acanthias*), ribaldo (*Mora moro*), smooth skate (*Dipturus innominatus*), rough skate (*Zearaja nasuta*), and red cod (*Pseudophycis bachus*) (Anderson 2014). The previous analysis of non-target catch and discards in the ling longline fishery (Anderson 2014) covered the period 1992–93 to 2011–12. Using a ratio method with a number of hooks-based estimator, total annual non-target catch in the ling longline fishery was estimated to have ranged from about 1400 t to about 3800 t and total annual discards from about 200 t to about 1100 t (Anderson 2014). Annual estimates of the rate of discarding ranged from 0.19 to 0.42 kg of discards for every 1 kg of ling landed (Anderson 2014).

1.1 Objectives

This report was prepared as an output from the Ministry for Primary Industries project DAE201801 “Catch composition in deepwater fisheries” which had 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 New Zealand deepwater fisheries.

Specific objectives for year 1 (of 3)

1. To estimate the quantity of non-target fish species caught, and the target and non-target fish species discarded in the ling longline fishery, for the fishing years since the last review, using data from Ministry for Primary Industries Observers and commercial fishing returns.
2. To compare estimated rates, amounts, and trends of bycatch and discards over time in the ling bottom longline 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.

This report addresses Objectives 1 and 2 and presents revised and updated estimates of annual non-target catch and discards in the ling longline fishery for the period 2002–03 to 2017–18, using a statistical model-based estimator.

1.2 Definitions

For this study *non-target fish species catch* is equivalent to *bycatch* and includes all fish and invertebrates caught that were not ling, whether or not they were discarded (for additional details on standardised definitions, see 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 fish lost from fishing gear at the surface, but excludes fish returned to the sea alive (as recorded by observers) (see Schedule 6 species under section 2.1.1). 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 been making detailed set by set records of catch by species or species group for a portion of the ling longline fleet in each year since 1992–93. The allocation of observers on commercial vessels accounts for a range of data collection requirements and compliance issues for multiple fisheries, as well as the capacity for the vessel to accommodate additional personnel. It has therefore not always been possible to achieve a representative or random spread of observer effort in each fishery (see Section 3.1 for more details).

2.1.1 Data preparation and grooming

A dataset was prepared from the Fisheries New Zealand Centralised Observer Database (*cod*) which included all observed longline sets that targeted ling between 2002–03 and 2017–18. This dataset contained a complete set of catch-by-species for all ling-targeted longline sets. Catches in various categories not relevant to this analysis were removed from the initial extract; e.g., seaweed, birds, and rubbish. Records in these categories comprised about 0.004% of the total records.

As well as recording the catch weight (and, usually, the number of fish) for each species caught in each set, observers also usually record the discard status (discarded or retained). Discarded fish in this fishery fall into the following categories: unwanted non-QMS species, unwanted QMS species legally discarded under Schedule 6 of the Fisheries Act 1996 (e.g., spiny dogfish), unwanted QMS species legally discarded under observer authorisation, fish of any species that are lost from the hook during landing or taken by marine predators (e.g., fur seals), fish smaller than the minimum legal size (e.g., red cod shorter than 25 cm). However, due to procedural issues, this information has been entered into *cod* for only about a third of all observed sets. This is not a constant fraction over time and affects the earlier years most strongly. Before 1999–2000 there were no discard data available for any sets entered into *cod* and although there was an improvement after 1999–2000, so that by 2005–06 discards were entered for all sets, recording of discards was poor again between 2008–09 and 2011–12. This issue seems to have since been rectified, with recording of discards in close to 100% of sets in the following seven years (Figure 1).

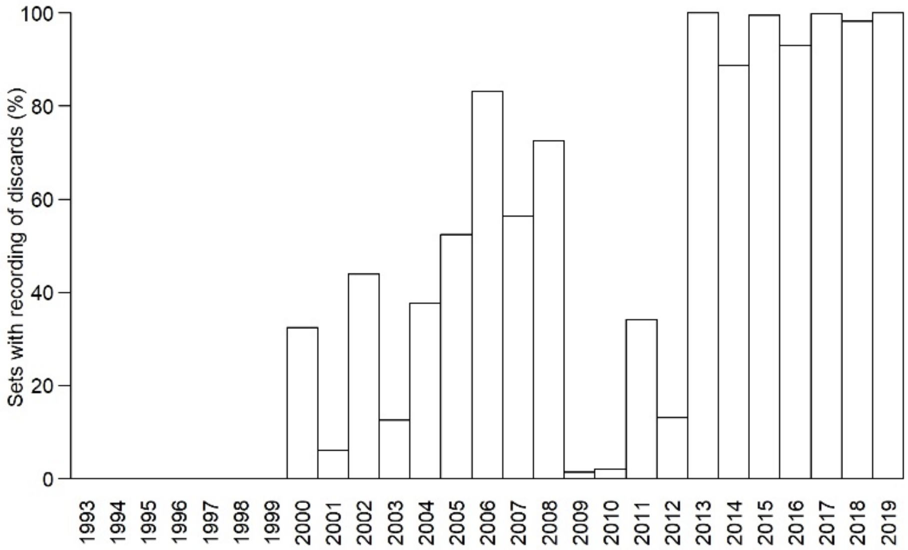

Figure 1: Percentage of observed ling longline sets in each fishing year for which discards were recorded and entered in the *cod* database,

Where discard status was recorded, it was used to determine the amount of discards by species, and these in turn were used to estimate discards for the remaining records, by calculating overall individual species discard rates and applying them to the recorded catch. These discard rates of fish and invertebrates were calculated separately for both numbers and weights, where both were recorded, and an average taken. A separate set of discard rates were similarly produced for two vessels for which landings records showed they had produced large amounts of fish meal from non-QMS species, suggesting that discards would be lower than in vessels without meal plants. These procedures gave estimated discard weights for each species formulated as a constant fraction of the catch of that species. Discard information was not available from *cod* to calculate discard fractions for all catch species recorded by observers, but most species without any direct discard data were either clearly non-commercial species and assigned a discard fraction of 1 or were a quota species which must be retained. These quota species were assigned a discard fraction of 0.012, the value calculated from the available discard data for ling (because there were too few data to accurately calculate fractions for individual species) to account for the small amount of unavoidable discarding due to lost or scavenged fish.

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 non-target species, main non-target groups, and discards.

- The bottom depth was calculated from the average of the recorded start and finish bottom depths.
- There were 10 records where number of hooks was missing for a set, and these were removed from the analysis.
- The length of each set, in kilometres, was calculated as the distance between the recorded start and finish positions. These can be considered minimum values, because sets are not always laid in a straight line, and were used primarily for identifying errors in recorded position. Records for which the start or finish position was incomplete, or where the calculated distance was greater than 50 km were identified and groomed using median imputation to substitute approximate values. This process substitutes the missing value with the median start or finish latitude or longitude for other sets by the vessel on the same day. Set lengths were then recalculated from the corrected positions.
- The 30 records where all position data were missing were removed from the analysis.
- The soak time for each set was derived from the difference between the recorded start time (when the first hook enters the water) and finish time (when the first hook leaves the water).
- Errors resulting from confusion between 12-h and 24-h clock systems were identified and rectified where required.
- Observer data were available from 39 vessels ranging in length from 12 m to 54 m. The majority of vessels (22) were autoliners (generally larger vessels able to set over 20 000 hooks per day) and were identified as such in the dataset; no vessel is identified in this report, and alphanumeric vessel codes are presented where necessary.
- Other variables were also available from observer records, such as bait type and bottom topography, and these were groomed for errors and then included in the dataset, but not subsequently used.

Using the dataset described above, the weights of species caught and discarded in each set were calculated for the following species categories. Species codes for all species listed below are defined in Tables A1 & A2 in Appendix A and Table B1 in Appendix B.

- QMS: All QMS species combined (fish and invertebrate), excluding ling. The composition of this category expanded over time as species were added to the QMS (Table B1); observers recorded 48 non-target QMS fish species and 11 non-target QMS invertebrate species in this fishery.
- Non-QMS: All non-QMS fish species combined. The composition of this category contracted over time as species were added to the QMS (Table B1); observers recorded 113 species which were non-QMS species at some time during the study period.
- INV: All non-QMS invertebrate species combined. The composition of this category contracted over time as species were added to the QMS (Table B1); observers recorded 109 INV species or species groups in this fishery.
- Schedule 6 species: QMS species which can be returned to the sea under certain circumstances. These are 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 (Subdivision Selachii): APR, BSH, BWS, CAP, CAR, CEN, CSH, CSQ, CYL, CYO, CYP, DCS, DWD, EMO, ETB, ETL, ETM, ETP, HEP, HEX, IBR, MAK, NSD, ODO, OSD, PDG, PLS, POS, RSH, SCH, SCM, SEV, SHA, SMI, SND, SNR, SOM, SOP, SPD, SPO, SQA, SSH, THR, WPS, ZAS.
- Rays (Subdivision Batoidea): BTA, BTH, DSK, ERA, LSK, OSK, PSK, RAY, RSK, SKA, SSK, STR.
- Chimaeras (Subclass Holocephali): CHG, CHI, CHP, ELE, GSH, GSP, HGB, HYB, HYD, LCH.
- Individual species/species complexes that comprised the main observed non-target species, i.e., HOK, HAK, LIN, RIB, SPE, SCH, GSH, GSP, SND, RCO, HCO, OSD, BSH.

The above abbreviations and group names (QMS, non-QMS, INV) 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).

Summaries of the observed catch and percentage discarded of individual species, broad taxa, and species categories are tabulated in Tables A1–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 12063. These data included all fishing and landing events associated with any longline fishing trip that reported any positive catch or landing of ling (LIN) between 1 October 2002 and 30 September 2018. Fishers recorded these data on the following form types: Catch, Effort and Landing Returns (CELRs), Lining Catch, Effort Returns (LCERs), and Lining Trip Catch, Effort Returns (LTCERs). Data were groomed for errors using checking and imputation algorithms developed in R (R Core Team 2018). Set position, length, duration, depths, and number of hooks were all groomed in this manner, primarily employing median imputation and range checks to identify and deal with missing or unlikely values and outliers (see Dunn et al. 2013 and Horn & Ballara 2012 for more details on the procedures used). These groomed records represented 69 287 sets from 132 vessels.

Groomed commercial catch data were used to directly estimate the total annual non-target catch in the fishery, because both the total catch and target species catch (unless the species catch was not included in the top five species by weight and therefore generally small) were recorded for each set. These estimates were provided here for comparison with the observer-based estimates and, in contrast to the observer-based estimates, no scaling was required because the data set was effectively complete. However, a study of the New Zealand ling longline fishery, which compared commercial catch reports between observed and unobserved vessels, casts some doubt on the use of this approach due to high levels of under-reporting and non-reporting of non-target species (Burns & Kerr 2008). For example, the authors found that only a quarter of the catch of the main non-target species (spiny dogfish) was reported between 2001 and 2004. Because only the top five or eight species by weight were recorded, it is not possible to properly estimate the non-target of individual species or species groups with this method.

2.3 Stratification

Fishing area, used as a predictor variable, has proved to be an important driver of non-target catch and discard rates in all New Zealand offshore fisheries examined, and it is becoming increasingly useful for these analyses to also provide breakdowns for standardised fishery areas (see e.g., Anderson & Edwards 2018, Anderson et al. 2019). The set of standard areas used in the 2018 Aquatic Environment and Biodiversity Annual Review (Ministry for Primary Industries 2018) were adopted for this study (Figure 2) and longline sets were assigned to areas using reported position data or General Statistical Area. This stratification varies slightly from the previous iteration of this work (Anderson 2014), which incorporated ling Fisheries Management Areas. Therefore fishing year and area were selected as the primary strata for analyses, with additional variables included as appropriate. The number of longline sets observed in each area in each year is given in Table 1.

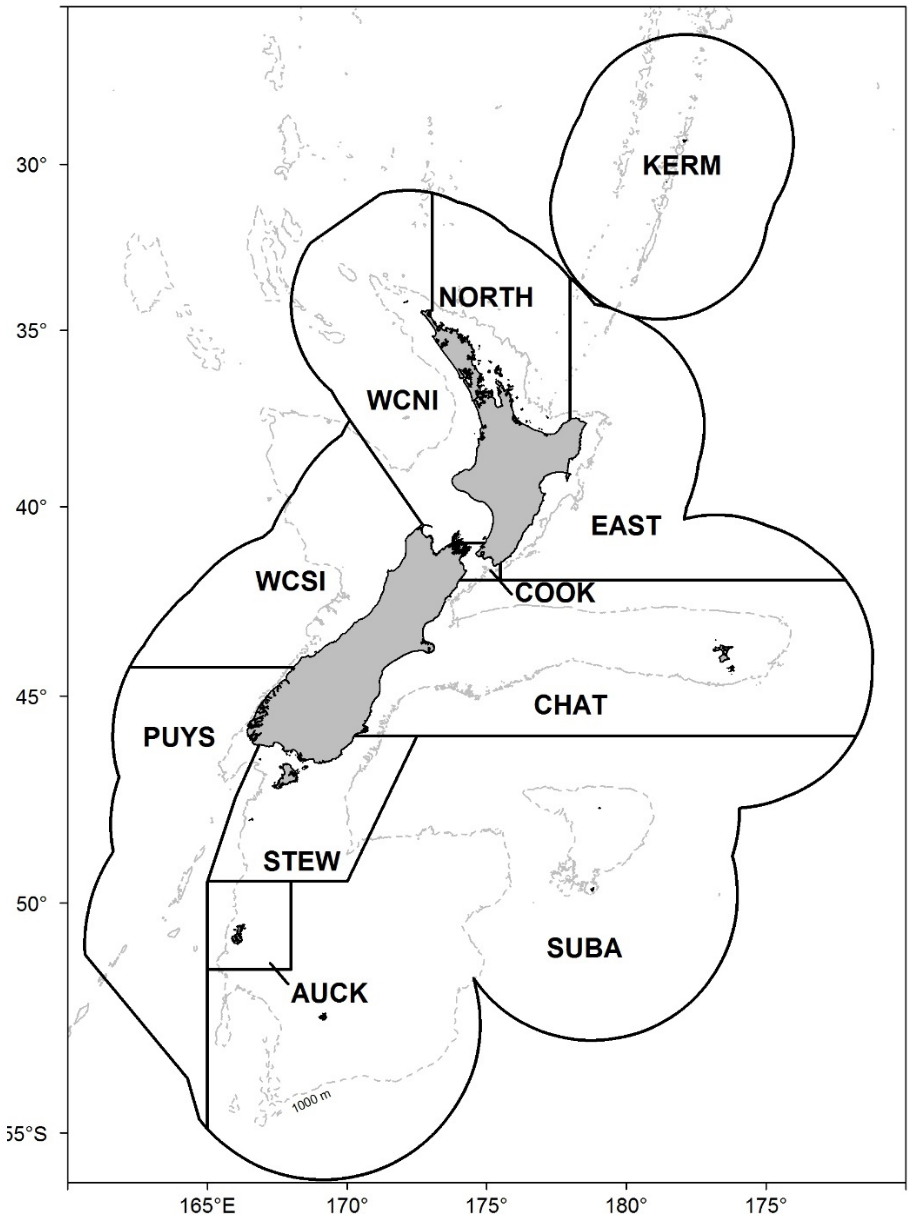

Figure 2: Areas used for estimation of total non-protected fish and invertebrate non-target catch in offshore fisheries: KERM, Kermadec region; NORTH, Northern North Island; WCNI, west coast North Island; EAST, east coast North Island; COOK, Cook Strait; WCSI, west coast South Island; CHAT, Chatham Rise; PUYS, Puysegur; STEW, Stewart-Snares shelf; AUCK, Auckland Islands; SUBA, sub-Antarctic. The grey lines indicate the 1000 m isobath.

Table 1: Number of observed longline sets targeting ling by area (see Figure 2 for area boundaries) and fishing year.

Fishing year	CHAT	COOK	EAST	NORTH	PUYS	AUCK	STEW	SUBA	WCNI	WCSI	All areas
2003	722	10	21	0	0	0	224	618	0	8	1 603
2004	218	0	0	0	43	13	139	327	0	19	759
2005	117	0	0	29	57	0	16	105	0	0	324
2006	233	122	37	0	0	0	170	0	0	0	562
2007	82	76	47	75	88	0	26	0	20	0	414
2008	261	1	1	9	18	0	13	173	0	0	476
2009	359	0	0	0	0	0	1	144	0	0	504
2010	0	0	0	0	0	29	99	69	0	0	197
2011	196	0	0	0	1	1	0	65	0	0	263
2012	0	0	0	0	0	46	4	134	0	35	219
2013	53	0	0	0	0	0	0	0	0	0	53
2014	259	0	0	0	2	9	22	97	0	0	389
2015	108	5	3	0	0	0	0	0	0	65	181
2016	299	0	62	0	4	0	28	0	0	14	407
2017	214	5	46	0	11	0	32	125	9	11	453
2018	490	24	0	0	5	65	9	38	0	35	666
Sum	3 611	243	217	113	229	163	783	1 895	29	187	7 470

2.4 Calculation of non-target catch and discards

Previous iterations (e.g., Anderson 2014) used a ratio-based method to estimate non-target catch: revised estimates of non-target catch and discards were provided based on the two-part, binomial/log-normal statistical model proposed and justified by Edwards et al. (2015). The model was fitted to set-by-set observer sampling data (with catch recorded in kg) using a Bayesian estimation framework. Estimated parameters were then used to predict the catch for unobserved commercial fishing effort (e.g., Anderson et al. 2019).

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

$$n_j \approx r_j + o_j$$

with the approximation necessary because of occasional double counts.

The observed zero/non-zero data are 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 (i.e., if the observed catch is greater than zero).

The positive catch data are included on a set-by-set basis, which is necessary for estimation of the standard error term σ. For observer record *i*:

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

For the binomial model part, the regression is:

$$\text{logit}(\theta_j) = \gamma_0 + \boldsymbol{x}_j^{\mathsf{T}}.\boldsymbol{\gamma}$$

where $\boldsymbol{x}_j^{\mathsf{T}}$ represents a row of discrete covariates from the design matrix. For the log-normal model part, the regression includes the number of hooks h as a continuous covariate:

$$\ln(\mu_{ij}) = \beta_0 + \boldsymbol{x}_j^{\mathsf{T}}.\boldsymbol{\beta} + \beta_h.\ln(h_{ij})$$

For the current analysis, the following discrete covariates were included: fishing year, standard area, and fishing method. For the log-normal model part, a year/area interaction was also included as a random effect. Furthermore, a standard error per year was estimated to account for changes in data quality over time, giving it a hierarchical structure.

The two-model parts are independent, giving the full likelihood per strata as:

$$L(\boldsymbol{\gamma},\boldsymbol{\beta},\sigma) = \prod_{i=1}^{o_j}\left\{(1-\theta_j).I(X_{ij}=0) + \theta_j.f_{LN}(X_{ij}|X_{ij}>0,\mu_{ij},\sigma)\right\}$$

where $f_{LN}(.)$ is the probability density function of a log-normal distribution evaluated at X_{ij} and θ_j is the probability mass function of a Bernoulli distribution evaluated at one (i.e., the probability of a positive catch).

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 for the modelling of species groups that did not change over time (e.g., sharks or 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 unobserved effort records cannot be matched, the residual effort is calculated on an aggregated scale by model strata (i.e., using the sum of the unobserved effort for a particular strata). For strata j, the residual effort is:

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

At this aggregated scale, it is necessary to simulate 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} are treated as known, giving the total predicted catch per stratum as:

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

The $\tilde{Z}_j$ are 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 $\{\boldsymbol{\gamma}_{(p)}, \boldsymbol{\beta}_{(p)}\}$ values are generated for $\{\theta_{j(p)}, \mu_{ij(p)}\}$, and then the catches are simulated. First, the number of positive tows from the Binomial distribution:

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

and then:

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

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

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

which yields a posterior distribution of the predicted total catch.

Performance of the model was diagnosed first by assessing convergence of the estimation routine. This was done through visual inspection of the Markov chain Monte Carlo (MCMC) trace outputs. Second, prediction by the fitted model (i.e., its suitability for estimation of unobserved bycatch or discards) was assessed using the posterior distribution of expected values. For the binomial model, the expected value for a particular posterior draw is:

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

and for the lognormal model part:

$$\mathrm{E}\left[Z_{j(p)}\right] = \theta_{j(p)} . \exp(\mu_{j(p)} + \log\left(o_j\right) + \sigma^2_{(p)}/2)$$

generating a distribution of expectations for each model part. These were compared with the observed values.

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

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

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

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

This was important for model convergence, particularly for the model runs with small quantities of data, because 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.

Precision estimates (CVs) were calculated using the Michaelis-Menten equation (Michaelis & Menten 1913):

$$CV = \sqrt{(E^{((\log(x)-\log(y))/4)2} - 1)}$$

where E is the point estimate and x and y are the upper and lower 95% confidence intervals.

2.5 Analysis of temporal trends in non-target catch and discards

Annual estimates of non-target catch and discards for all species and for the key combined species categories (with confidence intervals) were plotted for the time series examined. In addition, annual non-target catch 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.

3. RESULTS

3.1 Distribution and representativeness of observer data

Nearly 70 000 longlines were set by 132 vessels between the 2002–03 and 2017–18 fishing years (Table 2, Table 3). Observer coverage was highest at the beginning of the time series, when there were relatively fewer vessels in the fishery (14 in 2002–03 compared with a maximum of 60 in 2014–15). The overall average observer coverage included 17% of ling catch, 12% of sets, and 17% of hooks observed (Table 2). Observer coverage in the ling longline fishery has varied through time but in most years, especially before 1999–2000 (Anderson 2014) and after 2005–06, it represented less than 15% of the total target species catch from the fishery with the exception of the last year in the time series. Fishing effort has increased across the time series; the number of sets has increased from < 2 000 sets up until 2007 to over 5 000 sets since 2014, while the number of hooks has also increased from an average of ~17 500 hooks to >20 000 hooks in the first and second halves of the time series, respectively.

Observer coverage was generally low relative to most of the offshore trawl fisheries observed. For a period of several years in the early 2000s, however, a high level of coverage was achieved, frequently representing over 20% (and up to a maximum of 69%) of the total target species catch from the fishery. Observer coverage has been reasonably well spread over the spatial extent of this fishery, with observer coverage highest among the sub-Antarctic (SUBA, 27%) and Stewart-Snares shelf (STEW, 28%) (Table 3). Coverage was relatively low in the east coast North Island (EAST), west coast North Island (WCNI), and Northland (NORTH) areas. In general, these areas with low coverage were fished by smaller vessels that would not normally be able to carry observers. These areas also attributed to small proportions of the total effort of the fishery (Table 3).

Table 2: Summary of all effort and estimated target catch (t) in the ling longline fishery for observed sets and overall, by fishing year.

Fishing year	No. of sets Obs	No. of sets All	No. of hooks ('000) Obs	No. of hooks ('000) All	No. of vessels Obs	No. of vessels All	Ling total catch (t) Obs	Ling total catch (t) All	Percentage observed Sets	Percentage observed Hooks	Percentage observed Catch
2002–03	1 603	2 696	11 299	17 092	8	14	2 572	3 733	59.5	66.1	68.9
2003–04	759	3 178	5 695	22 674	8	11	1 189	3 881	23.9	25.1	30.6
2004–05	324	2 690	2 646	18 534	4	9	582	3 343	12	14.3	17.4
2005–06	562	2 229	3 611	13 728	2	8	924	2 471	25.2	26.3	37.4
2006–07	414	2 545	2 180	13 828	7	11	502	2 484	16.3	15.8	20.2
2007–08	476	4 807	3 237	18 756	8	51	772	4 679	9.9	17.3	16.5
2008–09	504	4 303	3 740	17 414	4	50	991	3 942	11.7	21.5	25.1
2009–10	197	4 737	1 718	18 355	1	52	511	4 491	4.2	9.4	11.4
2010–11	263	5 761	1 391	18 263	4	55	205	3 840	4.6	7.6	5.3
2011–12	219	4 635	1 704	16 961	3	51	418	4 222	4.7	10	9.9
2012–13	53	4 088	227	12 911	1	48	119	3 823	1.3	1.8	3.1
2013–14	389	5 728	2 069	21 688	7	54	346	5 185	6.8	9.5	6.7
2014–15	181	5 087	663	19 407	5	60	152	4 184	3.6	3.4	3.6
2015–16	407	5 614	2 110	23 558	7	51	312	4 774	7.2	9	6.5
2016–17	453	5 757	3 872	26 730	8	49	823	5 671	7.9	14.5	14.5
2017–18	666	5 432	5 191	22 311	9	45	1 007	5 199	12.3	23.3	19.4
All years	7 470	69 287	51 354	302 210	34	132	11 426	65 921	10.8	17	17.3

Table 3: Summary statistics for the ling target longline fishery, by area, including observer coverage and major data quality factors for 2002–03 to 2017–18 (e.g., number of sets with positional data). There was no reported fishing in the Kermadec region (KERM). The area divisions are shown in Figure 2.

Area	Median vessel length (m)	Total effort Number of sets	Total effort Number of hooks ('000)	Total effort Percent of sets observed	Percent of sets with position data	Percent of sets by vessels not observed
CHAT	34.6	31 378	163 971	11.5	94.9	2.7
SUBA	46.5	7 090	59 466	26.7	81.0	0.0
EAST	18.3	12 440	20 121	1.7	98.6	58.1
STEW	46.5	2 769	18 340	28.3	85.1	2.8
WCSI	17.7	6 145	13 671	3.0	46.3	96.6
PUYS	19.2	2 459	10 297	9.3	91.8	47.0
COOK	22.5	1 802	6 071	13.5	99.3	32.7
NORTH	21.3	2 711	4 527	4.2	99.3	51.9
WCNI	23.8	2 209	3 255	1.3	100	23.8
KERM	NA	NA	NA	NA	NA	NA

The spatial distribution of target line fishing effort between 1 October 2002 and 30 September 2018 is shown for all commercial sets and all observed sets in Figures 3a–3c. Observer coverage was well spread across fisheries in the Chatham Rise and sub-Antarctic areas, with little coverage of the smaller fisheries around the North Island and off the west coast South Island (Table 3). The spatial pattern of fishing effort and associated observer coverage was relatively constant in earlier years, but overall observer coverage decreased considerably between 2010 and 2013 and was absent around the North Island and Bounty Plateau. Representative spatial observer coverage has since increased in recent years, but is still mostly absent from around the North Island.

To more objectively assess spatial observer coverage, a comparison of the latitude and longitude of observed sets with all commercial sets recorded with position data was produced using density plots (Figure 4). These plots show that the spread of observed sets over the longitudinal and latitudinal extent of the fishery was well matched for all years combined, although regions centred between 45° S and 40° S (relating to the centre of effort on Chatham Rise) were slightly over-represented by observer sampling in all periods. Comparisons made between vessel sizes in the commercial fleet and the observed portion (5) showed that, across all years, observer coverage of sets was over-represented in vessels over 40 m in length and particularly under-represented in vessels up to about 30 m in length.

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 sets per day (Figure 6). The commercial ling longline fishery has been evenly spread over the fishing year, but with usually slightly more effort at the beginning and end of the fishing year. In recent years, observer coverage tended to over-sample these time periods, with a lesser extent of observer coverage between the months of December and April. For all years combined, however, the observer coverage closely matched the overall temporal spread of the commercial fishery (all years combined).

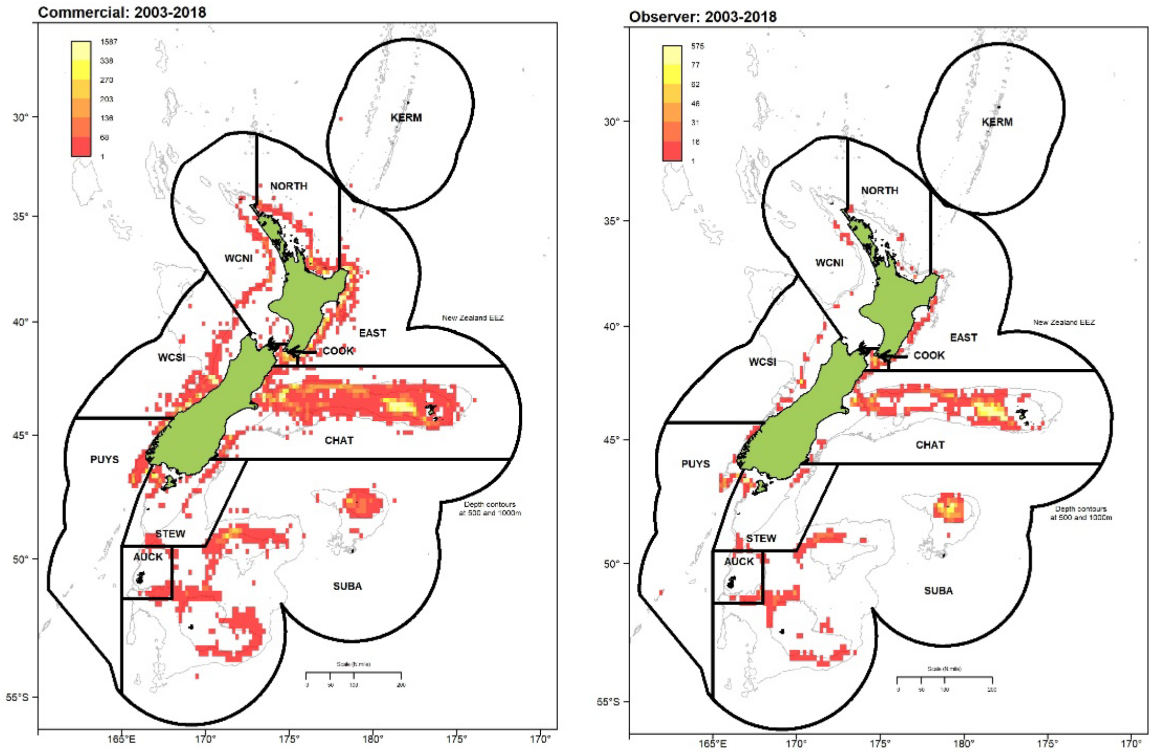

Figure 3a: Density plots showing the distribution of all commercial ling target sets with recorded position data (left) and all such sets recorded by observers (right), for fishing years 2003 (2002–03) to 2018 (2017–18). The legend indicates the average number of sets per year in each 0.2˚ cell; solid lines mark the boundary of the EEZ and areas used in the analyses; the dotted line shows the approximate 1000 m isobath.

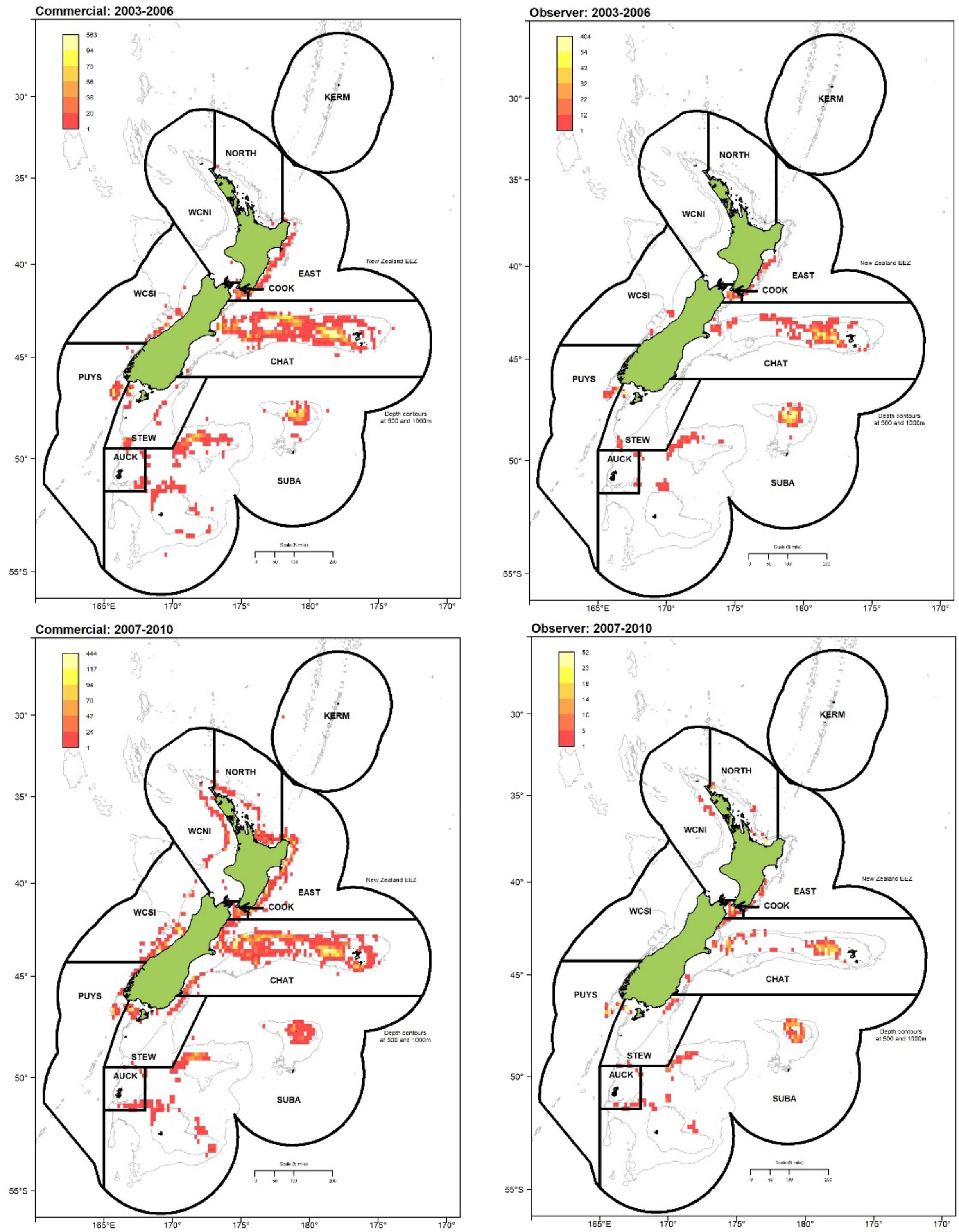

Figure 3b: Density plots showing the distribution of all commercial ling target sets with recorded position data (left) and all such sets recorded by observers (right), by blocks of fishing years. The legend indicates the average number of sets per year in each 0.2° cell. See Figure 3a caption for more details.

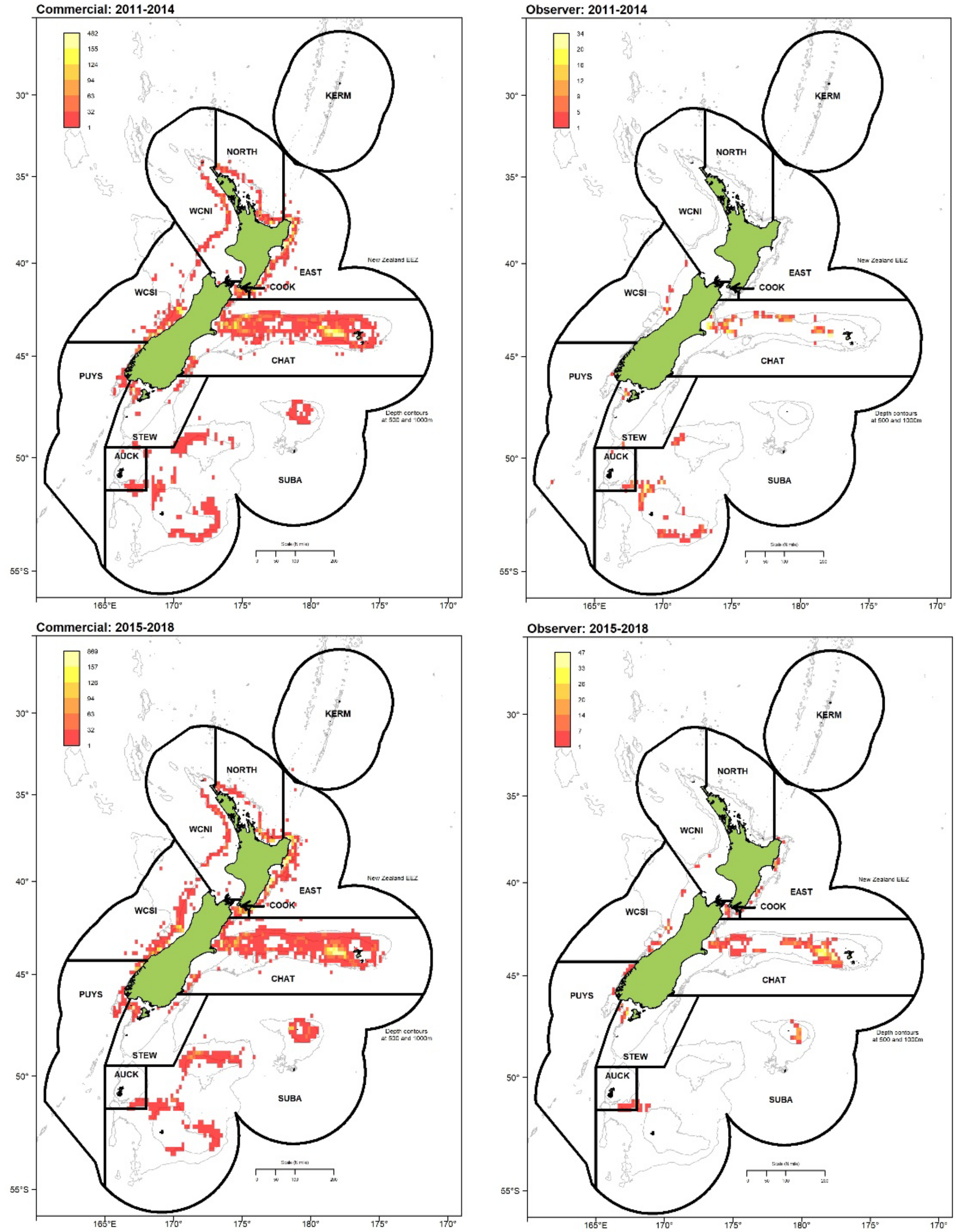

Figure 3c: Density plots showing the distribution of all commercial ling target sets with recorded position data (left) and all such sets recorded by observers (right), by blocks of fishing years. The legend indicates the average number of sets per year in each 0.2˚ cell. See Figure 3a caption for more details.

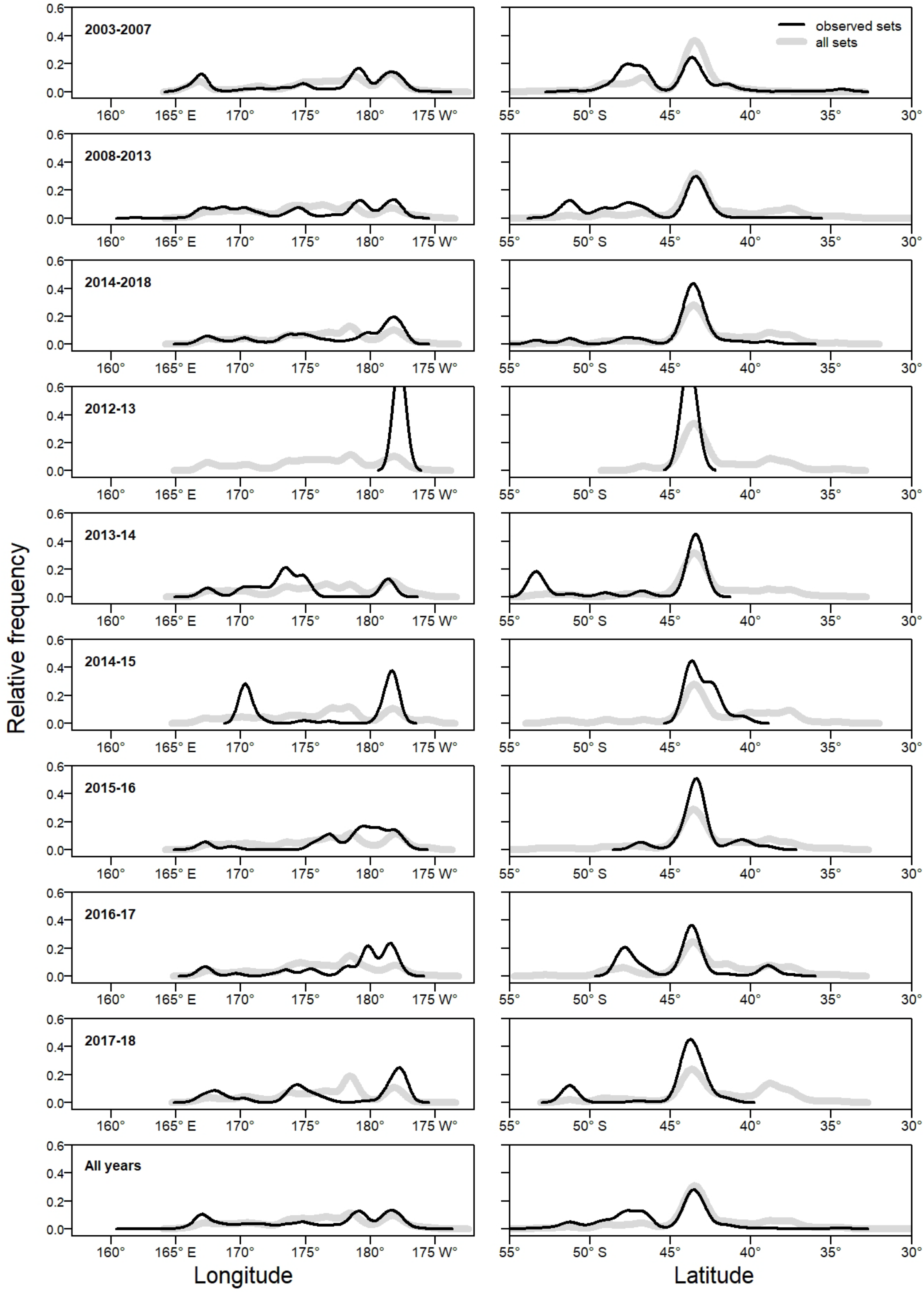

Figure 4: Comparison of start positions (latitude and longitude) of observed sets with those of all commercial set in the ling target longline fishery, by blocks of fishing years from 2003 to 2018, for individual fishing years from 2013 onwards, and for all years combined. The relative frequency was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.

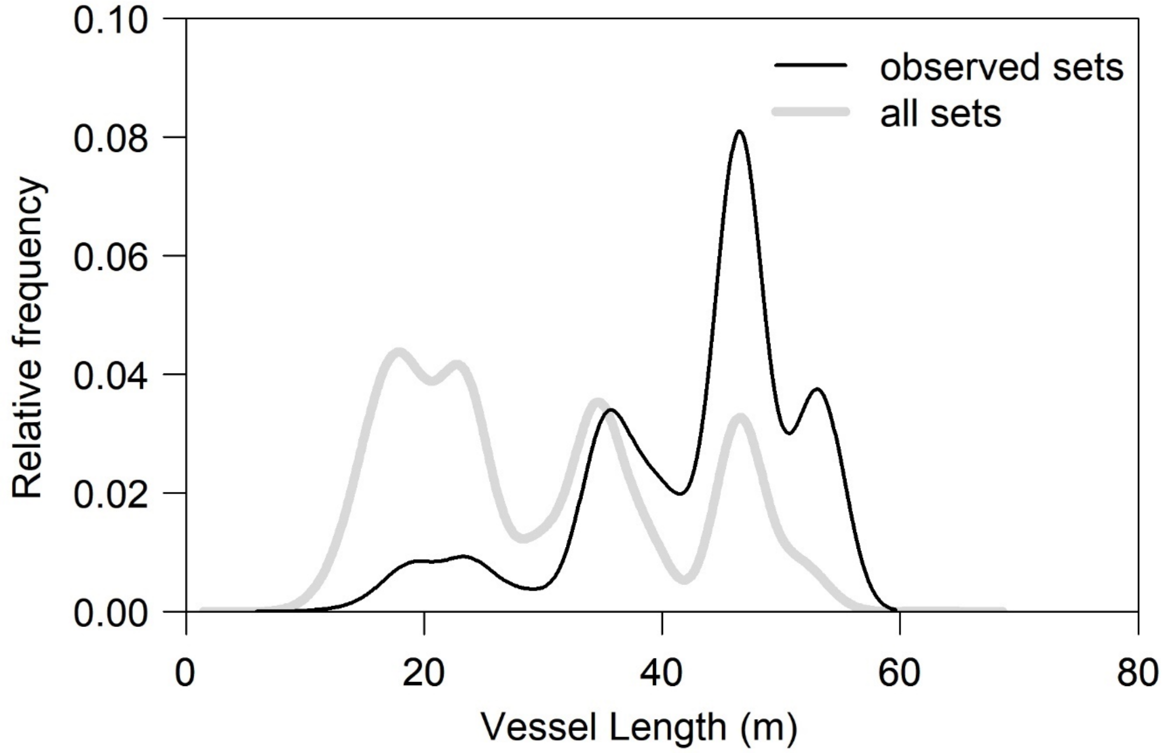

Figure 5: Comparison of vessel length (m) in observed sets versus all recorded commercial sets, standardised for the number of hooks per set, for the period 1 October 2002 to 30 September 2018, in the ling longline fishery. The relative frequency was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.

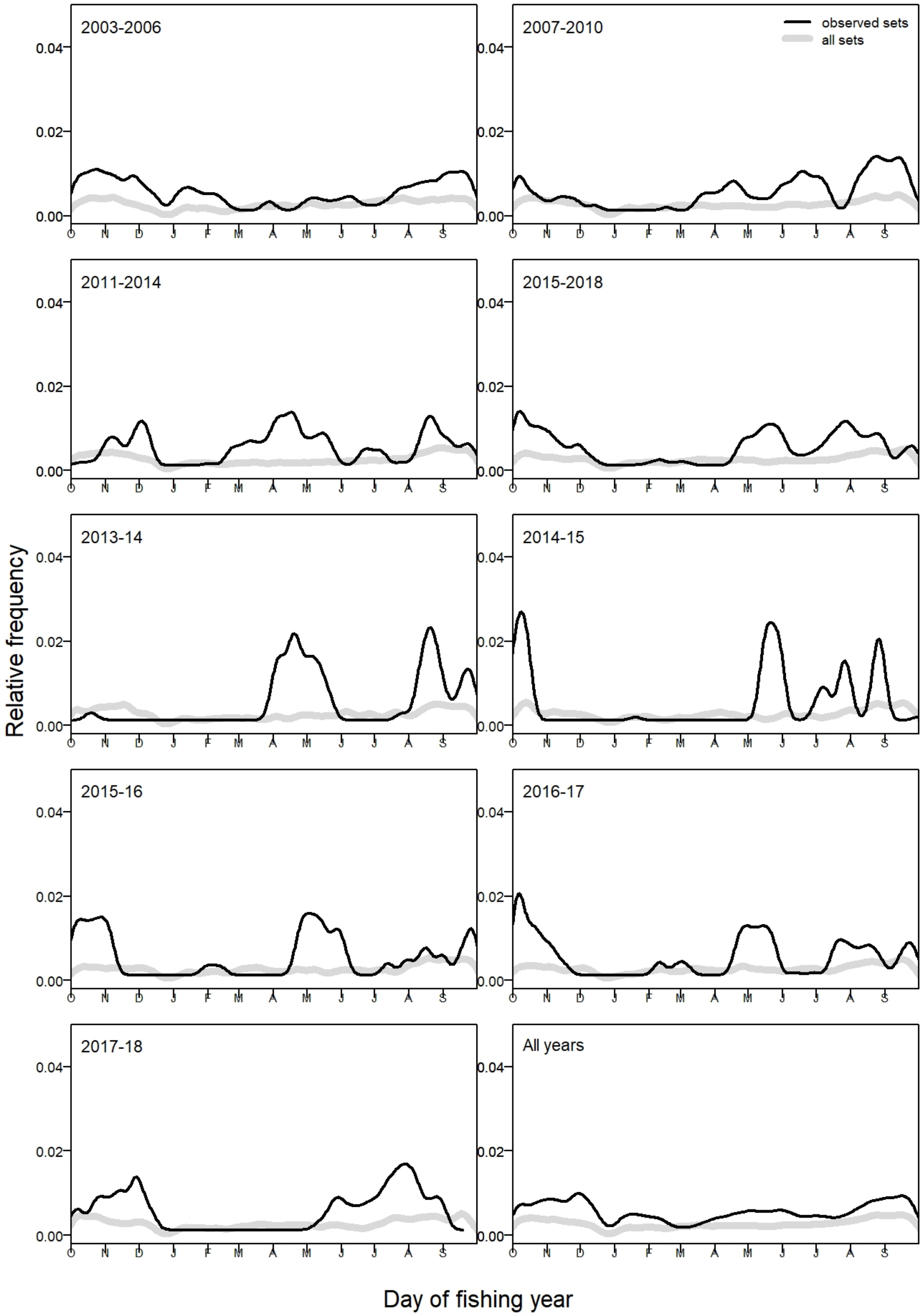

Figure 6: Comparison of the temporal spread of observed sets with all recorded commercial sets in the target ling longline fishery, by blocks of fishing years from 2003 to 2018, for individual fishing years from 2013–14 onwards, and for all years combined. The relative frequency of the numbers of sets was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.

3.2 Non-target catch data

3.2.1 Overview of raw catch data

Over 250 non-target species or species groups were identified by observers in the target ling longline fishery, most being non-commercial species, including invertebrate species, caught in low numbers (see summaries in Tables A1–A3 and Figure 7). Ling accounted for about 65.6% of the total estimated catch from all observed sets targeting ling between 1 October 2002 and 30 September 2018. The main non-target species were spiny dogfish (17% of total estimated catch), ribaldo (3.3%), rough skate (2.7%), black cod (1.7%), smooth skate (1.5%), sea perch (1.4%), and pale ghost shark (1.2%) (Figure 7). Of the fish non-target species, swollenhead conger (99.7%), unspecified deepwater dogfish (99.2%), and carpet shark (95.8%) had the largest rates of observed discarding in the fishery. Spiny dogfish was also frequently caught and usually discarded (67.9%); this trend has remained relatively constant throughout the time series (see Figure 24). Sharks were the primary fish non-target group, accounting for nearly 20% of the catch, and were generally (62.5%) discarded (Table A3 in Appendix A).

Of the invertebrates, unidentified starfish were the only group in the top 30 non-target taxa, and nearly all were discarded (96.1%). Invertebrates collectively accounted for under 0.5% of the catch and most were discarded (Table A3). Many invertebrates, in particular corals, echinoderms, and crustaceans, were identified to species, especially in the more recent records. This is due to improving knowledge of New Zealand marine invertebrate fauna, both in general and specifically by fisheries scientists and observers, and the use of invertebrate identification guides (e.g., Tracey et al. 2011) which have become available to observers.

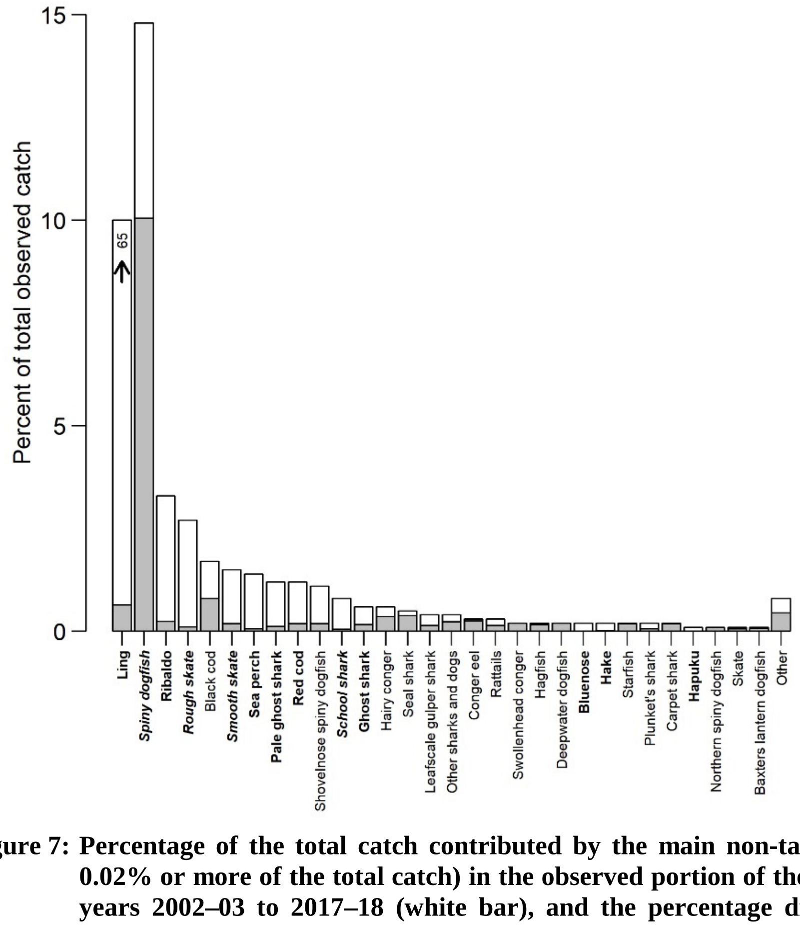

Figure 7: Percentage of the total catch contributed by the main non-target species (those representing 0.02% or more of the total catch) in the observed portion of the ling longline fishery for fishing years 2002–03 to 2017–18 (white bar), and the percentage discarded (grey bar). The Other category is the sum of all non-target species representing less than 0.02% of the total catch. Names in bold are QMS species and names in italics are QMS species which can be legally discarded under Schedule 6 of the Fisheries Act (1996) (since 1996 for spiny dogfish, 2003 for rough and smooth skate, and 2012 for school shark).

Exploratory plots were prepared to examine non-target catch per hook (plotted on a log scale) with respect to other relevant available parameters, including average depth of bottom, number of hooks, vessel, fishing year, month, area, primary bait species, and topography (Figures 8–11). Plots were prepared using data from all fishing years (i.e., 2002–03 to 2017–18) and by species category (ALL species, QMS species, non-QMS species, and invertebrates).

Total non-target catch per hook was highly variable between sets, ranging from 0.0 kg to 4.1 kg (Figure 8). Lines were mostly set at depths of 350–600 m but there was also a significant fraction of effort at 150–250 m, mostly related to the shallower fishing grounds around the Bounty Plateau. Total non-target catch levels increased slightly with average bottom depth greater than about 600 m. The number of hooks in the set had little influence on non-target catch rates, although the slight decrease in non-target catch with very large numbers of hooks may indicate that the ends of long sets may sometimes end up outside the main targeted area. There were some differences in total median non-target catch rates between vessels and between fishing years, with some increase in non-target catch in more recent years (range 0.03–0.18 kg per hook). The average ratio of non-target catch rate by month, across all years, varied between 0.55 and 2.68 kg of non-target catch per kg of ling, with rates lowest between October–December and highest between March–May. Across areas, median rates of total non-target catch were lowest at Puysegur and Stewart-Snares shelf (0.04 and 0.05 kg per hook, respectively) and highest in the west coast North Island area (0.36 kg per hook). The most common bait species associated with higher total non-target catch were barracouta (*Thyrsites atun*, BAR) and blue mackerel (*Scomber australasicus*, EMA). Topography had relatively little difference in total non-target catch rates (range 0.07–0.10), although longline sets over areas defined as pinnacles had the lowest median non-target catch rates at 0.07 kg per hook.

Patterns of non-target catch for QMS species in relation to these variables were mostly very similar to those for total non-target catch (Figure 9), as might have been expected given that the majority of the non-target catch were QMS species.

Non-target catch of non-QMS species also showed similar patterns to overall non-target catch and QMS species non-target catch, for most of the fishery parameters examined (Figure 10). The rate at which non-QMS species non-target catch decreased with increasing number of hooks was more pronounced than in the overall and QMS species trends. Non-QMS species non-target catch rates declined near the end of the fishing year (June to September) and were lowest around Auckland Islands and highest off WCNI.

Invertebrate species non-target catch, the smallest non-target catch category in terms of catch weight, also showed patterns of non-target catch per set that were mostly similar to the other catch categories (Figure 11). Invertebrate non-target catch was relatively lower between March and June and in the Puysegur and the Auckland Islands areas and higher in August and in SUBA.

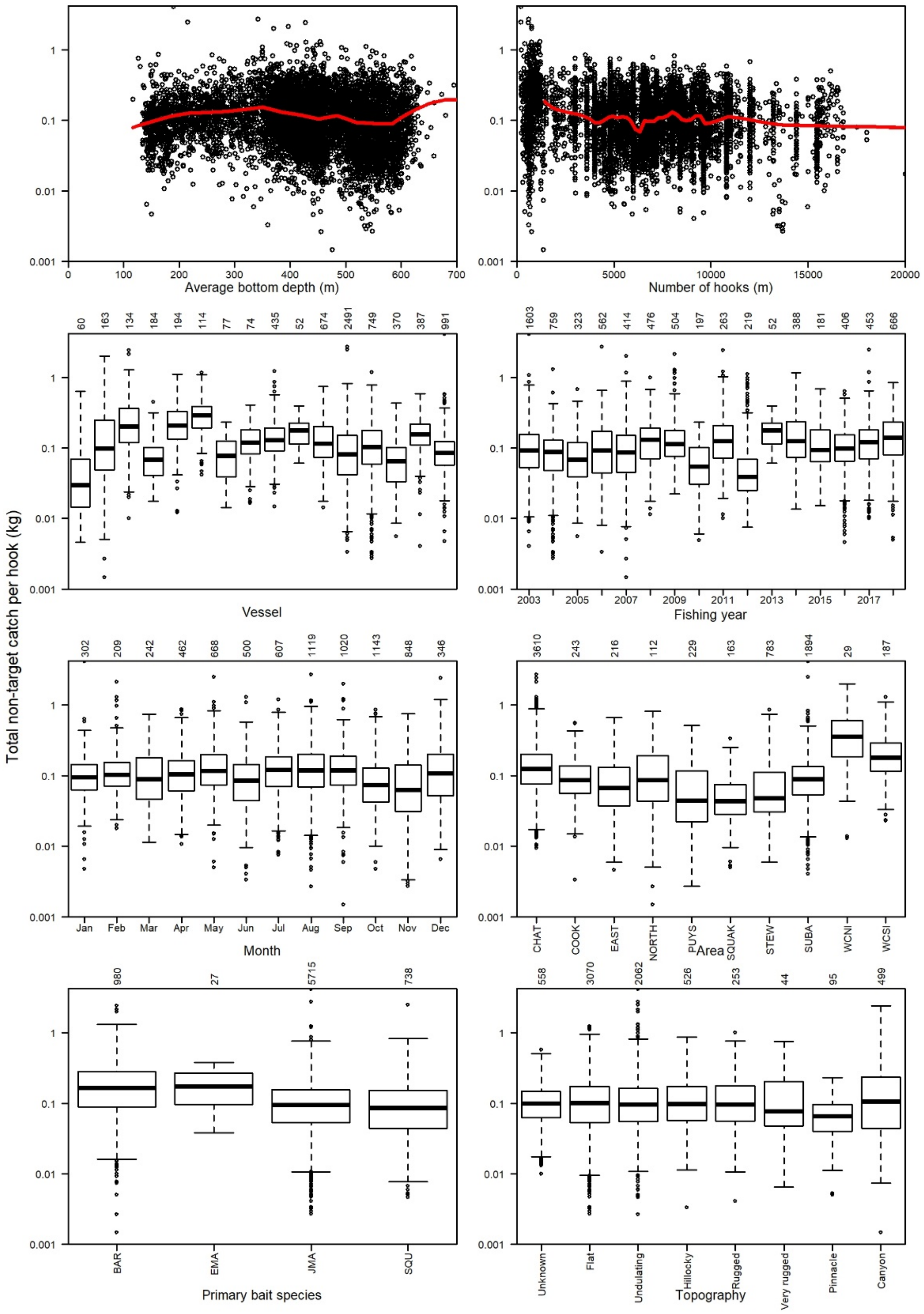

Figure 8: Total observed non-target catch (all species) in kilogram per hook plotted against selected variables in the target ling longline fishery for the fishing years 2002–03 to 2017–18, on a log scale. The dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) 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 (sets) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Average depth is the average of the start and finish depths at each end of the set. See Figure 2 for area codes. Note that the SQUAK area is the AUCK area shown in Figure 2.

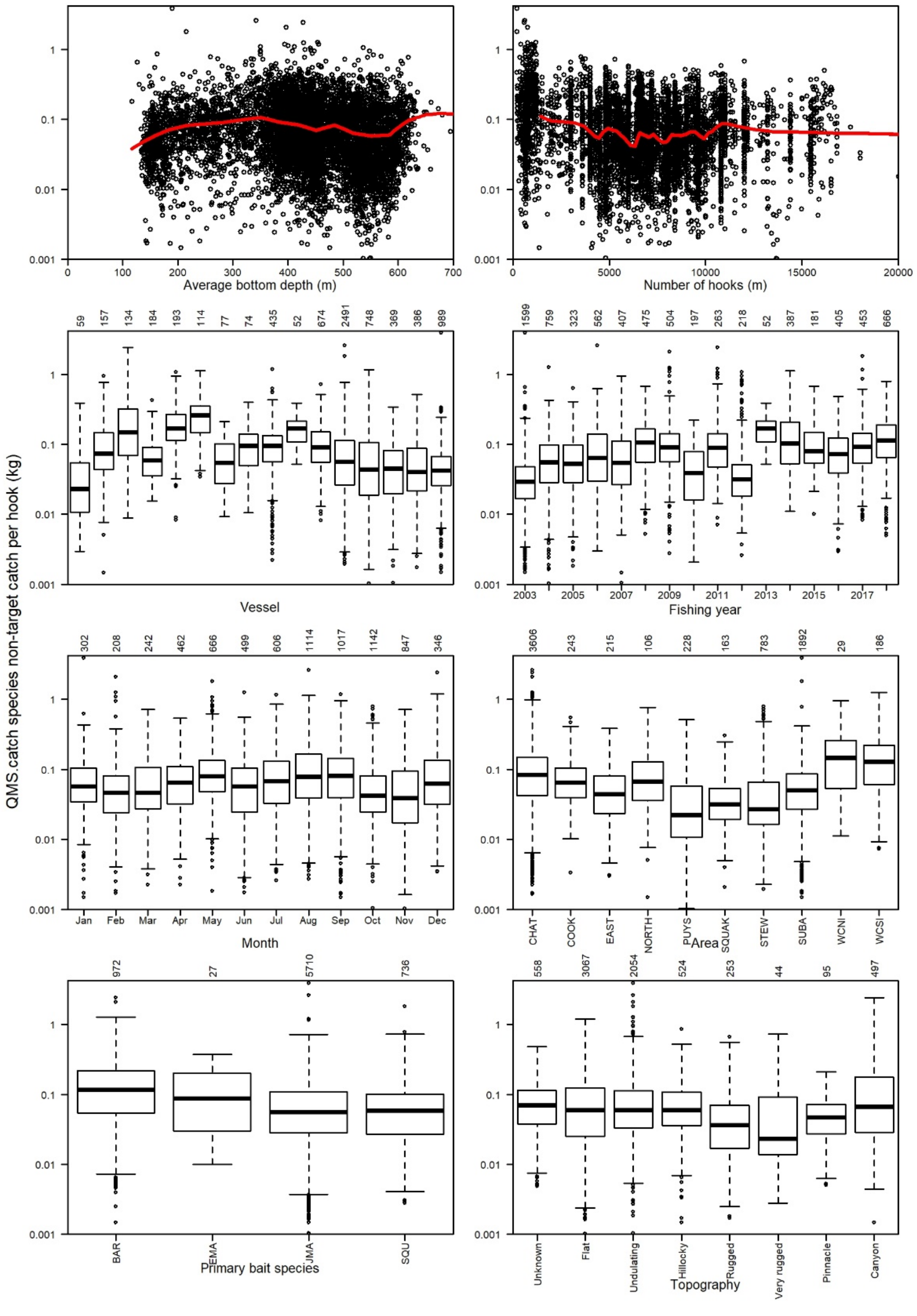

Figure 9: QMS (adjusted) species non-target catch in kilogram per hook plotted against selected variables in the target ling longline fishery for the fishing years 2003 to 2018, on a log scale. See Figure 8 caption for further details.

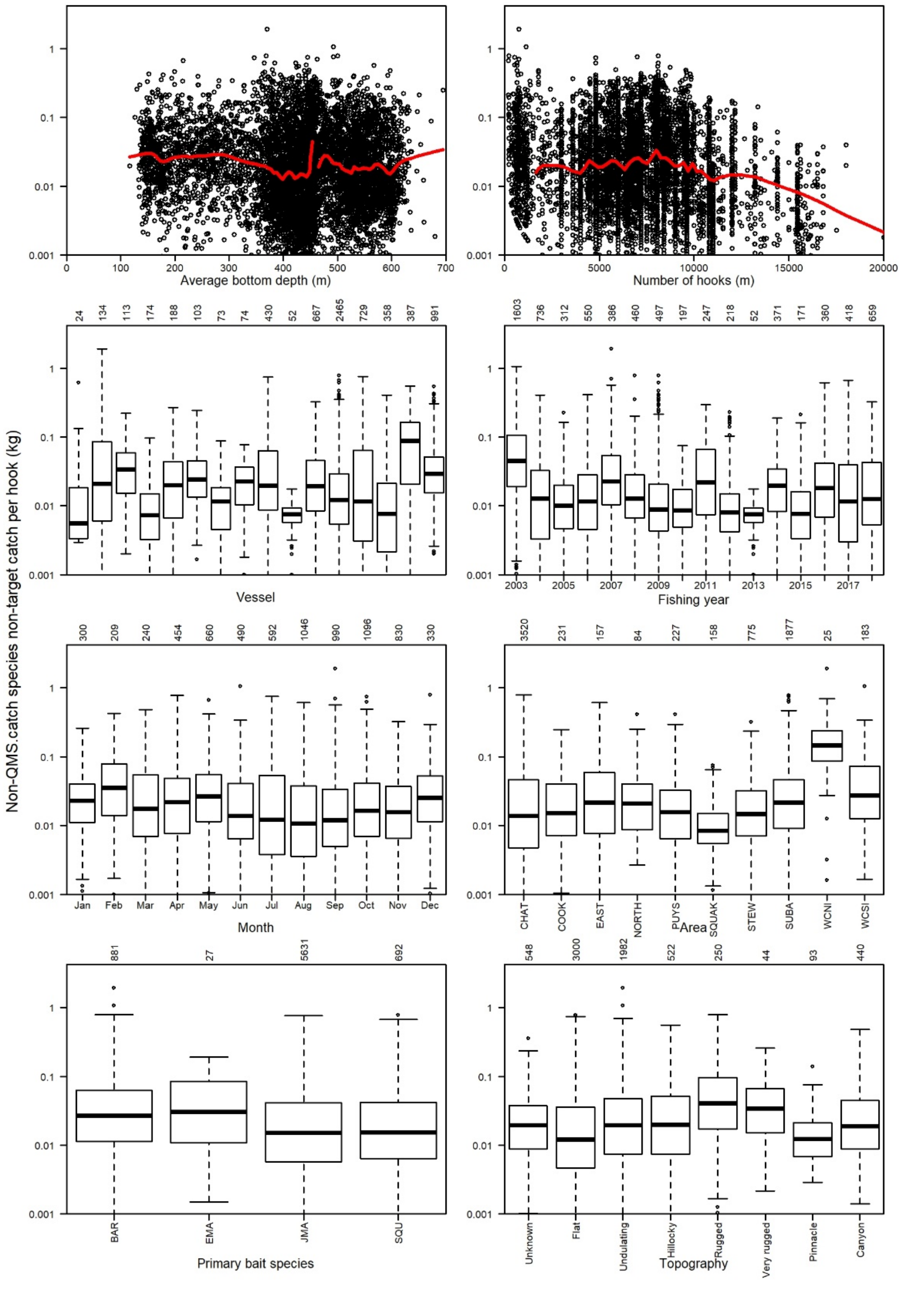

Figure 10: Non-QMS (adjusted) species non-target catch in kilogram per hook plotted against selected variables in the target ling longline fishery for the fishing years 2003 to 2018, on a log scale. See Figure 8 caption for further details.

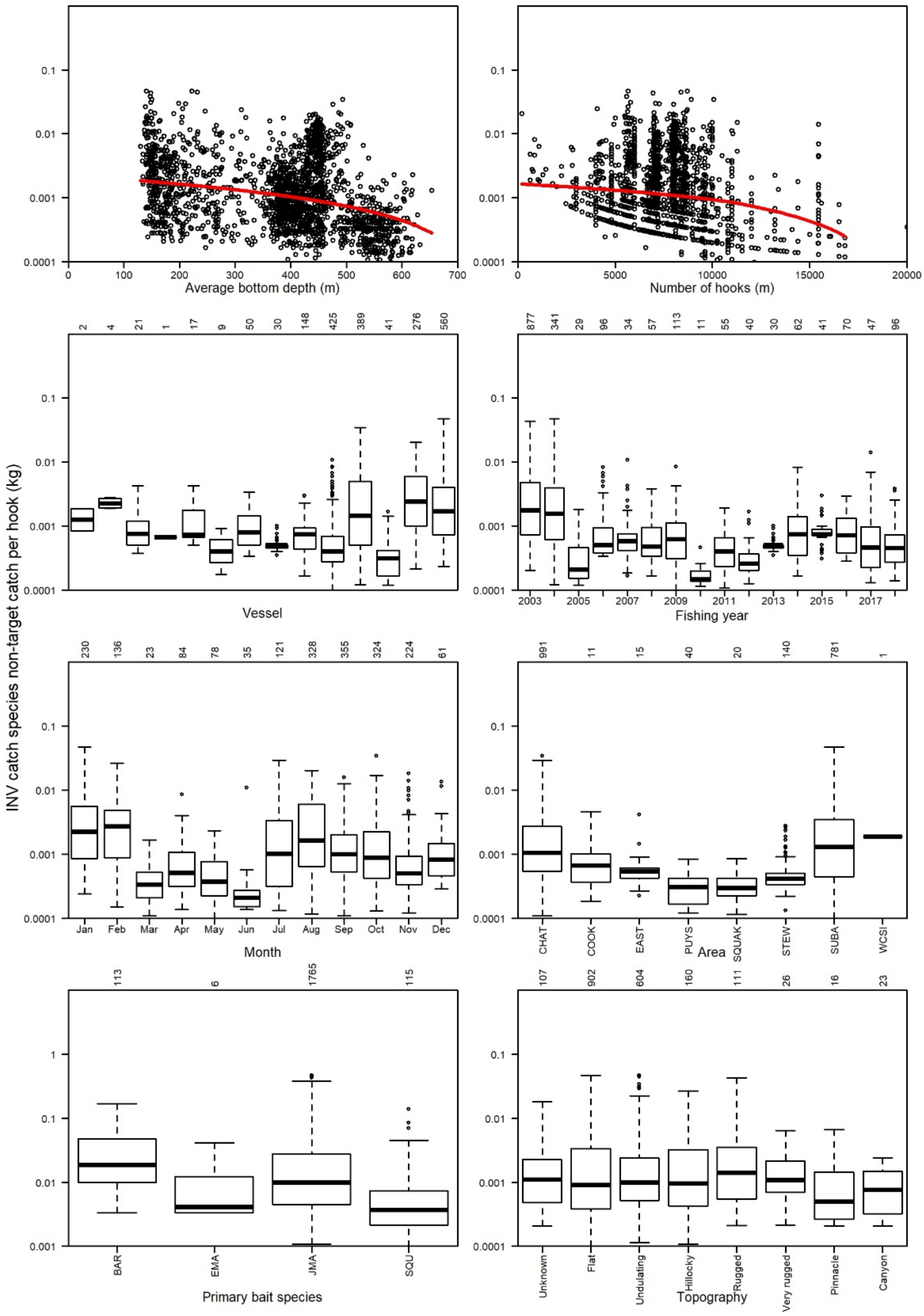

Figure 11: Invertebrate (adjusted) species non-target catch in kilogram per hook plotted against selected variables in the target ling longline fishery for the fishing years 2003 to 2018, on a log scale. See Figure 8 for further details.

3.3 Discard data

3.3.1 Overview of raw discard data

The non-target catch species most discarded by weight in the observed ling fishery was spiny dogfish, the most commonly caught non-target catch species, with almost 70% discarded since 1 October 2002 (Table A1, Figure 7). Only 1% of observed ling catch was discarded, but this accounted for the third highest observed discarded species in terms of weight, following spiny dogfish and black cod. Most spiny dogfish catch (68%) was discarded, as were some other (non-QMS) deepwater shark species, including those reported at the species level (e.g., seal shark, *Dalatias licha*) and those reported in generic categories (e.g., OSD, DWD). Conger eels (*Bassanago hirsutus, B. bulbiceps*, *Conger* spp.) were also regularly discarded, as were nearly half of all rattail (Macrouridae) catches. Commonly caught Schedule 6 QMS species, rough and smooth skate and school shark, were discarded at rates of 4.2%, 12.6%, and 6.4%, respectively. Of the main QMS invertebrate species caught, the giant spider crab (*Jacquinotia edwardsii*), queen scallop (*Zygochlamys delicatula*), and king crabs (*Lithodes aotearoa* and *Neolithodes brodiei*) were mostly retained, or their discard status was not reported. Other invertebrate species were generally fully discarded.

The variability in the level of discards per hook with respect to some of the available variables is shown for all species combined, QMS species, non-QMS species and combined invertebrates in Figures 12–15. The level of total discards was highly variable, ranging from 0.0 to 1.9 kg per hook (Figure 12). The quantity of total discards and QMS discards decreased slightly with increasing bottom depth beyond about 550 m, and more steadily declined throughout the depth range of the fishery for non-QMS species. The number of hooks set had no influence on total discard rates, but for non-QMS species and invertebrates separately the discard rate remained relatively constant with increasing numbers of hooks; there was a median discard rate of 0.02 kg per hook at both 5 000 and 10 000 hooks. There was some variability in discards between vessels and years, with the median annual discarding rate ranging from 0.01 to 0.05 kg per hook. Discarding was lower mid-fishing year (March–April, median rate of 0.01 kg per hook) and highest near the end of the fishing year (August–September, median rate of 0.06 kg per hook). Median discard rates were lowest around the Auckland Islands (0.007 kg per hook) and highest in the west coast North Island area (0.14 kg per hook). Overall, there were slightly lower discarding rates for non-QMS species when meal processing was occurring.

Patterns of discards for QMS species were similar to those produced for the overall trends, but more pronounced by year, month, and area and the presence of a meal processing plant did not affect the rate of discarding of QMS species (Figure 13). Patterns of discards for non-QMS species (Figure 14) and invertebrates (Figure 15) were more similar to those for total discards, because these categories were the main contributors to total discards.

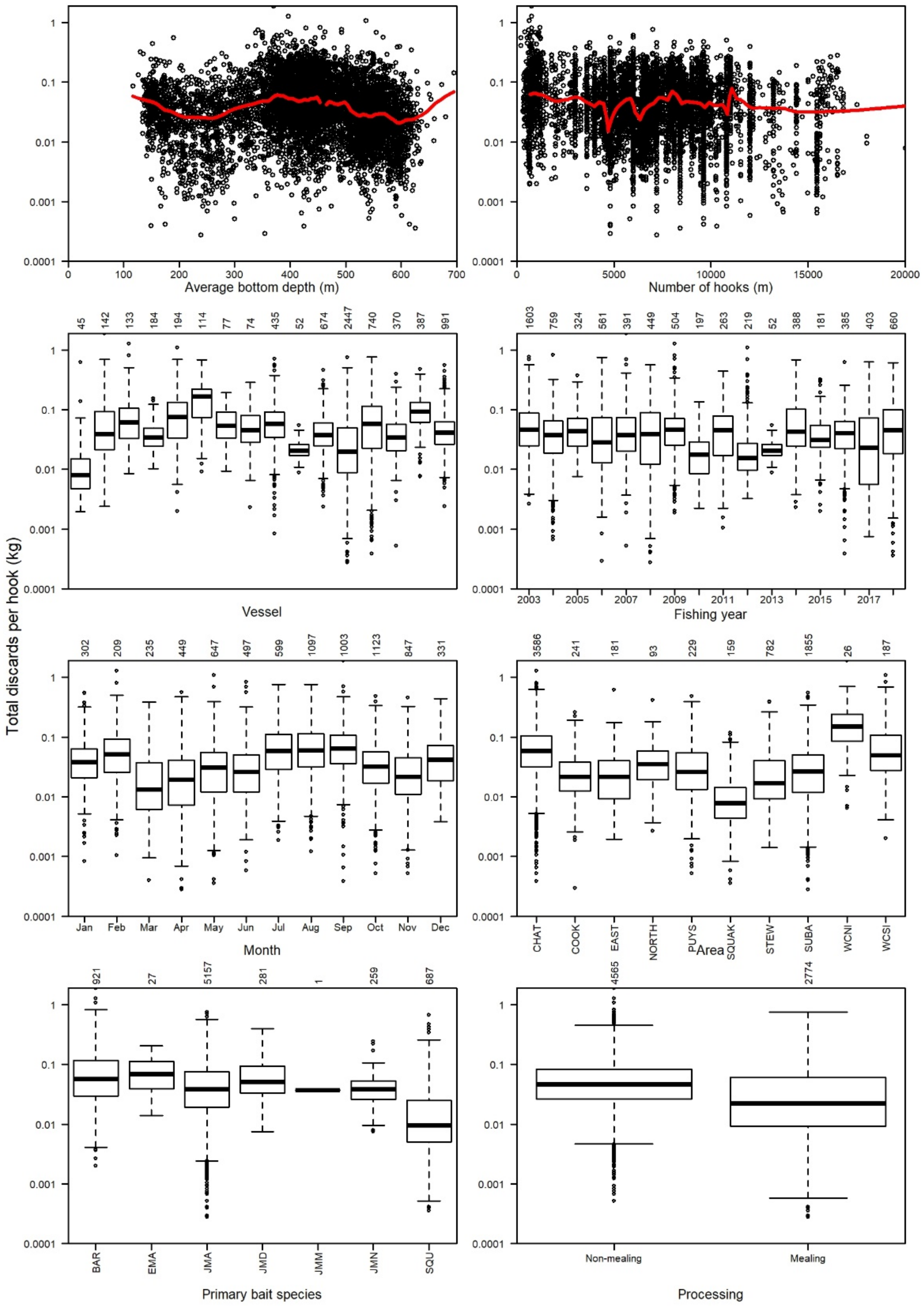

Figure 12: Total discards (all species) (kilogram per hook) plotted against selected variables in the ling longline target fishery for fishing years 2003 to 2018. Total discards are plotted on a log scale. See Figure 8 caption for further details.

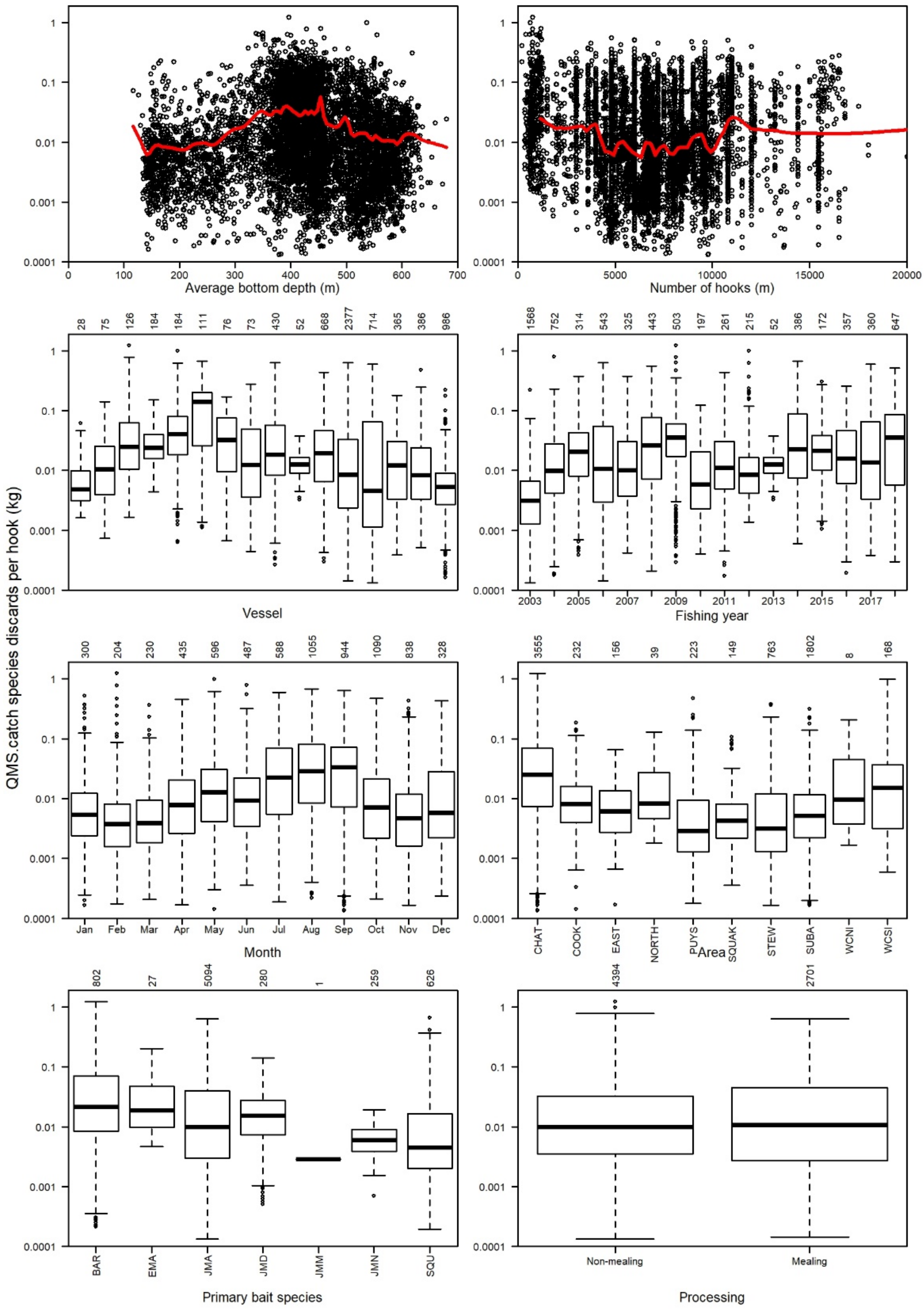

Figure 13: QMS species discards (kilogram per hook) plotted against selected variables in the ling longline target fishery for fishing years 2003 to 2018. See Figure 8 caption for further details.

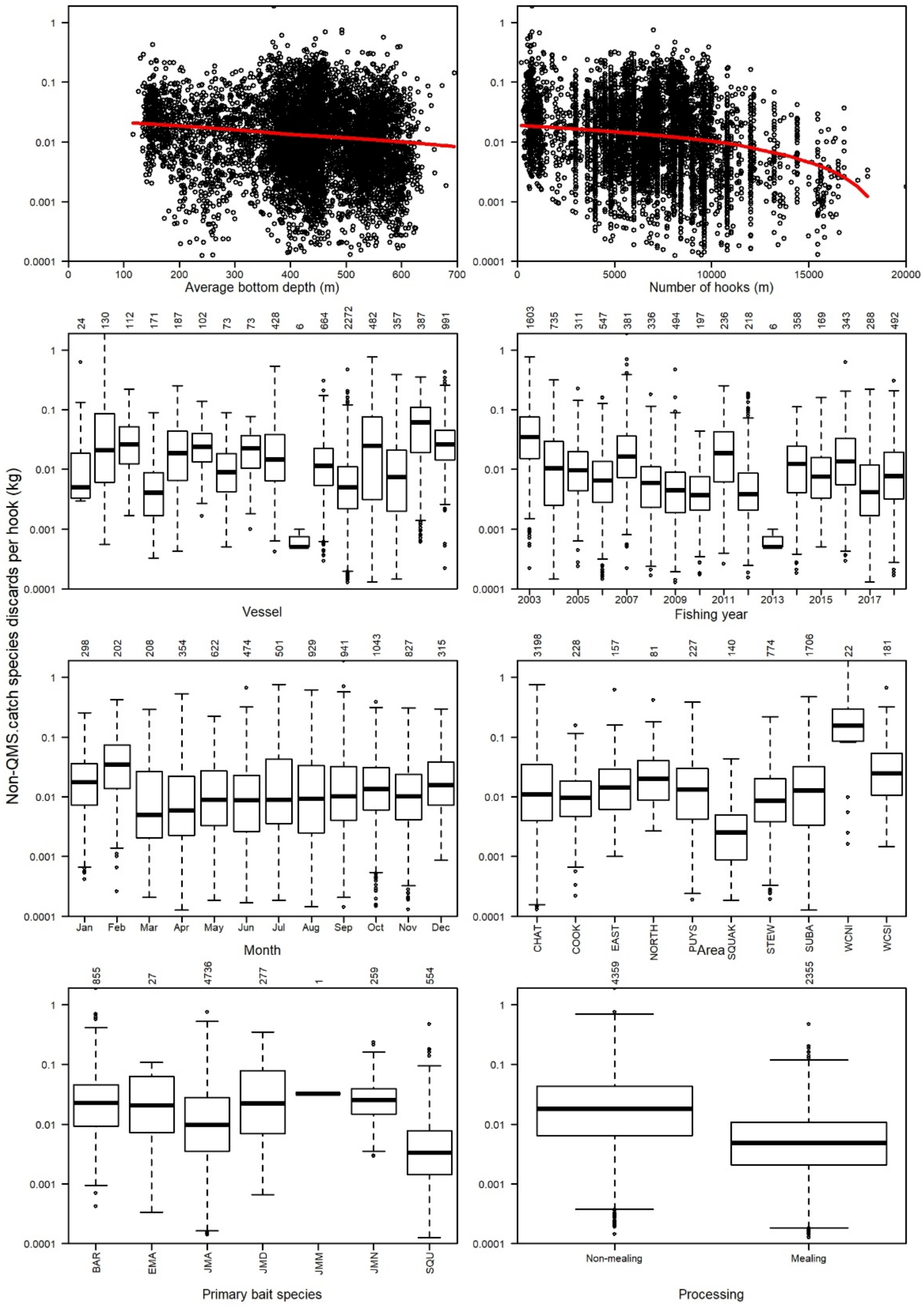

Figure 14: Non-QMS species discards (kilogram per hook) plotted against selected variables in the ling longline target fishery for fishing years 2003 to 2018. See Figure 8 caption for further details.

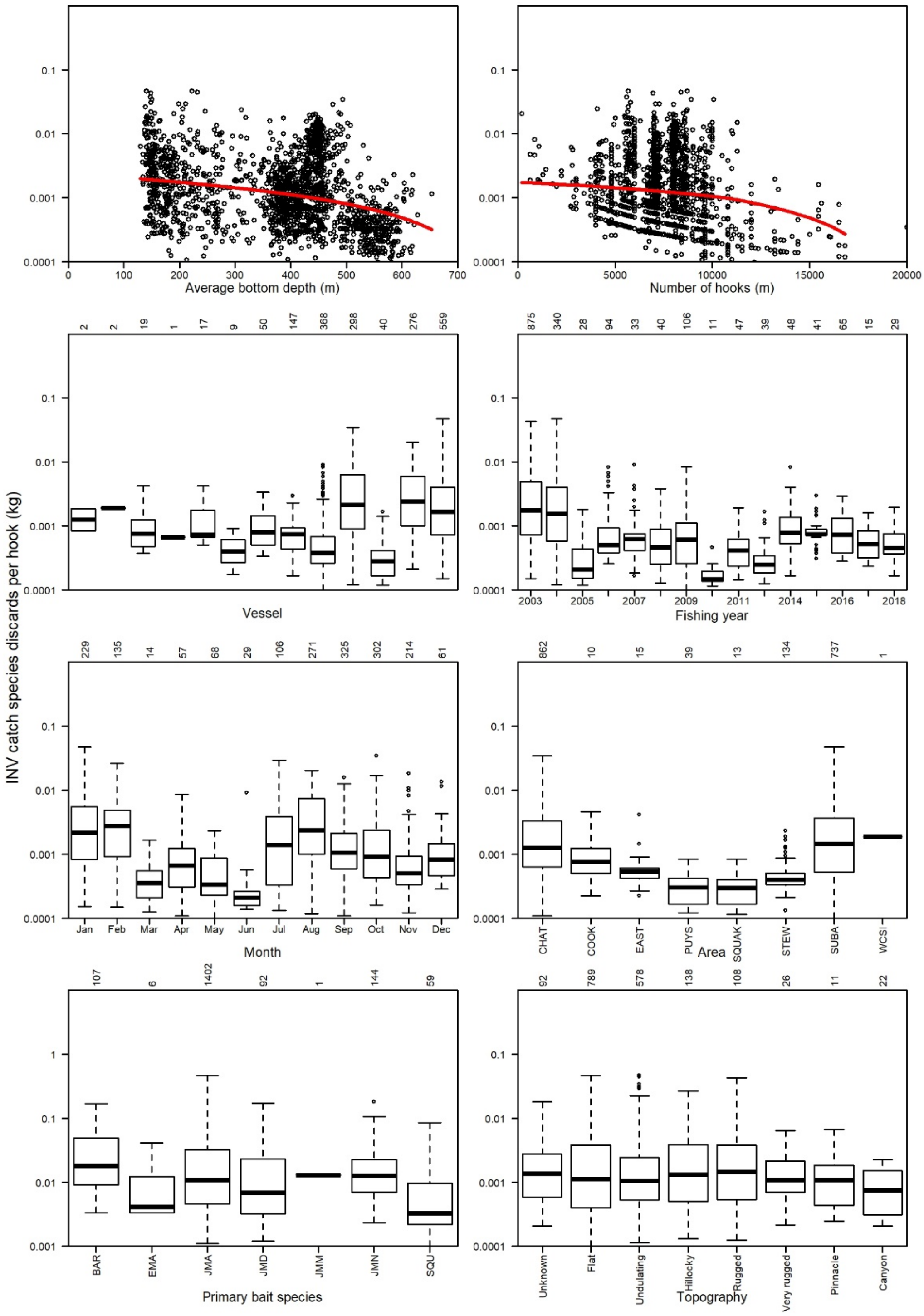

Figure 15: Invertebrate species discards (kilogram per hook) plotted against selected variables in the ling longline target fishery for fishing years 2003 to 2018. See Figure 8 caption for further details.

3.4 Estimation of non-target catch

3.4.1 Annual non-target catch levels

Linear regressions on non-target catch levels over time indicate slightly increasing non-target catch in the QMS species category and slightly decreasing non-target catch in the Non-QMS and Non-QMS Invertebrate categories (Table 4, Table 5), but none of these trends were statistically significant. Annual estimates of Total non-target catch have shown no trend over time.

<u>QMS species</u>
The estimated annual non-target catch ranged from a low 1058 t in 2002–03 to a high of 3957 t in 2016–17 (Table 4, Figure 16). There are no strong patterns or trends in the amounts of non-target catch of QMS species over time, although some increase in trend was observed since 2014–15.

<u>Non-QMS fish species</u>
The estimated annual non-target catch of non-QMS species was much lower than that of QMS species, and in most years was 600–800 t, with a low of 120 t in 2012–13. Maximum non-target catch occurred in the first year of the time series (2002–03, 2163 t) (the year before spiny dogfish entered the QMS), and as observed with QMS species, levels increased after 2014–15.

<u>Non-QMS Invertebrate species</u>
Non-QMS invertebrate species non-target catch was at much lower levels than QMS and non-QMS non-target catch, and apart from estimates of 44 t and 39 t in 2002–03 and 2003–04, respectively, has not exceeded 5 t per year.

Total non-target catch is composed primarily of QMS species and hence shows a similar pattern to QMS species non-target catch. Total annual non-target catch ranged from 1408 t in 2014–15 to 4724 t in 2016–17, with an increasing trend in estimated non-target catch since 2014–15. The total non-target catch estimates reported by Anderson (2014) were very similar to the current estimates for the same years (i.e., within 10%), not consistently higher or lower, and with overlapping confidence intervals in each year (Figure 16). Total non-target catch is correlated with effort, as may be expected, with effort having generally increased over time. However, there is little correlation between total non-target catch and the total estimated catch of ling from the target fishery, which has remained constant over the time series.

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 non-target catch are shown for QMS species, non-QMS species, and invertebrate species categories in Figures C1–C3 of Appendix C. Convergence is demonstrated in all cases.

Table 4: Estimates of annual non-target catch (t) in the ling longline fishery, by species category and fishing year, with 95% confidence intervals in parentheses.

Fishing year	QMS catch (t)		Non-QMS catch (t)		Non-QMS Invertebrate catch (t)		Total non-target catch (t)	
2002–03	1 058	(947–1 243)	2 163	(1 943–2 503)	44	(38–52)	3 025	(2 818–3 444)
2003–04	2 473	(2 220–2 814)	625	(523–798)	39	(32–47)	2 965	(2 711–3 339)
2004–05	2 230	(1 891–2 829)	375	(295–598)	2	(1–3)	2 499	(2 131–3 133)
2005–06	2 544	(2 161–3 551)	749	(486–1 479)	5	(4–7)	3 316	(2 755–4 740)
2006–07	1 668	(1 392–2 267)	784	(555–1 439)	2	(1–3)	2 522	(2 031–3 524)
2007–08	3 361	(2 797–4 655)	635	(484–1 068)	2	(2–4)	3 849	(3 269–5 171)
2008–09	2 729	(2 257–3 815)	576	(394–1 227)	4	(3–5)	3 193	(2 651–4 616)
2009–10	2 292	(836–8 814)	306	(123–1 183)	1	(0–3)	2 341	(969–8 312)
2010–11	1 985	(1 550–3 115)	772	(577–1 317)	2	(2–3)	2 797	(2 211–4 213)
2011–12	1 995	(862–7 750)	264	(131–951)	3	(1–11)	2 276	(1 065–6 848)
2012–13	1 698	(1 313–2 863)	120	(70–371)	3	(3–5)	2 530	(1 643–4 700)
2013–14	1 914	(1 620–2 708)	616	(455–1 089)	3	(2–4)	2 431	(2 079–3 389)
2014–15	1 201	(937–2 018)	238	(143–567)	5	(4–9)	1 408	(1 088–2 349)
2015–16	2 070	(1 716–3 364)	741	(564–1 309)	4	(3–8)	2 717	(2 262–4 086)
2016–17	3 957	(3 615–4 365)	755	(645–904)	5	(3–9)	4 724	(4 328–5 151)
2017–18	3 425	(3 064–4 346)	739	(595–1 124)	2	(2–3)	4 049	(3 643–5 075)

Table 5: Summary of results of linear regression analyses for trends in annual non-target catch, by species category, in the ling longline fishery. The *p* values indicate whether the slopes differed significantly from zero, with *p* values < 0.01 considered significant.

Species category	Slope	*p*
QMS	0.019	0.352
Non-QMS	-0.041	0.267
Non-QMS Invertebrate	-0.089	0.109
Total	0.001	0.967

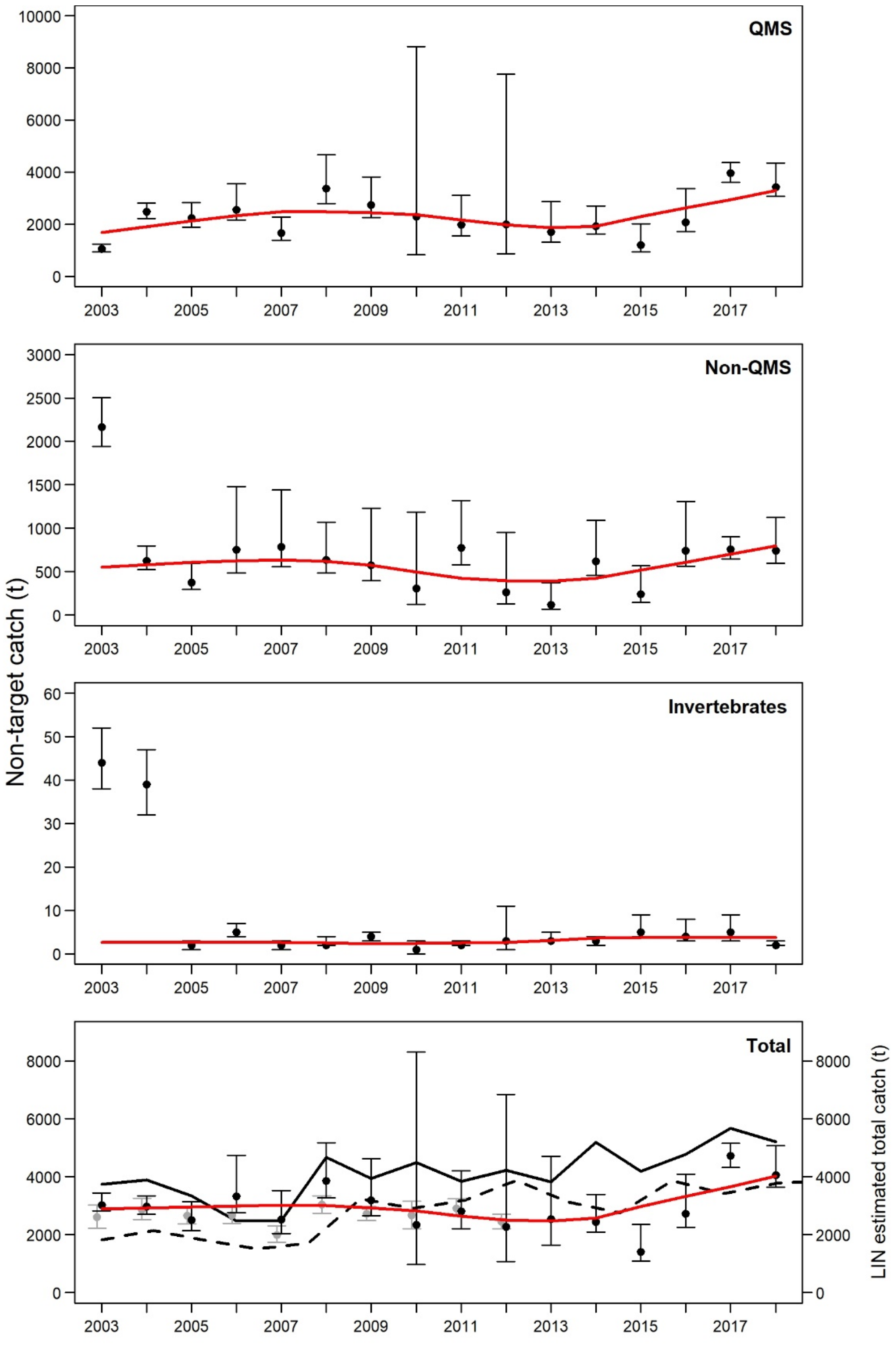

Figure 16: Annual estimates of non-target catch in the target ling longline fishery, by species category, for fishing years 2003 to 2018 (black dots). Error bars indicate 95% confidence intervals. The red lines show the fit of a locally-weighted polynomial regression to annual non-target catch. Bottom panel shows estimates (grey dots) of total non-target catch calculated up to 2012 from Anderson (2014), solid black line shows the total annual catch of the target species, and the dashed line shows annual effort (number of sets), scaled to have the mean equal to that of total non-target catch.

A breakdown of estimated non-target catch in each of the standard areas, for each catch category and overall, is shown in Figure 17 and in more detail (including confidence intervals) in Table A4. The majority of non-target catch in each category was taken from Chatham Rise, followed by sub-Antarctic, and in some earlier years, Stewart-Snares shelf. The proportion of QMS species non-target catch (and overall total non-target catch) reported from Chatham Rise has remained relatively consistent over most of the time series, with increases in recent years. Non-QMS species non-target catch has been variable by area, with a larger proportion of catch being reported from sub-Antarctic in some recent years. Non-target catch of non-QMS invertebrate species was reported exclusively from Chatham Rise in many years, with large contributions from sub-Antarctic in early years, and some more recent years.

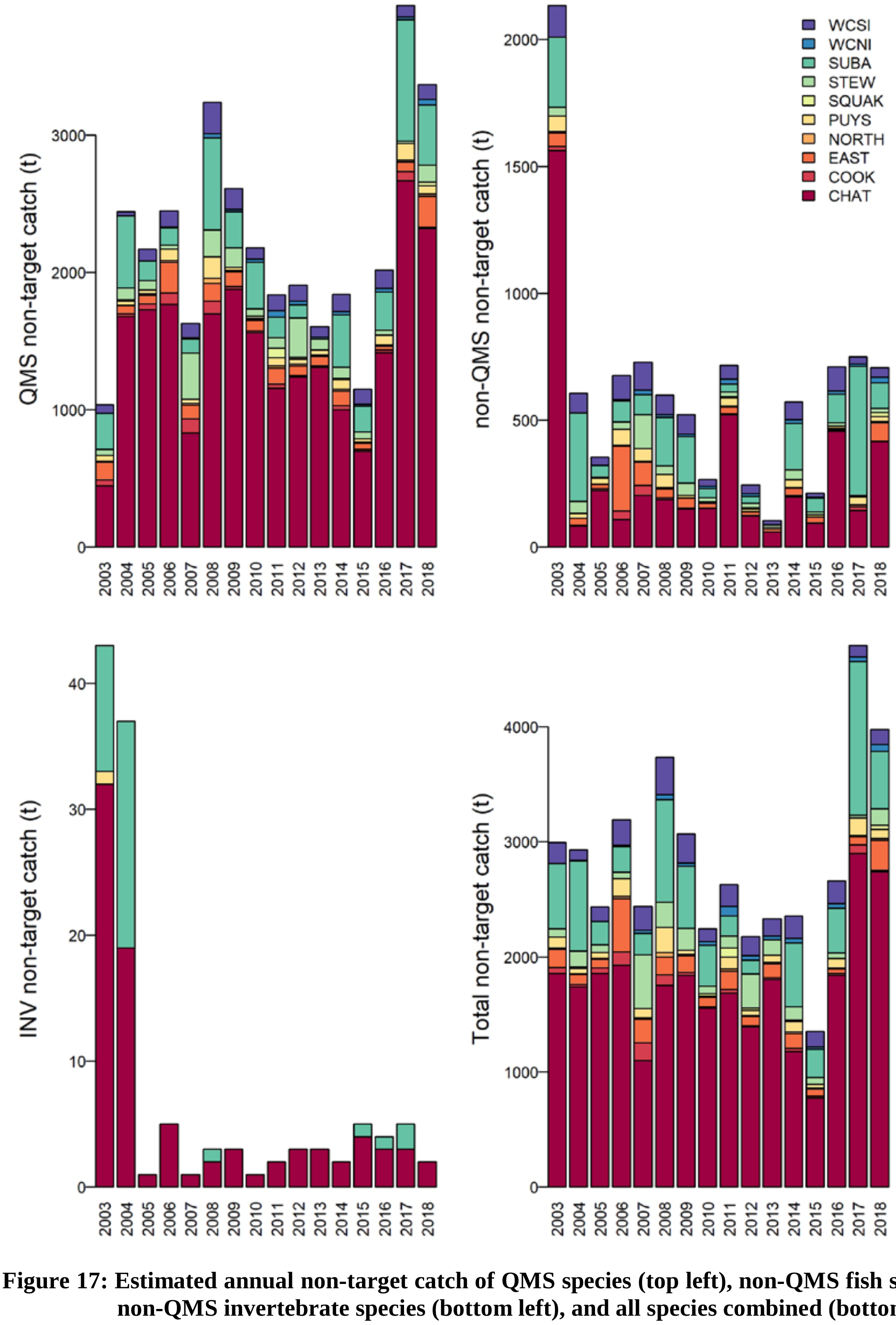

Figure 17: Estimated annual non-target catch of QMS species (top left), non-QMS fish species (top right), non-QMS invertebrate species (bottom left), and all species combined (bottom right) in each of ten standard areas where species were reported by fishing years 2003 to 2018. SQUAK is AUCK.

Total annual non-target catch 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 year examined (2015–16), and was below the 95% confidence intervals of the estimates based on observer data in most years (Table 6, Figure 18). The two sets of estimates follow a roughly similar trend with a 48% correlation.

Table 6: Total annual non-target catch estimates for the target ling longline fishery based on catch effort records (estimated total catch minus any estimated catch of the target species) compared with estimates from the observer-based model. Estimates are derived by summing the difference between the recorded total catch and ling catch for each set (LCER and LTCER forms) or group of sets (CELR forms).

Fishing year	Total non-target catch (t)	% of observer-based estimate
2002–03	1 132	37.4
2003–04	1 630	55.0
2004–05	1 402	56.1
2005–06	1 219	36.8
2006–07	1 147	45.5
2007–08	1 691	43.9
2008–09	1 855	58.1
2009–10	1 567	66.9
2010–11	1 900	67.9
2011–12	1 407	61.8
2012–13	1 011	40.0
2013–14	1 924	79.1
2014–15	1 741	123.7
2015–16	2 553	94.0
2016–17	2 598	55.0
2017–18	2 631	65.0
All years	27 408	61.6

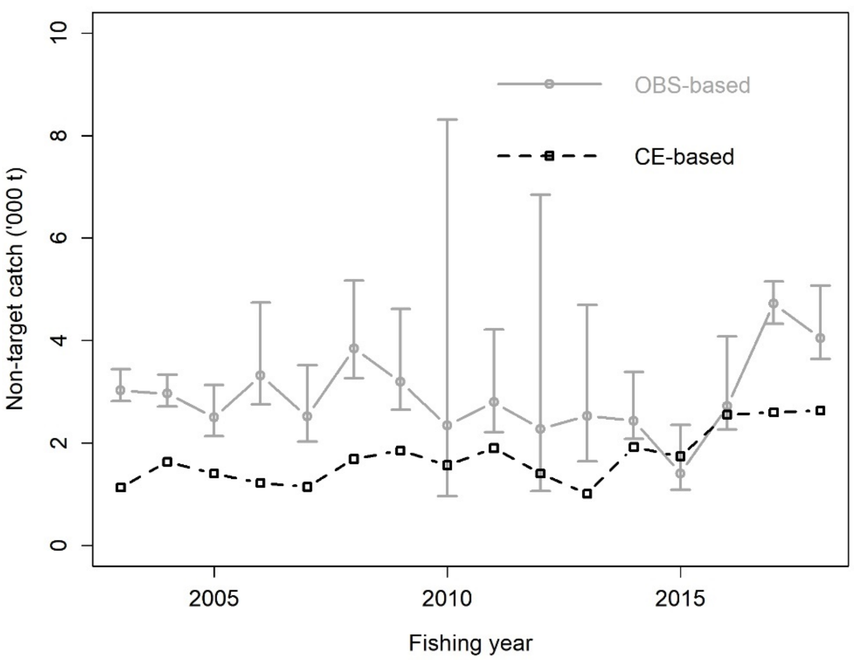

Figure 18: Total annual non-target catch in the ling longline fishery from scaled up observer catch rates (OBS) and commercial catch-effort (CE) forms (estimated total catch minus any estimated catch of the target species).

3.5 Estimation of discards

3.5.1 Annual discard levels

Plots and regression analyses indicated that discards of target species (LIN), non-QMS species, invertebrate species, and all species combined decreased over time (Figure 19, Table 7, Table 8), but only declines in ling discards were significant (Table 8). Discards of QMS species showed an increase over time, but not a significant increase.

Target species
Discarding of ling was generally low, less than 100 t per year in all years except for 2003–04 and 2004–05. Annual levels of discarding have declined over time, with a low of 11 t reported in 2017–18.

QMS species
Discards of QMS species were in most years greater than discards of other categories but were somewhat variable, ranging from a low of 113 t in 2012–13 to a high of 1868 t in 2017–18 (Table 7). Overall, QMS species discards have showed an increasing trend since 2013–14.

Non-QMS fish species
Apart from the first two years of the time series, discards of non-QMS species were generally much lower than those of QMS species, ranging from 2 t in 2012–13 to 1487 t in 2002–03. Annual discard rates have remained stable without trend since 2006–07.

Non-QMS Invertebrate species
Annual discards of invertebrates followed a similar pattern to non-target catch (as almost all the catch in this category is discarded) and, apart from the first two years of the time series, remained under 10 t and as low as <1 t.

Estimates of total annual discards ranged from 188 t in 2012–13 to 2442 t in 2006–07 and, like non-target catch, showed some increasing trend since 2014–15. Estimates generally matched well with those reported by Anderson (2014) and had overlapping confidence intervals in all but two years (Figure 19).

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 species, and invertebrate species categories in Figures C4–C6 in Appendix C. Convergence is demonstrated in all cases.

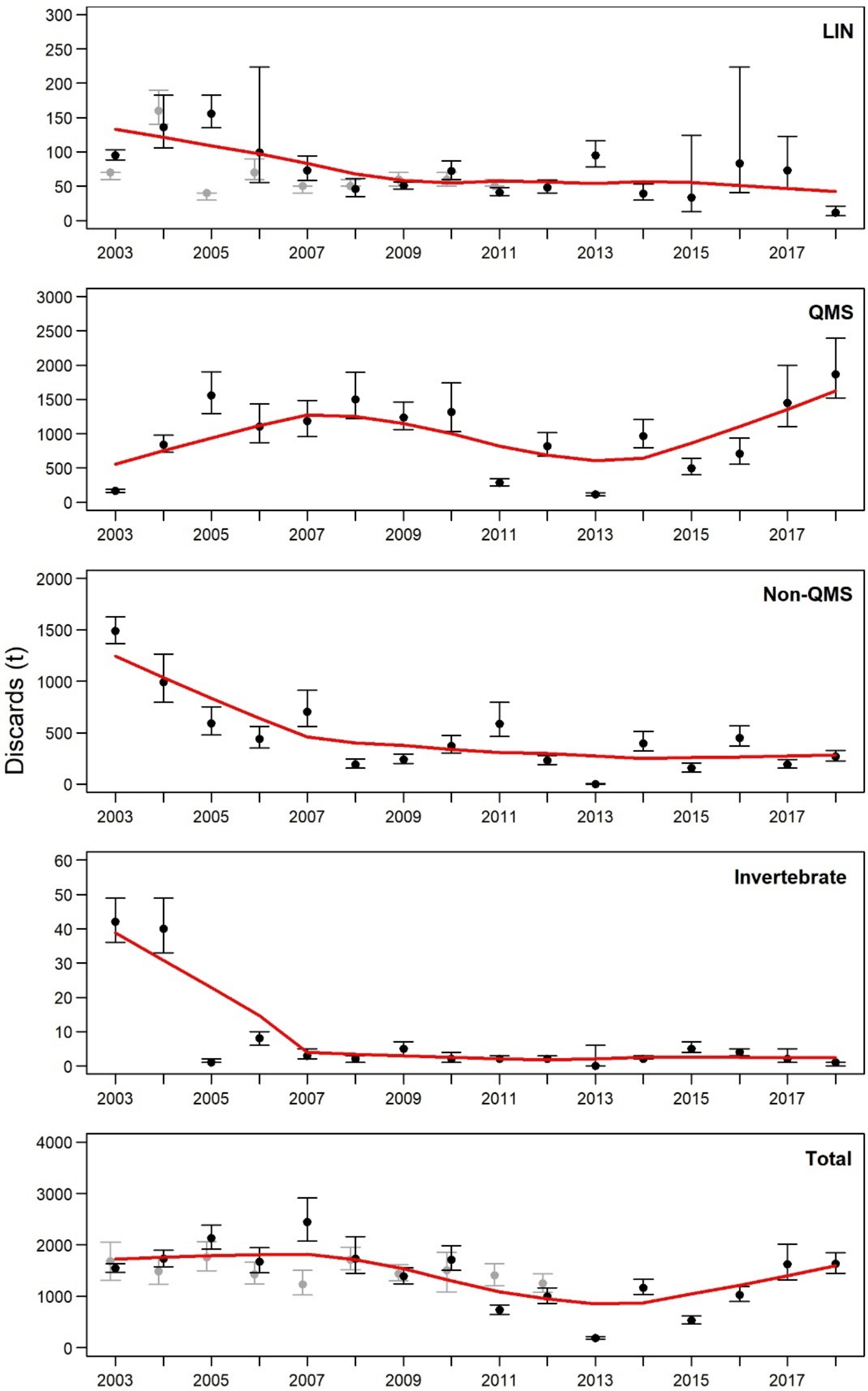

Figure 19: Annual estimates of discards in the target ling longline fishery, by species category, for 2003 to 2018 (black dots). Error bars indicate 95% confidence intervals. The red lines show the fit of a locally-weighted polynomial regression to annual discards. Also shown (grey dots, top and bottom panel) are earlier estimates of target species and total discards calculated for up to 2013 by Anderson (2014).

Table 7: Estimates of total annual discards (t) in the target ling longline fishery, by species category and fishing year, with 95% confidence intervals in parentheses.

Fishing year	LIN		QMS		Non-QMS		Invertebrate		Total discards	
2002–03	95	(88–103)	167	(148–189)	1 487	(1 367–1 626)	42	(36–49)	1 544	(1 463–1 634)
2003–04	136	(106–183)	839	(730–978)	990	(796–1 264)	40	(33–49)	1 731	(1 580–1 901)
2004–05	156	(135–183)	1 558	(1 295–1 903)	589	(478–750)	1	(1–2)	2 131	(1 918–2 390)
2005–06	99	(55–224)	1 106	(869–1 437)	439	(352–560)	8	(6–10)	1 671	(1 458–1 949)
2006–07	73	(58–94)	1 182	(956–1 486)	703	(563–913)	3	(2–5)	2 442	(2 073–2 910)
2007–08	46	(35–61)	1 500	(1 223–1 892)	191	(155–242)	2	(1–3)	1 728	(1 444–2 160)
2008–09	51	(46–56)	1 234	(1 058–1 461)	239	(198–291)	5	(3–7)	1 388	(1 239–1 556)
2009–10	72	(60–87)	1 313	(1 032–1 742)	372	(304–474)	2	(1–4)	1 711	(1 505–1 982)
2010–11	41	(36–48)	287	(242–344)	587	(461–794)	2	(2–3)	732	(645–832)
2011–12	48	(40–59)	815	(672–1 016)	227	(189–280)	2	(2–3)	999	(863–1 161)
2012–13	95	(78–116)	113	(96–135)	2	(1–4)	0	(0–6)	188	(166–216)
2013–14	39	(30–53)	961	(797–1 204)	397	(323–512)	2	(2–3)	1 165	(1 034–1 334)
2014–15	33	(13–124)	494	(398–643)	155	(117–204)	5	(4–7)	531	(464–618)
2015–16	83	(41–224)	709	(551–939)	451	(369–565)	4	(3–5)	1 031	(905–1 199)
2016–17	73	(47–123)	1 450	(1 107–1 995)	191	(156–239)	2	(1–5)	1 620	(1 318–2 017)
2017–18	11	(7–21)	1 868	(1 518–2 393)	268	(226–325)	1	(0–1)	1 631	(1 446–1 847)

Table 8: Summary of results of linear regression analyses for trends in annual discards, by species category, for the ling longline fishery between 2002–03 and 2017–18. 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*
LIN	**-0.086**	**0.007**
QMS	0.015	0.748
Non-QMS	-0.126	0.114
Non-QMS Invertebrate	-0.154	0.041
Total	-0.054	0.121

A breakdown of estimated discards in each of the standard areas, for each catch category and overall, is shown in Figure 20 and Figure 21 and in more detail (including confidence intervals) in Table A5. Target species discards were greatest in the Chatham Rise fishery, with smaller levels in the west coast North Island area. Chatham Rise accounted for most discards of QMS and non-QMS species, with some smaller proportions contributed by sub-Antarctic and west coast South Island. For non-QMS invertebrate species, discarding was nearly exclusively associated with Chatham Rise, although in 2003 and 2004 considerable proportions were reported from sub-Antarctic. The distribution of total discards among areas followed a similar pattern over time to that of the main contributor (QMS species), with Chatham Rise dominating in all years, and smaller contributions by sub-Antarctic and west coast South Island (Figure 21).

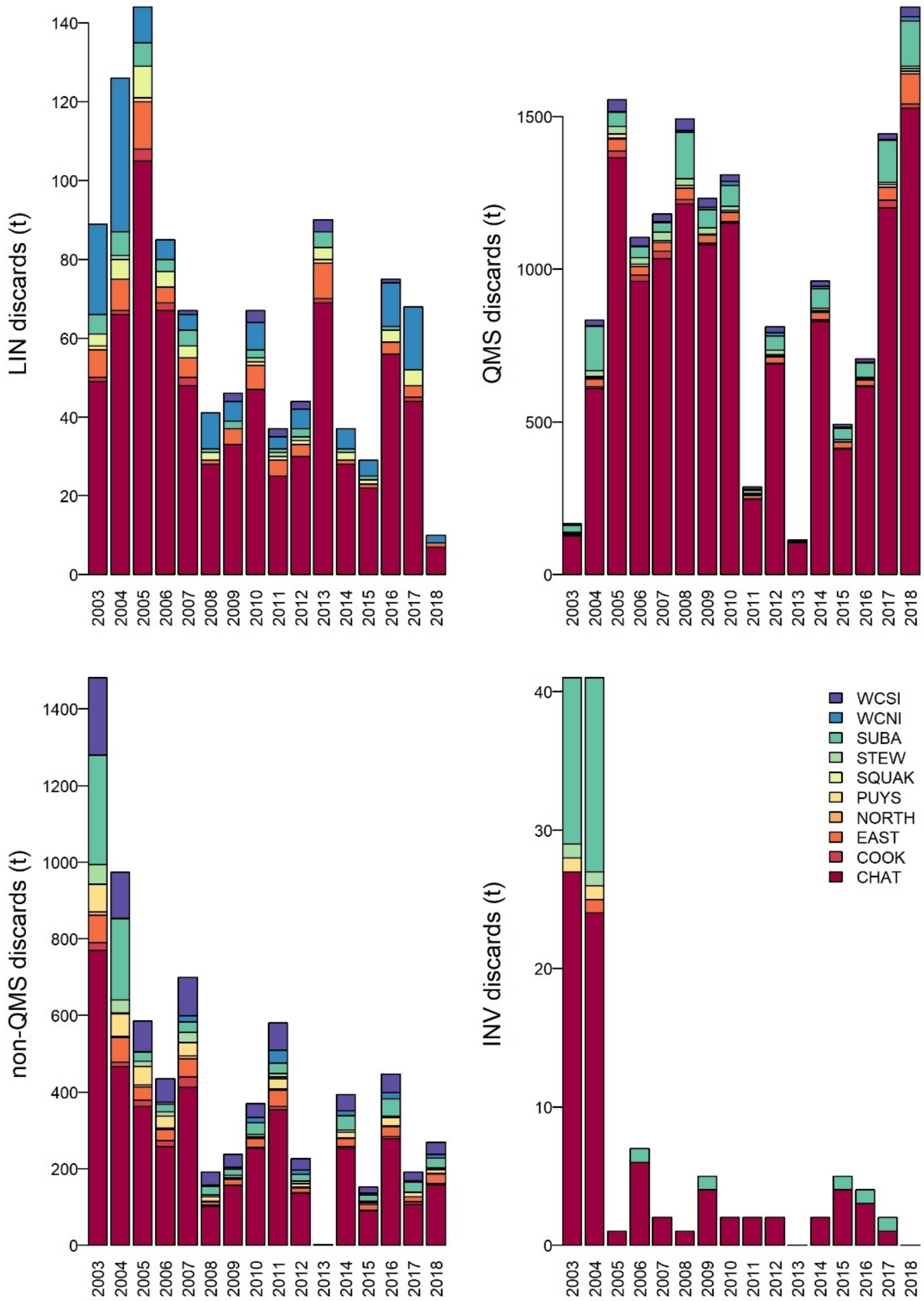

Figure 20: Estimated annual discards of ling (top left), QMS species (top right), non-QMS fish species (bottom left), and non-QMS invertebrate species (bottom right) in each of 10 standard areas where species were reported, for fishing years 2003 to 2018.

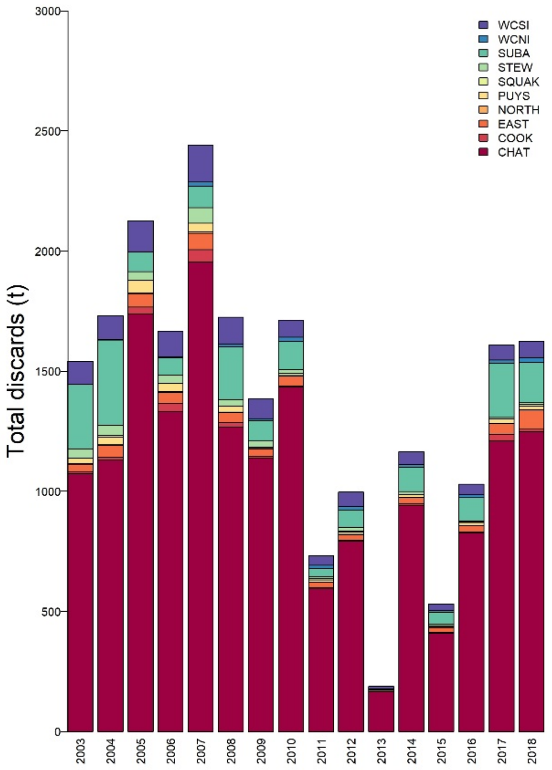

Figure 21: Estimated annual discards of all species combined in each of ten standard areas where species were reported. SQUAK is AUCK.

3.5.2 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) present at the time. Such discarding has been recorded at sea on an “Authority to return or abandon fish to the sea” form (using a non-specific code) but, from 1 October 2013, discards have been explicitly recorded on Catch Landing Returns (CLR) forms. To assess the extent of discarding reported in this way, an examination of CLR data was made, based on all longline fishing trips where ling was targeted. This showed that in the LIN fishery the approximate level of observer authorised discards was 159 t in 2014–15, 551 t in 2015–16, 198 t in 2016–17, and 1701 t in 2017–18. These amounts represent about 4–16% of the total (CLR) reported discards in those years.

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 larger than minimum legal size, 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.

3.6 Non-target catch utilisation rates

Annual non-target catch and discard estimates in the ling longline fishery were divided by the estimated annual target species catch, and annual discards of non-target catch were divided by annual non-target catch in the fishery, to provide measures of utilisation rates (Table 9). The non-target catch fraction (kilogram of non-target catch /kilogram 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 (kilogram of discards/kilogram of target species catch) provides a measure of the utilisation rate that can be compared across fisheries. Total discards as a fraction of total non-target catch provides an alternative measure of the utilisation of non-target catch that may be useful for fishery managers.

The non-target catch fraction in the fishery showed inter-annual variability but a declining trend from a peak in 2005–06 of 1.34 to a low of 0.34 in 2014–15 (Figure 22). The trend has since been increasing. The discard fraction showed a declining trend from a peak of 0.98 in 2006–07 to a low of 0.05 in 2012–13 and has since increased in recent years. Total discards as a fraction of non-target catch was highly variable throughout the time series, with a range of 0.07 in 2012–13 to 0.97 in 2006–07, and no real trend over time.

Table 9: Estimated annual catch of ling (t), total non-target catch (t), and total discards (t) in the target ling longline fishery; non-target catch fraction (kilogram of total non-target catch per kilogram of ling caught), discard fraction (kilogram of total discards per kilogram ling caught); and discards as a fraction of non-target catch.

Fishing year	Target species estimated catch	Total non-target catch	Total discards	Non-target fraction	Discard fraction	Discards /non-target
2002–03	3 733	3 025	1 544	0.81	0.41	0.51
2003–04	3 881	2 965	1 731	0.76	0.45	0.58
2004–05	3 343	2 499	2 131	0.75	0.64	0.85
2005–06	2 471	3 316	1 671	1.34	0.68	0.50
2006–07	2 484	2 522	2 442	1.02	0.98	0.97
2007–08	4 679	3 849	1 728	0.82	0.37	0.45
2008–09	3 942	3 193	1 388	0.81	0.35	0.43
2009–10	4 491	2 341	1 711	0.52	0.38	0.73
2010–11	3 840	2 797	732	0.73	0.19	0.26
2011–12	4 222	2 276	999	0.54	0.24	0.44
2012–13	3 823	2 530	188	0.66	0.05	0.07
2013–14	5 185	2 431	1 165	0.47	0.22	0.48
2014–15	4 184	1 408	531	0.34	0.13	0.38
2015–16	4 774	2 717	1 031	0.57	0.22	0.38
2016–17	5 671	4 724	1 620	0.83	0.29	0.34
2017–18	5 199	4 049	1 631	0.78	0.31	0.40
All years	65 922	46 642	22 243	0.73	0.37	0.49

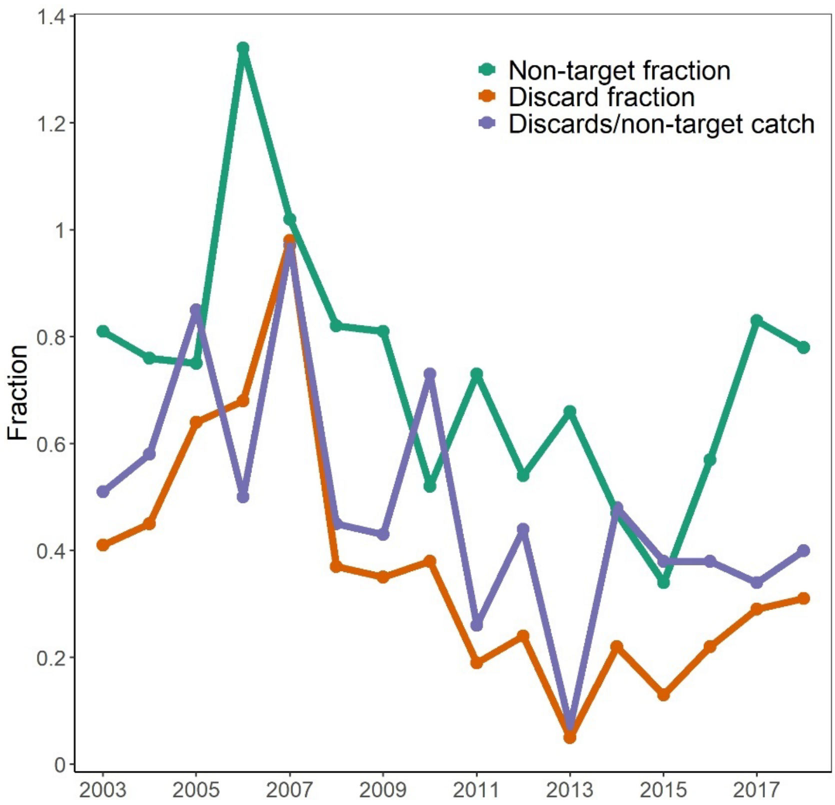

Figure 22: Non-target catch and discard fractions in the target ling longline fishery. Non-target fraction, total non-target catch divided by total estimated ling catch; Discard fraction, total discards divided by total estimated ling catch; Discards/non-target catch, total discards divided by total non-target catch.

3.7 The effect of observer coverage level on estimates of precision

Precision estimates (CVs) of the main catch categories of non-target catch and discards were compared with annual observer coverage levels to determine if model precision improved with increased levels of observer effort in the fishery (Table 10 and Figure 23).

Estimated precision improved with increased observer coverage for non-target catch in all categories. This is most clearly shown for QMS non-target catch, for which the CV is generally over 40% when observer coverage was less than 10% (Table 10). The CVs for QMS, non-QMS, and total species non-target catch were unusually high in 2009–10 and 2011–12 where observer coverage of target catch was about 10%. Precision was generally highest for non-QMS species and total (all species) categories, for both non-target catch and discards. For discards, estimated precision did not appear to improve with increased observer coverage. Discards of the target species were poorly estimated when observer coverage was both low (under 10%), and high (over 30%). Non-linear least squares regressions fitted to the data points for all categories indicated that to achieve a CV of 30%, for example, would require observer coverage of about 7% for non-target catch and about 5% for discards.

Table 10: Observer coverage (percent of total target species catch) and estimates of precision (CVs) for annual estimates of non-target catch and discards in the main catch categories. Rows are ordered from lowest to highest annual observer coverage; — not estimated.

Fishing year	Observer coverage (%)	Non-target catch CVs (%)				Discards CVs (%)				
		QMS	non-QMS	INV	Total	LIN	QMS	non-QMS	INV	Total
2013	3.1	57.1	113.9	13.4	84.7	21.4	18.7	29.5	—	15.1
2015	3.6	54.6	95.6	26.2	55.5	142.8	30.5	32.0	17.9	18.1
2011	5.3	51.0	57.2	8.5	47.9	13.9	21.1	35.4	8.5	16.5
2016	6.5	49.1	58.3	29.5	43.4	110.3	35.2	26.8	15.1	18.7
2014	6.7	36.4	59.8	18.3	35.1	27.7	27.5	28.7	8.5	17.0
2012	9.9	298.0	171.3	69.6	208.1	19.3	27.2	23.2	8.5	19.7
2010	11.4	369.2	229.2	0.0	289.7	19.4	36.2	27.5	29.5	18.9
2017	14.5	13.6	22.0	35.9	12.7	53.1	41.3	24.8	34.5	29.5
2008	16.5	37.5	53.6	14.5	33.9	27.7	30.2	25.9	23.2	28.0
2005	17.4	28.5	45.1	23.2	27.4	17.2	26.5	29.0	0.0	15.3
2018	19.4	25.3	42.6	8.5	24.2	44.5	32.0	21.7	0.0	16.8
2007	20.2	34.1	67.8	23.2	40.0	25.4	30.0	31.7	24.4	24.0
2009	25.1	38.2	81.8	15.1	41.0	9.8	21.8	22.8	27.4	15.4
2004	30.6	16.7	27.3	18.6	14.8	31.0	19.1	31.1	19.2	12.7
2006	37.4	35.8	81.8	17.9	40.1	87.3	34.2	29.2	18.6	20.0
2003	68.9	18.1	17.7	15.3	14.3	8.4	13.9	11.8	15.0	7.5

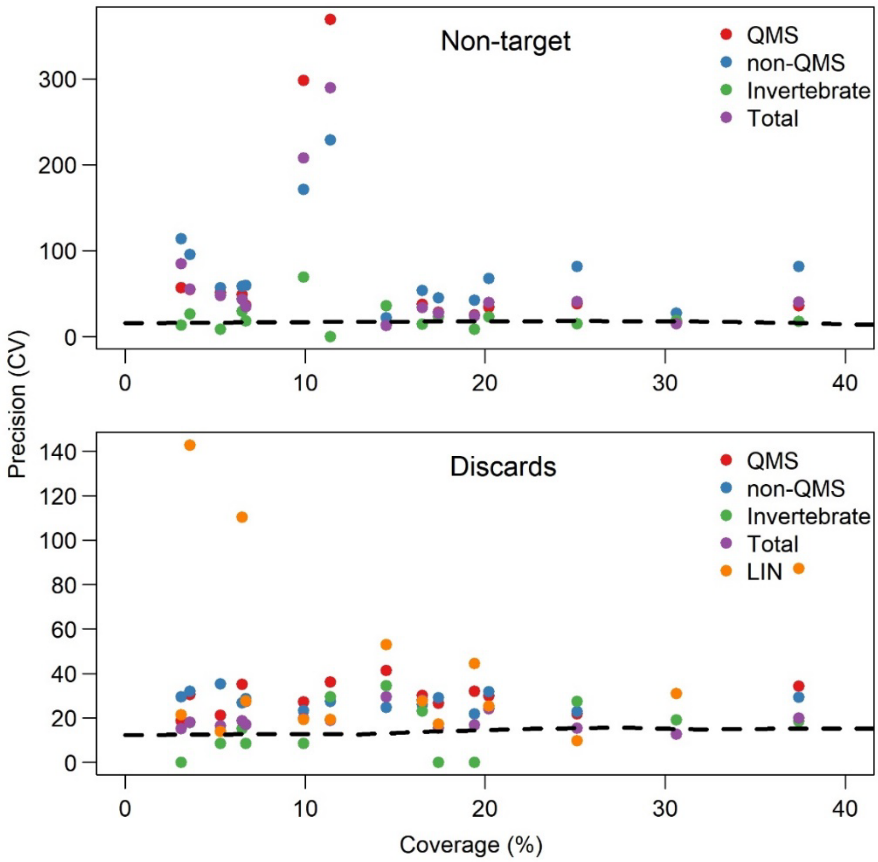

Figure 23: Precision (CV) of annual estimates of non-target catch (top) and discards (bottom) plotted against observer coverage levels (percentage of target species catch, see Table 2), for each of the main categories of catch and discards. The black line in each plot represents a non-linear least squares regression through the points.

3.8 Annual non-target catch and discards by selected categories and individual species

Annual non-target catch 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 Tables A6–A8 and Figure 24.

Based on these estimates, the non-target catch species or species categories caught in the greatest amounts over the entire commercial fishery were (in decreasing order) sharks (cumulative), spiny dogfish (SPD), Schedule 6 species, morid cods, ribaldo (RIB), rays, shovelnose dogfish (SND), sea perch (SPE), rough skate (RSK), smooth skate (SSK), chimaeras, and red cod (RCO) (Table A6, Figure 24). Of the top 30 non-target catch species/species groups examined, only one species, hoki (HOK) had a significant and increasing trend (at the 1% level of significance) over time (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 non-target catch and often close to zero (Figure 24). 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), as well as red cod, dark ghost shark, and hoki in recent years. Over the time series, there were significant decreases in discards of ling and school shark, and although many other species and species groups showed decreasing trends in discards as well, these trends were not significant (Figure 24).

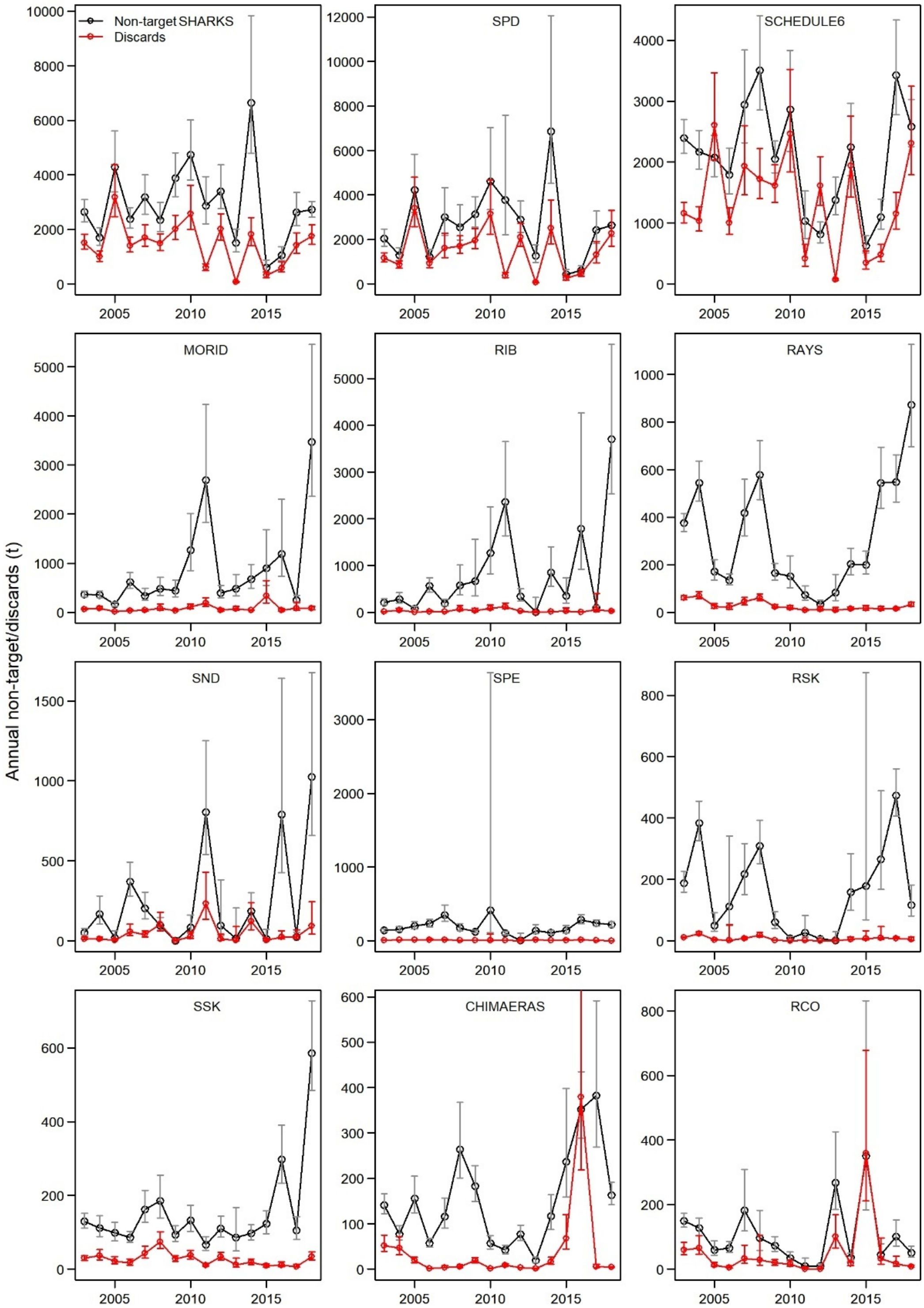

Figure 24: Estimates of annual non-target catch and discards in the target ling longline fishery for selected non-target species groups and the main individual non-target species, with 95% CIs. Plots are ordered (from left to right, top to bottom) by decreasing total catch over the period. See Table A1 for species code definitions. Note: the scale changes on the y-axis between plots.

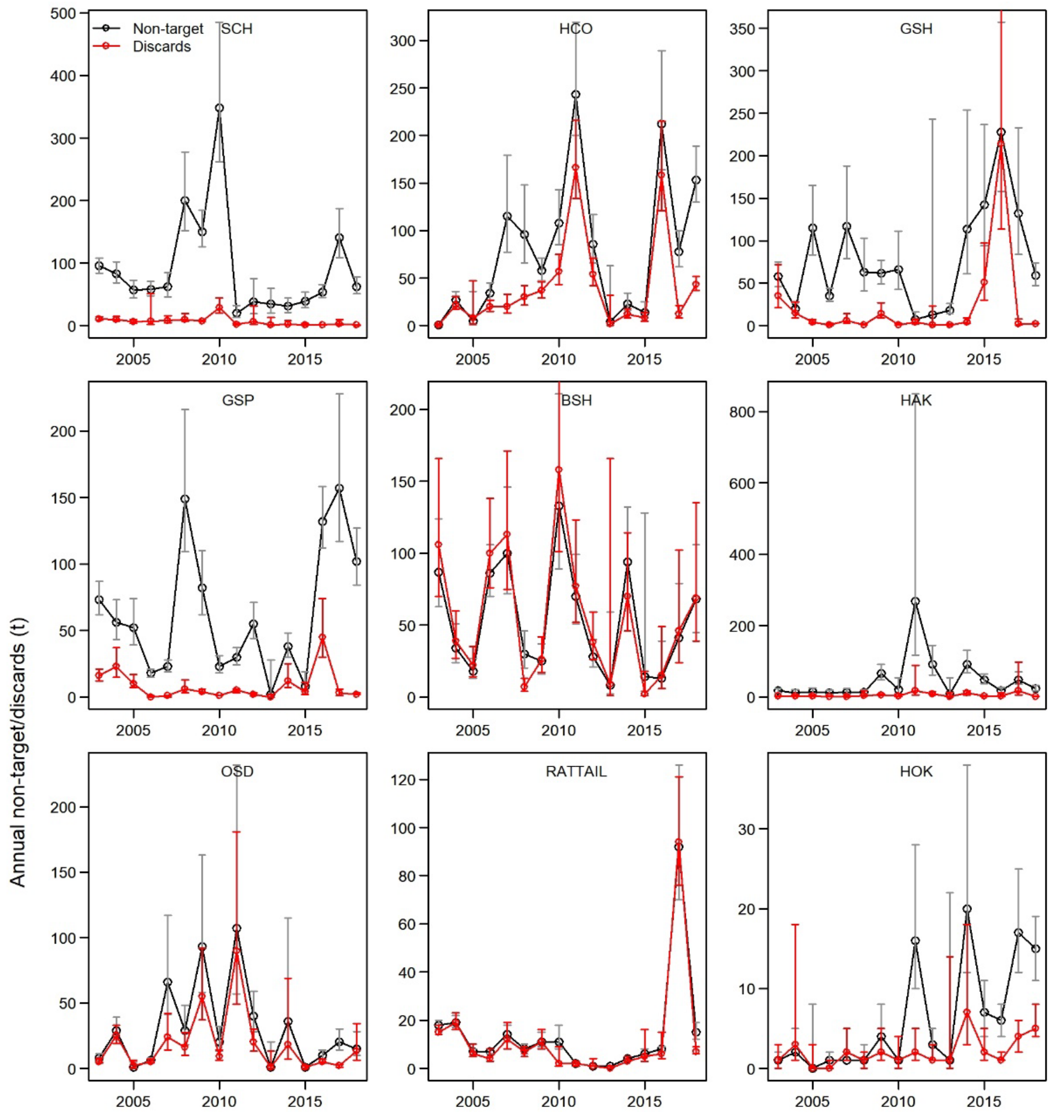

Figure 24: ***continued*****.**

4. SUMMARY AND DISCUSSION

Observer coverage

The annual estimates of non-target catch and discards for the ling target longline fishery rely on data collected from the observed fraction of the fishery and therefore are 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.

The level of observer coverage in the ling longline fishery has historically been lower than most of the other deepwater fisheries for which non-target catch and discard levels are assessed. For comparison with other deepwater 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 20% in the combined hoki, hake, ling, silver warehou, and white warehou trawl fishery (Anderson & Edwards 2018, Anderson 2009; Anderson 2014, Anderson et al. 2017a; Anderson et al. 2017b, Anderson et al. 2019). Since 2002–03, observer coverage of target catch in the ling longline fishery averaged 17%, slightly higher than the 13% previously reported for the 1992–93 to 2011–12 period (Anderson 2014). Annual coverage in the ling longline fishery has been highly variable, and below 10% for most of the last decade. The increase to 19.4% in the 2017–18 fishing year was the highest observer coverage since 2008–09 (25.1%), but still well below the 69% coverage observed in 2002–03.

The distribution of observer effort has been fairly representative of total commercial effort across the variables shown in the models to influence rates of non-target catch and discards. The main longline fisheries for ling on the Chatham Rise and sub-Antarctic (Bounty Plateau, Campbell Plateau, and Puysegur Banks) were all well sampled by observers in most years, although overall observer coverage decreased considerably between 2010 and 2013. The smaller vessels in the fishery were poorly sampled compared with the large vessels, and although representative spatial observer coverage has since increased in recent years, it is still mostly absent from around the North Island (where smaller vessels operate).

Model structure and output

The selection of standard fishery areas 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 Quota Management Areas (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.

The model-based method has been shown to perform better than the previously used ratio-based method, reducing bias and producing more reliable representation of uncertainty (Edwards et al. 2015). 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 for this analysis comprised area, fishing year, and fishing effort (number of hooks).

Estimation of non-target catch 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, and invertebrate species categories used in previous analyses of this fishery, because 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, as well as species of interest. These revised categories limited the comparison of these results with earlier analyses of the fishery to estimates of *total* non-target catch and *total* discards, and discards of the target species. The repeated estimates of total annual non-target catch and discards were very similar to earlier estimates for most years. The small differences observed are due to a change in the estimation model from the ratio method used previously to the binomial/log-normal model used here (which is better able to estimate rates in data-poor strata by utilising relevant information from other strata), as well as changes in stratification and slight differences in data grooming methods.

Composition and level of non-target catch and discards

Since 2002–03, ling accounted for about 65% of the total estimated catch weight recorded by observers in the fishery. Spiny dogfish accounted for 17%, and other main catch species included ribaldo (3.3%), rough skate (2.7%), black cod (1.7%), smooth skate (1.5%), sea perch (1.4%), and pale ghost shark (1.2%). An additional range of other (mainly non-QMS) species including various species of cartilaginous fishes and rattails were reported. Starfish were the only invertebrate group in the top 30 non-target catch taxa, accounting for over 0.5% of the catch.

Non-target catch across all years comprised predominantly QMS species, in particular spiny dogfish. Chondrichthyans (sharks, skates, rays, and chimaeras) were the primary fish non-target catch group, with shark species accounting for nearly 20% of the catch. Shark species were among the most observed non-QMS fish species in the fishery, including shovelnose dogfish (*Deania calcea*) and seal shark (*Dalatias licha*). The majority of shark catch (63%) was discarded, and approximately 10% and 20% of rays and chimaeras were discarded, respectively. Some of these species, including spiny dogfish, smooth and rough skate, and school shark, are listed under Schedule 6, allowing for alive individuals to be legally returned to the sea. The fate of returned individuals is unknown, as is the overall impact on deepwater fisheries on these species (Francis et al. 2016). Limited tagging data of deepwater sharks suggests at-vessel mortality and post-release mortality from longline fisheries is low (Rodríguez-Cabello & Sánchez, 2017). Given the large amount of deepwater shark non-target catch and discarding in this fishery, and their predominance as non-target catch species in other fisheries (e.g. Anderson et al. 2019), there is opportunity here to conduct research to further assess the impact of fishing on these species.

None of the non-target catch in either of the combined fish species categories, non-QMS species discards, and total non-target catch and total discards, showed strong or significant patterns or trends over time, although some general positive trend was observed since 2014–15. Non-target catch and discards of non-QMS invertebrates have remained consistently low and, in most recent years, accounted for under 5 t annually. In the first two years of the time series, non-target catch of non-QMS invertebrates was much higher (up to 40 t) than the last ten years. This may be explained by the larger spatial coverage of the fishery in Chatham Rise and sub-Antarctic during that earlier time period. Total non-target catch determined from commercial catch-effort records, although much lower than that estimated from observer data, showed an increasing trend since 2014–15. Discarding of the target species (ling) was generally low although variable; for most years discards were less than 100 t, with a minimum of 11 t. Discards of QMS species, non-QMS fish, and non-QMS invertebrate species followed a similar pattern to that of non-target catch, with some increasing trends in discarding in recent years.

Discards relative to target catch

The discard fraction (kilogram of discards/kilogram of target species catch) showed a declining trend from a peak of 0.98 in 2006–07 to a low of 0.05 in 2012–13 (when observer coverage was exceptionally low), with an increase in recent years. The overall discard fraction average was 0.36, which is similar to that estimated in the last iteration of this work (0.3, Anderson 2014). These rates can be compared with recent mean rates in other New Zealand deepwater trawl fisheries which are similarly monitored, as follows: arrow squid (0.12), scampi (3.6), southern blue whiting (0.005), jack mackerel (0.007), orange roughy (0.07), oreos (0.01), and the hoki/hake/ling/silver warehou/white warehou mixed fishery (0.06) (Anderson 2009, 2014, Anderson et al. 2017a, Ballara & O'Driscoll 2015, Anderson et al. 2017b, Anderson & Edwards 2018, Anderson et al. 2014).

5. ACKNOWLEDGEMENTS

We thank the observers of Fisheries New Zealand for their dedication and continued efforts over a long period to collect the high-quality data that made this analysis possible. Thanks also to members of the Aquatic Environment Working Group for their reviews of the analyses and report, in particular Marco Milardi and Daniel Kerrigan (Fisheries New Zealand). Thanks also to Sira Ballara (NIWA) for the data extraction and David Foster (Fisheries New Zealand) for provisions of the vessel class data and review comments. This report was internally reviewed at NIWA by Adele Dutilloy and Ian Tuck. This work was funded by Ministry for Primary Industries project DAE201801.

6. REFERENCES

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. (2009). Fish and invertebrate bycatch and discards in southern blue whiting fisheries, 2002–07. *New Zealand Aquatic Environment and Biodiversity Report No. 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 No. 138*. 66 p.

Anderson, O.F.; Clark, M.R.; Gilbert, D.J. (2000). Bycatch and discards in trawl fisheries for jack mackerel and arrow squid, and in the longline fishery for ling, in New Zealand waters. *NIWA Technical Report 74*. 44 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.; 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.; Edwards, C.T.T.; Ballara (2019). 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. *New Zealand Aquatic Environment and Biodiversity Report No. 220*. 117 p.

Ballara, S.L. (1997). Catch per unit effort (CPUE) analysis of ling (*Genypterus blacodes*): Chatham Rise bottom longline and Puysegur trawl fisheries. New Zealand Fisheries Assessment Research Document 97/17. 35 p. (Unpublished report held in NIWA library, Wellington.)

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.

Dunn, M.R.; Edwards, C.T.T.; Ballara, S.L.; Horn, P.L. (2013). Stock assessment of ling (*Genypterus blacodes*) in Cook Strait and off the West Coast South Island (LIN 7), and a descriptive analysis of all ling fisheries, for the 2012–13 fishing year. *New Zealand Fisheries Assessment Report 2013/63*. 102 p.

Fisheries New Zealand (2019a). Annual operational plan deepwater fisheries for 2019–20. *Fisheries New Zealand Technical Paper No. 2019/05*. 41 p.

Fisheries New Zealand (2019b). Fisheries Assessment Plenary, May 2019: stock assessments and stock status. Compiled by the Fisheries Science and Information Group, Fisheries New Zealand, Wellington, New Zealand. 1641 p.

Francis, M. P.; Roberts, J.; MacGibbon, D. J. (2016). Indicator based analysis of the status of eight shark and chimaera species in New Zealand waters. *New Zealand Fisheries Assessment Report 2016/65*. 87 p.

Edwards, C.T.T.; Doonan, I.; Anderson, O.F. (2015). Comparison of bycatch estimation for fish species using a ratio estimator and model-based method. *New Zealand Aquatic Environment and Biodiversity Report No. 154*. 30 p.

Horn, P.L. (2007). A descriptive analysis of commercial catch and effort data for ling from New Zealand waters in Fishstocks LIN 2, 3, 4, 5, 6, and 7. *New Zealand Fisheries Assessment Report 2007/22*. 71 p.

Horn, P.L.; Ballara, S.L. (2012). A descriptive analysis and CPUE from commercial fisheries for ling (*Genypterus blacodes*) in Fishstocks LIN 2, 3, 4, 5, 6, and 7 from 1990 to 2009. *New Zealand Fisheries Assessment Report 2012/13*. 69 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.

Michaelis, L.; Menten, M. L. (1913). Die Kinetik der Invertinwirkung, *Biochemische Zeitschrift* 49, 333–369

Ministry for Primary Industries (2018). Aquatic Environment and Biodiversity Annual Review 2018. 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/.

Rodríguez-Cabello, C.; Sánchez, F. (2017). Catch and post-release mortalities of deep-water sharks caught by bottom longlines in the Cantabrian Sea (NE Atlantic). *Journal of Sea Research 130*: 248–255.

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. I*nternational 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 No. 86*. 317 p.

APPENDIX A: Data summary tables

Table A1: **Observed FISH catch and discards for target ling longline. Species codes, common and scientific names, observed catch estimates, percentage of total catch, and overall percentage discarded of the top 100 fish species or species groups by weight from observer records for the target trawl fishery from 1 Oct 2002 to 30 Sep 2018. Records are ordered by decreasing percentage of catch. [Continued on next page]**

Species code	Common name	Scientific name	Observed catch estimates (t)	% of catch	% discarded
LIN	Ling	*Genypterus blacodes*	11 451.5	64.6	1.0
SPD	Spiny dogfish	*Squalus acanthias*	2 615.7	14.8	67.9
RIB	Ribaldo	*Mora moro*	579.7	3.3	7.4
RSK	Rough skate	*Zearaja nasuta*	474.0	2.7	4.2
BCD	Black cod	*Paranotothenia magellanica*	294.7	1.7	47.2
SSK	Smooth skate	*Dipturus innominatus*	260.2	1.5	12.6
SPE	Sea perch	*Helicolenus* spp.	255.1	1.4	4.2
GSP	Pale ghost shark	*Hydrolagus bemisi*	220.9	1.2	10.0
RCO	Red cod	*Pseudophycis bachus*	210.4	1.2	15.7
SND	Shovelnose spiny dogfish	*Deania calcea*	189.3	1.1	17.5
SCH	School shark	*Galeorhinus galeus*	134.9	0.8	6.4
GSH	Ghost shark	*Hydrolagus novaezealandiae*	113.7	0.6	28.3
HCO	Hairy conger	*Bassanago hirsutus*	105.3	0.6	60.6
BSH	Seal shark	*Dalatias licha*	92.0	0.5	77.4
CSQ	Leafscale gulper shark	*Centrophorus squamosus*	77.2	0.4	36.3
OSD	Other sharks and dogs	Selachii	76.6	0.4	58.8
CON	Conger eel	*Conger* spp.	48.3	0.3	87.1
RAT	Rattails	Macrouridae	44.5	0.3	46.2
SCO	Swollenhead conger	*Bassanago bulbiceps*	37.6	0.2	99.7
HAG	Hagfish	*Eptatretus cirrhatus*	35.1	0.2	83.0
DWD	Deepwater dogfish	Selachii	31.0	0.2	99.2
BNS	Bluenose	*Hyperoglyphe antarctica*	30.5	0.2	2.1
HAK	Hake	*Merluccius australis*	30.0	0.2	7.3
PLS	Plunket's shark	*Proscymnodon plunketi*	27.3	0.2	29.6
CAR	Carpet shark	*Cephaloscyllium isabellum*	26.7	0.2	95.8
HAP	Hapuku	*Polyprion oxygeneios*	24.7	0.1	0.9
NSD	Northern spiny dogfish	*Squalus griffini*	22.7	0.1	94.9
SKA	Skate	Rajidae Arhynchobatidae	19.4	0.1	61.8
ETB	Baxters lantern dogfish	*Etmopterus granulosus*	16.4	0.1	71.4
CHI	*Chimaera* spp.	*Chimaera* spp.	12.6	0.1	28.9
BAS	Bass groper	*Polyprion americanus*	11.4	0.1	0.6
HPB	Hapuku & bass	*Polyprion oxygeneios* & *P americanus*	10.8	0.1	0.4
ETL	Lucifer dogfish	*Etmopterus lucifer*	9.6	0.1	85.2
ETM	*Etmopterus* sp	*Etmopterus* sp.	8.1	<0.1	84.8
SEE	Silver conger	*Gnathophis habenatus*	7.0	<0.1	56.6
HOK	Hoki	*Macruronus novaezelandiae*	6.1	<0.1	18.2
DSK	Deepwater spiny skate	*Amblyraja hyperborea*	6.0	<0.1	100.0
CHP	Chimaera brown	*Chimaera* sp.	5.3	<0.1	100.0
CHG	Giant chimaera	*Chimaera lignaria*	5.3	<0.1	80.0
HEX	Sixgill shark	*Hexanchus griseus*	5.0	<0.1	89.8
POS	Porbeagle shark	*Lamna nasus*	4.2	<0.1	43.6
CYO	Smooth skin dogfish	*Centroscymnus owstoni*	3.3	<0.1	97.8
SQA	*Squalus* spp	*Squalus* spp.	2.9	<0.1	100.0
DWE	Deepwater eel		2.4	<0.1	100.0
CYP	Longnose velvet dogfish	*Centroscymnus crepidater*	2.1	<0.1	95.1
BWS	Blue shark	*Prionace glauca*	2.0	<0.1	35.4
RBM	Rays bream	*Brama brama*	1.5	<0.1	13.4
SEV	Broadnose sevengill shark	*Notorynchus cepedianus*	1.4	<0.1	96.1

Table A1: continued

Species code	Common name	Scientific name	Observed catch estimates (t)	% of catch	% discarded
SSH	Slender smooth-hound	*Gollum attenuatus*	1.3	<0.1	100.0
RSO	Gemfish	*Rexea* spp.	1.2	<0.1	2.7
SBR	Southern bastard cod	*Pseudophycis barbata*	1.1	<0.1	93.8
BCO	Blue cod	*Parapercis colias*	1.1	<0.1	36.2
SWO	Broadbill swordfish	*Xiphias gladius*	1.0	<0.1	0.0
TRU	Trumpeter	*Latris lineata*	1.0	<0.1	1.7
GIZ	Giant stargazer	*Kathetostoma* spp.	0.9	<0.1	54.4
DCS	Dawson's catshark	*Bythaelurus dawsoni*	0.9	<0.1	35.8
HYD	*Hydrolagus* sp	*Hydrolagus* sp.	0.8	<0.1	100.0
JAV	Javelin fish	*Lepidorhynchus denticulatus*	0.8	<0.1	78.4
RCK	Rockfish	Acanthoclinidae	0.8	<0.1	100.0
SHA	Shark	Selachii	0.6	<0.1	100.0
WHX	White rattail	*Trachyrincus aphyodes*	0.5	<0.1	100.0
PTO	Patagonian toothfish	*Dissostichus eleginoides*	0.5	<0.1	0.0
MAK	Mako shark	*Isurus oxyrinchus*	0.5	<0.1	45.2
HYB	Black ghost shark	*Hydrolagus homonycteris*	0.5	<0.1	100.0
BRC	Northern bastard cod	*Pseudophycis breviuscula*	0.4	<0.1	100.0
CSH	Catshark		0.4	<0.1	99.2
NMP	Tarakihi	*Nemadactylus macropterus, N. rex*	0.4	<0.1	5.7
TOA	Toadfish	*Neophrynichthys* sp.	0.3	<0.1	85.7
PSK	Longnosed deepsea skate	*Bathyraja shuntovi*	0.3	<0.1	100.0
BYX	Alfonsino & long-finned beryx	*Beryx splendens* & *B. decadactylus*	0.3	<0.1	2.7
HEP	Sharpnose sevengill shark	*Heptranchias perlo*	0.3	<0.1	100.0
BTH	Bluntnose skates deepsea skates	*Notoraja* spp.	0.3	<0.1	100.0
SPO	Rig	*Mustelus lenticulatus*	0.2	<0.1	100.0
THR	Thresher shark	*Alopias vulpinus*	0.2	<0.1	70.2
BEE	Basketwork eel	*Diastobranchus capensis*	0.2	<0.1	99.5
SNR	Rough shovelnose dogfish	*Deania histricosa*	0.2	<0.1	88.1
OSK	Skate other	Rajidae	0.2	<0.1	14.5
TOP	Pale toadfish	*Ambophthalmos angustus*	0.1	<0.1	52.5
ETP	Smooth lanternshark	*Etmopterus pusillus*	0.1	<0.1	100.0
ELT	*Electrona* spp	*Electrona* spp.	0.1	<0.1	100.0
AST	Snaggletooths	Astronesthinae	0.1	<0.1	100.0
SOP	Pacific sleeper shark	*Somniosus pacificus*	0.1	<0.1	100.0
SSO	Smooth oreo	*Pseudocyttus maculatus*	0.1	<0.1	100.0
FHD	Deepsea flathead	*Hoplichthys haswelli*	0.1	<0.1	76.8
OFH	Oilfish	*Ruvettus pretiosus*	0.1	<0.1	15.5
WWA	White warehou	*Seriolella caerulea*	0.1	<0.1	0.6
SPR	Sprats	*Sprattus antipodum S. muelleri*	0.1	<0.1	1.0
HJO	Slender cods	*Halargyreus* spp.	0.1	<0.1	100.0
APR	Catshark	*Apristurus* spp.	0.1	<0.1	100.0
VCO	Violet cod	*Antimora rostrata*	0.1	<0.1	100.0
WIT	Witch	*Arnoglossus scapha*	0.1	<0.1	100.0
MOR	Moray eel	Muraenidae	0.1	<0.1	100.0
SNA	Snapper	*Pagrus auratus*	0.1	<0.1	0.0
ODO	Smalltooth sand tiger shark	*Odontaspis ferox*	0.1	<0.1	30.2
HGB	Giant black ghost shark	*Hydrolagus* sp. d	0.1	<0.1	100.0
LCH	Long-nosed chimaera	*Harriotta raleighana*	0.1	<0.1	74.4
CYL	Portuguese dogfish	*Centroscymnus coelolepis*	0.1	<0.1	51.7

Table A2: **Observed INVERTEBRATE non-target and discards for target ling longline. Species codes, common and scientific names, observed estimated catch, percentage of total catch, and overall percentage discarded for the top 100 invertebrate species or species groups by weight from observer records for the target trawl fishery from 1 Oct 2002 to 30 Sep 2018. Records are ordered by decreasing percentage of catch. [Continued on next page]**

Species code	Common name	Scientific name	Observed estimates (kg)	% of catch	% discarded
SFI	Starfish	Asteroidea & Ophiuroidea	28 447.1	0.2	96.1
ANT	Anemones	Anthozoa	5 974.9	<0.1	99.7
CRB	Crab		1 182.0	<0.1	99.5
ONG	Sponges	Porifera	512.0	<0.1	99.6
PSI	Geometric star	*Psilaster acuminatus*	461.1	<0.1	78.8
ASR	Asteroid (starfish)		283.5	<0.1	97.6
COU	Coral (unspecified)	AlcyonaceaGorgonaceaScleractiniaAntipatharia (Orders) & Stylasteridae(Family*)*	176.8	<0.1	100.0
DMG	*Dipsacaster magnificus*	*Dipsacaster magnificus*	173.0	<0.1	46.2
OCT	Octopus	*Pinnoctopus cordiformis*	163.0	<0.1	74.5
GAS	Gastropods	Gastropoda	160.5	<0.1	83.7
HMT	Deepsea anemone	Hormathiidae	133.3	<0.1	96.8
PKN	Abyssal star	*Plutonaster knoxi*	121.0	<0.1	100.0
PNE	*Proserpinaster neozelanicus*	*Proserpinaster neozelanicus*	118.0	<0.1	99.2
GSC	Giant spider crab	*Jacquinotia edwardsii*	116.0	<0.1	0.3
QSC	Queen scallop	*Zygochlamys delicatula*	96.1	<0.1	1.0
GDU	Bushy hard coral	*Goniocorella dumosa*	73.3	<0.1	94.5
CPA	Pentagon star	*Ceramaster patagonicus*	56.0	<0.1	91.1
SOT	*Solaster torulatus*	*Solaster torulatus*	50.0	<0.1	94.0
SPI	Spider crab		49.0	<0.1	90.8
ZOR	Rat-tail star	*Zoroaster* spp.	48.7	<0.1	90.1
COR	Hydrocorals	Stylasteridae	42.0	<0.1	100.0
MOL	Molluscs		38.0	<0.1	100.0
ACS	Smooth deepsea anemones	Actinostolidae	36.8	<0.1	88.3
MSL	Starfish	*Mediaster sladeni*	34.0	<0.1	100.0
ECN	Echinoid (sea urchin)		27.8	<0.1	100.0
KIC	King crab	*Lithodes murrayi Neolithodes brodiei*	27.0	<0.1	0.2
CBB	*Coral rubble*		24.2	<0.1	100.0
FMA	*Fusitriton magellanicus*	*Fusitriton magellanicus*	21.7	<0.1	85.3
LEI	*Leiopathes* spp.	*Leiopathes* spp.	15.0	<0.1	100.0
SMO	Cross-fish	*Sclerasterias mollis*	15.0	<0.1	93.3
SCA	Scallop	*Pecten novaezelandiae*	14.0	<0.1	100.0
BOO	Bamboo coral	*Keratoisis* spp.	13.1	<0.1	100.0
ATR	Sea anemones	Actiniaria	12.3	<0.1	100.0
HTH	Sea cucumber	*Holothurian unidentified*	12.2	<0.1	83.6
GPA	Sea urchin	*Goniocidaris parasol*	10.0	<0.1	80.0
PCH	*Penion chathamensis*	*Penion chathamensis*	10.0	<0.1	0.0
SIA	Stony corals	Scleractinia	8.4	<0.1	100.0
JFI	Jellyfish		8.0	<0.1	100.0
SCC	Sea cucumber	*Stichopus mollis*	8.0	<0.1	100.0
VOL	Volute	Volutidae	8.0	<0.1	87.5
DDI	*Desmophyllum dianthus*	*Desmophyllum dianthus*	7.9	<0.1	24.1
SUA	Fleshy club sponge	*Suberites affinis*	6.3	<0.1	97.1
CJA	Sun star	*Crossaster multispinus*	6.1	<0.1	83.6
HIS	*Histocidaris* spp.	*Histocidaris* spp.	6.1	<0.1	100.0
DPP	*Diplopteraster* sp.	*Diplopteraster* sp.	6.0	<0.1	66.7
HTR	Trojan starfish	*Hippasteria phrygiana*	6.0	<0.1	61.0
PSL	*Paralomis dosleini*	*Paralomis dosleini*	6.0	<0.1	100.0
SCI	Scampi	*Metanephrops challengeri*	6.0	<0.1	66.7
URO	Sea urchin other		6.0	<0.1	100.0

Table A2: continued

Species code	Common name	Scientific name	Observed estimates (kg)	% of catch	% discarded
CIC	Orange frond sponge	*Crella incrustans*	5.0	<0.1	100.0
GOR	*Gorgonocephalus* spp	*Gorgonocephalus* spp.	4.5	<0.1	55.6
NEB	Brodie's king crab	*Neolithodes brodiei*	4.0	<0.1	0.0
OPH	Ophiuroid (brittle star)		4.0	<0.1	100.0
PRU	*Pseudechinaster rubens*	*Pseudechinaster rubens*	3.7	<0.1	100.0
PLE	Sea fans	Plexauridae	3.6	<0.1	100.0
PLN	Chipped fibreglass matt sponge	*Poecillastra laminaris*	3.3	<0.1	6.1
SQU	Arrow squid	*Nototodarus sloanii* & *N. gouldi*	3.0	<0.1	100.0
TFA	Frilled crab	*Trichopeltarion fantasticum*	3.0	<0.1	66.7
WHE	Whelks		3.0	<0.1	100.0
HDR	Hydroid	Hydrozoa	2.9	<0.1	65.5
BHE	*Bathypectinura heros*	*Bathypectinura heros*	2.0	<0.1	50.0
GMC	Garrick's masking crab	*Leptomithrax garricki*	2.0	<0.1	100.0
LLC	Long-legged masking crab	*Leptomithrax longipes*	2.0	<0.1	100.0
NCB	Smooth red swimming crab	*Nectocarcinus bennetti*	2.0	<0.1	100.0
NUD	Nudibranchs	Nudibranchia	2.0	<0.1	100.0
PAD	Paddle crab	*Ovalipes catharus*	2.0	<0.1	1.0
PAO	*Pillsburiaster aoteanus*	*Pillsburiaster aoteanus*	2.0	<0.1	0.0
PMN	*Primnoa* spp.	*Primnoa* spp.	2.0	<0.1	100.0
PZE	Prickly king crab	*Paralomis zealandica*	2.0	<0.1	100.0
SDM	Pagurid	*Sympagurus dimorphus*	2.0	<0.1	0.0
SMK	Spiny masking crab	*Teratomaia richardsoni*	2.0	<0.1	100.0
BES	*Benthopecten* spp.	*Benthopecten* spp.	1.8	<0.1	100.0
COV	*Comitas onokeana vivens*	*Comitas onokeana vivens*	1.3	<0.1	100.0
DSO	Demosponges	Demospongiae	1.3	<0.1	23.1
BOC	Deepsea anemone	*Bolocera* spp.	1.2	<0.1	100.0
GYS	Siboga sea pen	*Gyrophyllum sibogae*	1.2	<0.1	100.0
AWI	*Alcithoe wilsonae*	*Alcithoe wilsonae*	1.1	<0.1	100.0
CMT	Feather star	Comatulida	1.1	<0.1	100.0
SOC	Soft coral	Alcyonacea	1.1	<0.1	9.1
ANI	*Austropenaeus nitidis*	*Austropenaeus nitidis*	1.0	<0.1	100.0
BNO	*Benthoctopus* spp.	*Benthoctopus* spp.	1.0	<0.1	0.0
CAO	*Caenopedina otagoensis*	*Caenopedina otagoensis*	1.0	<0.1	0.0
CAY	*Caryophyllia* spp	*Caryophyllia* spp.	1.0	<0.1	100.0
CDY	*Cosmasterias dyscrita*	*Cosmasterias dyscrita*	1.0	<0.1	100.0
CRE	White hydrocoral	*Calyptopora reticulata*	1.0	<0.1	0.0
ELP	Gill biter	*Elthusa propinqua*	1.0	<0.1	100.0
GAT	*Gastroptychus* spp.	*Gastroptychus* spp.	1.0	<0.1	0.0
GLS	Glass sponges	Hexactinellida	1.0	<0.1	0.0
GVO	Golden volute	*Provocator mirabilis*	1.0	<0.1	100.0
LPT	Spiny lace coral	*Lepidotheca* spp.	1.0	<0.1	0.0
OPI	Umbrella octopus	*Opisthoteuthis* spp.	1.0	<0.1	100.0
OSP	Pacific oyster spat	*Crassostrea gigas*	1.0	<0.1	100.0
PHB	Grey fibrous massive sponge	*Phorbas* spp.	1.0	<0.1	100.0
PRI	Primnoidae	Primnoidae	1.0	<0.1	0.0
SQX	Squid		1.0	<0.1	100.0
SSC	Giant masking crab	*Leptomithrax australis*	1.0	<0.1	100.0
STP	Solitary bowl coral	*Stephanocyathus platypus*	1.0	<0.1	0.0
SUR	Kina	*Evechinus chloroticus*	1.0	<0.1	1.0
SVA	*Solenosmilia variabilis*	*Solenosmilia variabilis*	1.0	<0.1	100.0
TLO	Encrusting long polyps coral	*Telesto* spp.	1.0	<0.1	100.0

Table A3: **Observed estimated non-target catch by species group for the target longline fishery. Observed estimated catch, percentage of total catch, and overall percentage discarded from observer records for the target ling longline fishery from 1 Oct 2002 to 30 Sep 2018.**

Group	Observed catch estimates (kg)	% of catch	% discarded
Fish			
Ling	11 451 483.5	64.6	1.0
Sharks	3 353 618.2	18.9	62.5
Fish (other)*	1 504 271.9	8.5	17.8
Rays	760 369.0	4.3	9.4
Chimaeras	359 230.1	2.0	18.1
Eels	201 032.7	1.1	74.7
Rattails (all species combined)	45 886.3	0.3	47.4
Invertebrates			
Echinoderms	29 917.8	0.2	95.5
Cnidaria	6 547.2	0.0	99.4
Crustacea	1 412.2	0.0	88.3
Porifera	530.8	0.0	98.6
Other molluscs	359.1	0.0	62.0
Octopuses	165.0	0.0	74.2
Squid	6.0	0.0	66.7
Zoo&Phytoplankton	2.0	0.0	100.0

* All fish species not in any of the other categories in this table.

Table A3: Estimates of annual non-target catch (rounded to the nearest t) in the target ling longline fishery, by species category and standard area. 95% confidence intervals in parentheses. SQUAK is AUCK.

(a) QMS species

Fishing year	CHAT		COOK		EAST		NORTH		PUYS	
2002–03	446	(407-489)	42	(24-75)	131	(89-200)	7	(1-42)	43	(8-200)
2003–04	1678	(1480-1920)	18	(4-97)	61	(12-304)	4	(1-22)	28	(20-38)
2004–05	1726	(1481-2031)	44	(8-216)	63	(12-343)	9	(6-12)	28	(22-36)
2005–06	1768	(1581-1981)	83	(69-101)	220	(170-287)	16	(3-90)	82	(16-436)
2006–07	831	(677-1012)	103	(81-134)	100	(76-131)	12	(9-15)	32	(24-42)
2007–08	1696	(1441-2010)	93	(27-349)	130	(32-501)	38	(21-78)	155	(92-277)
2008–09	1877	(1661-2134)	21	(4-138)	105	(18-554)	11	(2-67)	22	(4-122)
2009–10	1560	(280-7918)	13	(2-67)	77	(15-441)	9	(1-56)	4	(1-25)
2010–11	1155	(1026-1333)	30	(5-176)	117	(20-760)	17	(3-117)	58	(18-187)
2011–12	1240	(238-6856)	10	(2-59)	70	(14-377)	12	(2-79)	35	(7-176)
2012–13	1308	(1118-1559)	12	(2-83)	70	(11-505)	9	(1-64)	35	(6-234)
2013–14	1001	(912-1104)	28	(5-152)	106	(19-536)	13	(2-82)	70	(31-165)
2014–15	698	(611-796)	12	(7-21)	44	(23-85)	9	(2-54)	24	(4-134)
2015–16	1416	(1275-1588)	18	(4-99)	28	(23-35)	9	(2-50)	70	(35-146)
2016–17	2667	(2375-3006)	67	(35-129)	70	(55-88)	12	(3-68)	124	(79-199)
2017–18	2318	(2138-2506)	11	(8-15)	224	(47-1135)	17	(3-93)	61	(32-112)

Fishing year	SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	0	(0-0)	41	(34-50)	262	(236-292)	0	(0-1)	65	(37-118)
2003–04	12	(7-20)	87	(72-105)	523	(466-588)	1	(0-8)	28	(19-41)
2004–05	2	(0-12)	67	(43-103)	142	(113-176)	1	(0-6)	86	(16-446)
2005–06	0	(0-0)	30	(26-36)	126	(27-689)	6	(1-38)	115	(19-617)
2006–07	0	(0-0)	333	(233-472)	102	(23-448)	10	(7-16)	103	(19-507)
2007–08	1	(0-8)	196	(109-363)	669	(551-825)	29	(4-204)	229	(46-1329)
2008–09	0	(0-0)	143	(40-512)	262	(214-324)	17	(2-120)	151	(26-850)
2009–10	18	(11-31)	52	(37-73)	338	(252-464)	23	(3-154)	85	(16-494)
2010–11	72	(24-226)	77	(16-377)	149	(120-190)	44	(7-289)	118	(23-710)
2011–12	16	(12-23)	285	(143-576)	94	(80-112)	27	(4-185)	118	(92-152)
2012–13	0	(0-0)	80	(11-588)	0	(0-0)	14	(2-112)	75	(12-489)
2013–14	11	(6-21)	80	(58-114)	381	(328-448)	25	(4-166)	125	(24-640)
2014–15	0	(0-0)	51	(11-249)	189	(37-934)	12	(2-83)	112	(94-134)
2015–16	3	(1-20)	35	(24-52)	279	(53-1486)	24	(3-164)	133	(85-207)
2016–17	0	(0-0)	16	(11-22)	881	(764-1035)	22	(13-36)	81	(52-132)
2017–18	26	(20-35)	123	(74-202)	439	(345-554)	37	(6-223)	111	(86-143)

Table A4: continued

(b) Non-QMS species

Fishing year	CHAT		COOK		EAST		NORTH		PUYS	
2002–03	1563	(1407-1731)	16	(9-31)	53	(34-82)	6	(1-42)	60	(9-349)
2003–04	83	(67-105)	4	(1-25)	26	(5-162)	1	(0-6)	17	(10-28)
2004–05	224	(180-284)	6	(1-31)	17	(3-98)	1	(1-2)	23	(16-34)
2005–06	108	(89-133)	34	(25-49)	255	(164-402)	5	(1-39)	62	(10-376)
2006–07	204	(152-284)	39	(27-60)	91	(58-145)	5	(3-9)	49	(32-81)
2007–08	187	(155-232)	8	(2-33)	34	(7-149)	5	(2-13)	53	(27-102)
2008–09	150	(128-179)	4	(1-27)	38	(6-255)	2	(0-19)	9	(1-73)
2009–10	153	(27-965)	1	(0-9)	19	(3-112)	1	(0-12)	1	(0-9)
2010–11	521	(414-653)	4	(1-36)	27	(4-187)	3	(0-18)	34	(9-162)
2011–12	123	(22-789)	1	(0-6)	15	(2-84)	2	(0-13)	9	(1-48)
2012–13	59	(48-76)	1	(0-6)	10	(1-78)	1	(0-9)	6	(1-45)
2013–14	199	(163-247)	4	(1-25)	29	(5-181)	2	(0-15)	31	(8-106)
2014–15	94	(69-131)	1	(0-3)	24	(7-84)	1	(0-11)	8	(1-47)
2015–16	457	(379-566)	3	(0-16)	6	(4-11)	1	(0-11)	9	(3-25)
2016–17	145	(122-173)	13	(5-30)	8	(5-13)	1	(0-9)	31	(17-59)
2017–18	416	(352-492)	1	(1-3)	73	(14-401)	4	(1-26)	20	(8-55)

Fishing year	SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	0	(0-0)	35	(29-44)	277	(246-315)	0	(0-2)	123	(65-233)
2003–04	2	(1-5)	47	(33-68)	348	(286-436)	1	(0-6)	78	(43-144)
2004–05	0	(0-3)	5	(3-10)	47	(35-65)	0	(0-3)	32	(5-211)
2005–06	0	(0-0)	29	(21-41)	83	(14-458)	5	(1-45)	96	(16-538)
2006–07	0	(0-0)	133	(78-239)	79	(14-450)	18	(9-39)	110	(19-622)
2007–08	0	(0-1)	33	(17-68)	191	(149-252)	11	(2-86)	77	(14-468)
2008–09	0	(0-0)	49	(11-212)	184	(142-249)	9	(1-77)	77	(12-527)
2009–10	4	(3-7)	16	(12-22)	35	(28-47)	9	(1-69)	28	(5-194)
2010–11	4	(1-19)	19	(3-123)	30	(21-44)	20	(2-158)	54	(8-362)
2011–12	5	(3-7)	18	(8-42)	27	(22-34)	10	(1-73)	35	(25-49)
2012–13	0	(0-0)	9	(1-71)	0	(0-0)	3	(0-29)	16	(2-154)
2013–14	1	(0-5)	39	(21-72)	183	(132-250)	14	(2-102)	70	(11-474)
2014–15	0	(0-0)	11	(2-77)	53	(9-330)	5	(1-44)	15	(11-24)
2015–16	1	(0-6)	13	(8-26)	112	(18-669)	14	(2-103)	95	(47-190)
2016–17	0	(0-0)	6	(4-9)	509	(410-643)	8	(4-17)	29	(16-54)
2017–18	16	(9-28)	17	(7-42)	101	(66-160)	21	(3-135)	38	(24-59)

Table A4: continued

(c) INVERTEBRATE species

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2003	32	(26-38)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-3)	0	(0-0)	0	(0-1)	10	(9-13)	0	(0-0)	0	(0-1)
2004	19	(15-26)	0	(0-0)	0	(0-2)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-1)	18	(15-22)	0	(0-0)	0	(0-0)
2005	1	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2006	5	(3-6)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2007	1	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2008	2	(1-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-1)	0	(0-0)	0	(0-0)
2009	3	(2-4)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-0)
2010	1	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2011	2	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2012	3	(1-10)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)
2013	3	(2-3)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)
2014	2	(2-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2015	4	(3-6)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	1	(0-3)	0	(0-0)	0	(0-0)
2016	3	(2-4)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-4)	0	(0-0)	0	(0-0)
2017	3	(2-5)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	2	(1-4)	0	(0-0)	0	(0-0)
2018	2	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)

Table A4: continued

(d) ALL species

Fishing year	CHAT		COOK		EAST		NORTH		PUYS	
2002–03	1 855	(1739-1983)	53	(34-83)	160	(116-218)	11	(2-62)	96	(22-460)
2003–04	1 741	(1564-1949)	22	(5-104)	86	(19-391)	5	(1-26)	44	(34-58)
2004–05	1 858	(1616-2141)	44	(10-190)	78	(16-341)	9	(6-12)	48	(38-61)
2005–06	1 927	(1737-2162)	114	(95-137)	465	(356-612)	19	(4-99)	157	(31-796)
2006–07	1 099	(884-1380)	154	(119-202)	205	(152-272)	15	(11-19)	79	(59-107)
2007–08	1 752	(1518-2036)	93	(27-315)	152	(48-480)	41	(22-75)	219	(137-354)
2008–09	1 841	(1678-2032)	24	(5-130)	146	(27-726)	12	(2-62)	34	(7-154)
2009–10	1 554	(327-7330)	12	(2-59)	83	(18-380)	8	(1-44)	6	(1-28)
2010–11	1 686	(1493-1915)	33	(7-166)	157	(32-796)	19	(4-98)	103	(38-296)
2011–12	1 392	(322-5939)	10	(2-44)	80	(17-365)	11	(2-63)	44	(10-211)
2012–13	1 803	(1304-2753)	16	(2-100)	120	(20-800)	12	(2-79)	64	(11-413)
2013–14	1 177	(1078-1294)	30	(6-119)	126	(28-617)	14	(3-70)	93	(44-196)
2014–15	776	(692-879)	12	(7-20)	64	(34-120)	9	(2-47)	31	(7-148)
2015–16	1 840	(1660-2021)	18	(4-84)	36	(29-44)	10	(2-45)	78	(40-155)
2016–17	2 898	(2602-3229)	78	(43-147)	70	(56-88)	12	(3-58)	148	(97-225)
2017–18	2 741	(2553-2955)	11	(8-15)	263	(56-1190)	16	(3-81)	76	(43-135)

Fishing year	SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	0	(0-0)	70	(62-80)	565	(525-610)	0	(0-1)	185	(114-298)
2003–04	13	(8-22)	141	(120-166)	784	(710-873)	2	(0-12)	94	(66-131)
2004–05	2	(1-13)	68	(48-99)	200	(167-241)	1	(0-8)	126	(28-588)
2005–06	0	(0-0)	54	(46-65)	223	(48-1068)	13	(2-68)	219	(48-980)
2006–07	0	(0-0)	465	(323-672)	189	(44-792)	25	(16-41)	209	(49-860)
2007–08	1	(0-7)	218	(128-376)	890	(746-1 071)	45	(8-247)	323	(79-1511)
2008–09	0	(0-0)	192	(62-575)	538	(454-644)	29	(5-166)	252	(49-1260)
2009–10	19	(13-28)	62	(50-79)	360	(293-452)	30	(5-191)	111	(21-551)
2010–11	81	(26-242)	104	(22-480)	174	(141-217)	82	(14-433)	192	(40-989)
2011–12	19	(15-26)	297	(168-505)	117	(103-134)	42	(7-237)	165	(134-203)
2012–13	0	(0-0)	135	(22-829)	0	(0-0)	31	(4-221)	152	(25-953)
2013–14	12	(7-23)	114	(84-156)	554	(476-648)	43	(9-229)	193	(44-852)
2014–15	0	(0-0)	60	(14-283)	248	(58-1073)	20	(4-111)	131	(111-157)
2015–16	4	(1-21)	49	(35-68)	387	(85-1717)	39	(8-207)	199	(137-291)
2016–17	0	(0-0)	24	(18-33)	1 338	(1 155-1 551)	38	(23-60)	99	(66-154)
2017–18	38	(30-50)	143	(88-225)	499	(395-629)	59	(12-342)	132	(103-170)

Table A4: Estimates of annual discards (rounded to the nearest t) in the ling longline fishery, by species category and standard area. 95% confidence intervals in parentheses.

(a) Ling

Fishing year	CHAT		COOK		EAST		NORTH		PUYS	
2002–03	49	(45-54)	1	(1-1)	7	(5-10)	1	(0-1)	3	(2-4)
2003–04	66	(50-93)	1	(0-2)	8	(4-15)	0	(0-1)	5	(3-11)
2004–05	105	(90-124)	3	(2-4)	12	(8-19)	1	(1-2)	8	(6-11)
2005–06	67	(36-168)	2	(1-8)	4	(1-16)	0	(0-2)	4	(2-22)
2006–07	48	(38-63)	2	(1-3)	5	(3-8)	0	(0-1)	3	(2-4)
2007–08	28	(21-39)	0	(0-1)	1	(1-3)	0	(0-0)	2	(1-4)
2008–09	33	(31-36)	0	(0-0)	4	(3-6)	0	(0-1)	0	(0-1)
2009–10	47	(40-56)	0	(0-0)	6	(4-10)	1	(0-1)	0	(0-0)
2010–11	25	(23-28)	0	(0-1)	4	(3-6)	0	(0-0)	1	(1-2)
2011–12	30	(25-36)	0	(0-0)	3	(2-5)	0	(0-1)	1	(1-2)
2012–13	69	(59-82)	1	(0-1)	9	(5-15)	1	(0-1)	3	(2-5)
2013–14	28	(21-38)	0	(0-0)	1	(0-2)	0	(0-0)	2	(1-3)
2014–15	22	(8-87)	0	(0-1)	1	(0-6)	0	(0-0)	1	(0-8)
2015–16	56	(28-166)	0	(0-2)	3	(1-11)	0	(0-1)	3	(1-14)
2016–17	44	(28-79)	1	(1-3)	3	(1-6)	0	(0-0)	4	(2-8)
2017–18	7	(4-15)	0	(0-0)	1	(0-2)	0	(0-0)	0	(0-1)

Fishing year	SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	0	(0-0)	5	(4-6)	23	(21-25)	0	(0-0)	6	(4-8)
2003–04	1	(0-4)	6	(4-13)	39	(29-58)	0	(0-1)	7	(4-12)
2004–05	0	(0-1)	6	(5-8)	9	(7-12)	0	(0-1)	10	(7-14)
2005–06	0	(0-0)	3	(1-17)	5	(2-24)	0	(0-3)	6	(2-23)
2006–07	0	(0-0)	4	(3-6)	4	(3-7)	1	(0-4)	5	(3-7)
2007–08	0	(0-0)	1	(1-2)	9	(7-13)	0	(0-1)	2	(1-4)
2008–09	0	(0-0)	2	(2-3)	5	(4-5)	2	(1-4)	3	(2-4)
2009–10	1	(1-1)	2	(1-2)	7	(6-9)	3	(1-9)	3	(2-4)
2010–11	1	(1-1)	1	(1-1)	3	(2-3)	2	(1-7)	2	(2-3)
2011–12	1	(0-1)	2	(1-3)	5	(4-6)	2	(1-6)	3	(2-4)
2012–13	0	(0-0)	4	(3-5)	0	(0-0)	3	(1-8)	5	(3-7)
2013–14	0	(0-0)	1	(0-1)	5	(4-8)	0	(0-1)	1	(1-3)
2014–15	0	(0-0)	1	(0-4)	4	(2-22)	0	(0-2)	1	(0-6)
2015–16	0	(0-1)	1	(0-5)	11	(4-42)	1	(0-8)	3	(1-12)
2016–17	0	(0-0)	0	(0-2)	16	(9-32)	0	(0-3)	2	(1-6)
2017–18	0	(0-1)	0	(0-0)	2	(1-5)	0	(0-1)	0	(0-1)

Table A5: continued

(b) QMS species

Fishing year	CHAT		COOK		EAST		NORTH		PUYS	
2002–03	128	(112-148)	1	(1-2)	4	(3-5)	0	(0-0)	1	(1-1)
2003–04	610	(522-725)	6	(4-10)	24	(18-33)	0	(0-1)	6	(4-9)
2004–05	1 365	(1 128-1 677)	23	(16-34)	39	(28-53)	2	(1-3)	13	(9-19)
2005–06	960	(753-1 268)	20	(12-34)	28	(19-42)	1	(0-1)	8	(5-15)
2006–07	1 035	(830-1 309)	23	(17-33)	29	(20-41)	0	(0-1)	6	(4-10)
2007–08	1 213	(979-1 542)	15	(9-27)	37	(26-54)	1	(0-2)	8	(5-14)
2008–09	1 080	(927-1 285)	5	(3-8)	27	(20-37)	1	(0-1)	2	(1-3)
2009–10	1 151	(903-1 535)	4	(2-8)	30	(21-44)	1	(0-1)	1	(0-1)
2010–11	246	(208-296)	2	(2-3)	10	(7-13)	0	(0-0)	2	(1-2)
2011–12	690	(566-868)	3	(2-4)	20	(15-28)	1	(0-1)	4	(3-6)
2012–13	104	(88-124)	0	(0-1)	3	(2-4)	0	(0-0)	1	(0-1)
2013–14	829	(681-1 043)	6	(4-9)	23	(16-33)	1	(0-1)	4	(3-7)
2014–15	411	(329-536)	3	(2-5)	20	(14-29)	0	(0-1)	2	(1-3)
2015–16	615	(474-816)	4	(2-8)	18	(12-27)	0	(0-0)	4	(2-6)
2016–17	1 201	(909-1674)	25	(15-48)	43	(27-67)	0	(0-1)	8	(5-15)
2017–18	1 527	(1 230-2 021)	14	(8-26)	98	(70-142)	1	(0-2)	8	(5-14)

Fishing year	SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	0	(0-0)	4	(3-5)	24	(20-28)	0	(0-0)	4	(3-6)
2003–04	2	(1-5)	20	(16-27)	145	(122-177)	1	(0-3)	20	(16-28)
2004–05	1	(0-3)	24	(17-33)	47	(36-66)	1	(0-3)	40	(30-54)
2005–06	0	(0-0)	21	(14-35)	36	(22-62)	2	(0-7)	28	(19-41)
2006–07	0	(0-0)	29	(22-40)	30	(20-45)	3	(1-10)	26	(16-40)
2007–08	0	(0-1)	23	(16-38)	151	(114-211)	6	(1-19)	39	(27-56)
2008–09	0	(0-0)	20	(15-28)	60	(47-78)	7	(2-21)	30	(23-41)
2009–10	6	(3-11)	12	(8-19)	70	(52-100)	12	(4-34)	22	(16-33)
2010–11	2	(1-3)	3	(2-4)	11	(8-14)	5	(2-13)	6	(5-8)
2011–12	3	(2-6)	14	(10-19)	47	(37-62)	10	(3-28)	20	(15-27)
2012–13	0	(0-0)	2	(1-2)	0	(0-0)	1	(0-2)	2	(2-3)
2013–14	1	(0-2)	9	(6-14)	64	(50-88)	7	(2-20)	18	(13-25)
2014–15	0	(0-0)	6	(4-10)	37	(28-51)	3	(1-10)	10	(7-14)
2015–16	0	(0-1)	4	(2-8)	47	(33-72)	3	(1-12)	11	(7-18)
2016–17	0	(0-0)	7	(4-16)	138	(94-214)	3	(0-11)	19	(11-34)
2017–18	9	(5-22)	7	(4-15)	149	(108-220)	15	(5-48)	30	(20-46)

Table A5: continued

(c) Non–QMS species

Fishing year	AUCK		CHAT		COOK		EAST		NORTH	
2002–03	770	(700-852)	20	(15-28)	71	(54-93)	9	(6-13)	72	(52-102)
2003–04	466	(362-626)	12	(7-25)	64	(44-99)	3	(2-7)	59	(36-118)
2004–05	362	(288-466)	16	(11-25)	35	(25-50)	5	(3-7)	49	(34-75)
2005–06	258	(205-337)	16	(10-25)	28	(20-40)	4	(2-6)	31	(19-53)
2006–07	412	(326-541)	27	(19-42)	48	(35-68)	7	(5-12)	35	(23-59)
2007–08	101	(82-130)	4	(2-6)	9	(6-13)	1	(0-2)	11	(8-18)
2008–09	156	(129-192)	2	(1-4)	14	(10-20)	1	(1-2)	3	(2-7)
2009–10	254	(206-326)	2	(1-4)	22	(16-30)	2	(1-3)	2	(1-3)
2010–11	354	(276-481)	8	(5-13)	42	(29-63)	4	(2-7)	26	(17-42)
2011–12	136	(111-171)	1	(1-2)	13	(10-18)	2	(1-3)	8	(6-12)
2012–13	1	(1-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2013–14	253	(204-327)	4	(3-7)	21	(15-32)	2	(1-3)	15	(10-24)
2014–15	90	(68-121)	2	(1-3)	14	(10-22)	1	(1-2)	5	(3-9)
2015–16	278	(226-350)	5	(3-8)	27	(19-40)	2	(1-3)	21	(14-32)
2016–17	106	(85-136)	8	(5-12)	12	(8-17)	0	(0-1)	11	(7-16)
2017–18	157	(130-193)	4	(2-6)	25	(17-35)	1	(0-1)	11	(8-17)

Fishing year	PUYS		STEW		SUBA		WCNI		WCSI	
2002–03	0	(0-0)	51	(42-64)	286	(253-327)	0	(0-2)	202	(158-255)
2003–04	3	(1-9)	33	(23-55)	212	(165-294)	2	(1-10)	119	(83-183)
2004–05	0	(0-1)	14	(10-20)	24	(17-36)	1	(0-4)	80	(58-115)
2005–06	0	(0-0)	12	(8-19)	20	(14-33)	4	(2-11)	62	(44-91)
2006–07	0	(0-0)	26	(18-38)	28	(19-45)	16	(8-35)	100	(71-145)
2007–08	0	(0-0)	5	(4-8)	23	(17-31)	4	(2-9)	33	(24-45)
2008–09	0	(0-0)	6	(4-9)	17	(13-23)	5	(3-10)	33	(24-46)
2009–10	2	(2-4)	6	(4-8)	30	(24-41)	13	(7-25)	37	(28-52)
2010–11	5	(3-10)	9	(6-16)	28	(20-45)	34	(18-70)	71	(50-107)
2011–12	1	(1-2)	6	(4-8)	18	(15-24)	11	(6-19)	30	(23-40)
2012–13	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)
2013–14	0	(0-1)	6	(4-10)	38	(29-54)	12	(6-23)	43	(31-62)
2014–15	0	(0-0)	3	(2-5)	16	(12-24)	5	(3-10)	17	(13-25)
2015–16	0	(0-1)	4	(3-7)	45	(34-61)	17	(8-35)	48	(35-68)
2016–17	0	(0-0)	2	(1-3)	26	(19-35)	4	(2-9)	22	(16-31)
2017–18	2	(1-4)	2	(1-3)	26	(19-36)	9	(4-20)	31	(22-43)

Table A5: continued

(d) INVERTEBRATE species

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2003	27	(23-34)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-1)	0	(0-0)	1	(1-1)	12	(10-15)	0	(0-0)	0	(0-1)
2004	24	(19-30)	0	(0-0)	1	(0-2)	0	(0-0)	1	(0-1)	0	(0-0)	1	(0-1)	14	(11-17)	0	(0-0)	0	(0-0)
2005	1	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2006	6	(5-8)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-1)	0	(0-0)	0	(0-0)
2007	2	(2-4)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2008	1	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2009	4	(3-6)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-1)	0	(0-0)	0	(0-0)
2010	2	(1-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2011	2	(1-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2012	2	(1-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2013	0	(0-6)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2014	2	(1-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2015	4	(3-6)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(1-1)	0	(0-0)	0	(0-0)
2016	3	(2-4)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(1-1)	0	(0-0)	0	(0-0)
2017	1	(0-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-1)	0	(0-0)	0	(0-0)
2018	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)

Table A5: continued

(e) ALL species

Fishing year	CHAT		COOK		EAST		NORTH		PUYS	
2002–03	1073	(1005-1143)	10	(8-13)	30	(25-37)	2	(2-3)	22	(18-28)
2003–04	1129	(1020-1251)	12	(9-16)	51	(41-63)	2	(1-2)	33	(26-42)
2004–05	1737	(1563-1955)	30	(24-38)	56	(46-71)	4	(3-6)	51	(42-63)
2005–06	1333	(1159-1563)	32	(24-43)	46	(36-58)	4	(3-5)	35	(26-49)
2006–07	1956	(1648-2342)	50	(39-68)	68	(52-87)	6	(4-9)	36	(27-51)
2007–08	1269	(1047-1608)	16	(10-27)	42	(30-59)	3	(2-5)	25	(16-41)
2008–09	1139	(1015-1281)	5	(4-8)	33	(27-42)	2	(1-2)	5	(4-8)
2009–10	1434	(1256-1661)	5	(4-7)	39	(31-49)	2	(1-3)	2	(1-3)
2010–11	594	(524-678)	5	(4-6)	23	(19-29)	1	(1-2)	8	(7-11)
2011–12	793	(681-928)	3	(2-4)	23	(18-30)	2	(1-3)	9	(7-12)
2012–13	166	(147-191)	1	(1-1)	5	(4-6)	0	(0-0)	2	(2-2)
2013–14	942	(833-1082)	6	(4-7)	26	(20-32)	1	(1-2)	11	(8-14)
2014–15	409	(355-480)	3	(2-4)	21	(16-26)	1	(1-1)	5	(4-7)
2015–16	827	(724-967)	5	(3-7)	26	(20-33)	1	(1-2)	11	(8-15)
2016–17	1209	(976-1521)	29	(20-44)	44	(32-62)	1	(1-2)	17	(12-26)
2017–18	1249	(1101-1428)	9	(7-13)	80	(64-100)	2	(2-4)	14	(10-20)

Fishing year	SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	0	(0-0)	38	(33-44)	270	(250-293)	0	(0-0)	96	(81-114)
2003–04	5	(3-7)	43	(37-51)	355	(318-399)	2	(1-3)	99	(83-121)
2004–05	1	(1-2)	35	(29-42)	81	(69-96)	1	(1-3)	130	(108-159)
2005–06	0	(0-0)	33	(26-44)	73	(56-97)	5	(3-10)	106	(86-136)
2006–07	0	(0-0)	64	(51-82)	89	(67-117)	18	(10-33)	154	(121-201)
2007–08	0	(0-1)	28	(20-45)	218	(169-291)	12	(6-25)	112	(84-154)
2008–09	0	(0-0)	25	(20-31)	85	(72-102)	9	(5-15)	83	(68-102)
2009–10	8	(6-10)	17	(14-20)	117	(100-138)	18	(11-29)	71	(59-89)
2010–11	5	(4-6)	8	(6-10)	34	(29-41)	14	(9-23)	39	(32-48)
2011–12	4	(3-6)	17	(14-21)	72	(61-87)	14	(9-23)	60	(49-74)
2012–13	0	(0-0)	3	(3-4)	0	(0-0)	2	(1-3)	9	(8-11)
2013–14	1	(0-2)	12	(9-15)	102	(87-122)	10	(6-17)	53	(44-67)
2014–15	0	(0-0)	7	(6-9)	52	(44-63)	5	(3-9)	27	(22-33)
2015–16	1	(0-1)	6	(5-9)	96	(81-117)	12	(8-21)	45	(36-57)
2016–17	0	(0-0)	8	(5-14)	226	(175-301)	12	(6-22)	63	(45-91)
2017–18	9	(6-14)	5	(3-8)	168	(140-207)	21	(13-36)	68	(54-87)

Table A5: **Total annual non–target catch estimates (t) (with estimated 95% CIs in parenthesis) for selected categories and main non–target species for the target ling longline 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	Chimaeras		Morid cods		Rays		Schedule 6		Sharks		BSH		GSH		GSP		HAK		HCO	
2003	141	(122-166)	369	(321-429)	375	(339-417)	2397	(2145-2697)	2641	(2284-3094)	87	(63-124)	58	(46-75)	73	(62-87)	17	(12-24)	1	(1-2)
2004	77	(64-96)	355	(296-434)	545	(468-637)	2166	(1887-2518)	1698	(1423-2073)	34	(24-51)	20	(15-27)	56	(43-73)	12	(7-21)	27	(20-36)
2005	156	(124-205)	160	(124-210)	172	(136-221)	2075	(1764-2442)	4276	(3377-5608)	18	(13-27)	115	(83-165)	52	(39-74)	14	(8-25)	5	(1-36)
2006	57	(49-68)	621	(492-808)	135	(115-162)	1791	(1483-2234)	2382	(2054-2801)	86	(70-106)	35	(29-44)	18	(15-21)	12	(7-19)	34	(26-45)
2007	116	(91-157)	339	(248-495)	418	(321-561)	2941	(2314-3841)	3180	(2554-3999)	100	(72-146)	117	(79-188)	23	(19-28)	13	(7-23)	115	(77-179)
2008	264	(201-368)	481	(348-717)	579	(475-723)	3508	(2856-4401)	2352	(1921-2995)	30	(20-46)	63	(41-103)	149	(109-216)	13	(8-20)	96	(66-148)
2009	183	(149-228)	441	(317-652)	166	(136-206)	2049	(1824-2348)	3878	(3194-4802)	25	(16-37)	62	(49-77)	82	(62-110)	66	(48-91)	58	(47-71)
2010	57	(44-74)	1263	(849-2018)	151	(104-237)	2862	(2178-3832)	4743	(3813-6018)	133	(89-211)	66	(43-111)	23	(18-31)	21	(9-54)	108	(85-143)
2011	42	(34-53)	2691	(1832-4234)	74	(52-112)	1038	(747-1529)	2866	(2209-3935)	70	(51-99)	7	(4-16)	30	(24-37)	268	(117-850)	243	(200-319)
2012	77	(63-97)	393	(293-554)	33	(23-52)	813	(676-1018)	3388	(2758-4378)	28	(21-40)	13	(1-243)	55	(44-71)	91	(62-145)	86	(66-117)
2013	19	(14-27)	482	(337-776)	83	(49-159)	1381	(1136-1750)	1503	(1168-2017)	8	(2-59)	18	(14-26)	2	(0-28)	8	(2-54)	4	(0-63)
2014	117	(87-164)	676	(492-974)	204	(158-269)	2248	(1780-2964)	6641	(4783-9830)	94	(70-132)	114	(61-254)	38	(30-48)	92	(68-131)	23	(16-34)
2015	236	(159-398)	903	(552-1682)	199	(161-258)	630	(511-793)	608	(446-872)	14	(4-128)	142	(94-237)	8	(4-19)	48	(37-64)	14	(8-25)
2016	352	(289-435)	1190	(730-2302)	545	(439-695)	1097	(900-1391)	1060	(854-1373)	13	(6-39)	228	(158-357)	132	(112-158)	17	(12-27)	212	(164-289)
2017	382	(269-591)	253	(194-344)	549	(465-662)	3428	(2781-4334)	2623	(2136-3365)	41	(24-79)	132	(84-233)	157	(117-228)	48	(35-70)	78	(62-100)
2018	163	(142-191)	3464	(2366-5460)	872	(697-1128)	2583	(2254-3026)	2737	(2453-3035)	68	(45-106)	59	(47-74)	102	(84-127)	24	(18-33)	153	(130-189)
Slope	0.042		0.088		0.013		-0.029		-0.029		-0.042		0.046		0.004		0.077		0.143	

Table A6: continued

Fishing year	HOK		OSD		RCO		RIB		RSK		SCH		SND		SPD		SPE		SSK	
2003	1	(0-2)	8	(5-11)	150	(131-173)	211	(156-292)	188	(158-227)	96	(84-108)	52	(36-78)	2032	(1709-2463)	124	(124-163)	111	(111-151)
2004	2	(1-5)	29	(22-39)	127	(104-159)	283	(200-426)	383	(326-455)	83	(68-102)	168	(104-280)	1284	(1051-1644)	129	(129-193)	88	(88-145)
2005	0	(0-8)	1	(0-5)	60	(43-87)	83	(55-134)	50	(31-91)	57	(44-73)	19	(8-62)	4218	(3218-5826)	159	(159-259)	77	(77-127)
2006	1	(1-2)	6	(5-8)	66	(52-86)	562	(439-744)	111	(50-342)	58	(48-71)	371	(281-492)	1223	(990-1551)	188	(188-294)	73	(73-102)
2007	1	(1-2)	66	(41-117)	182	(119-309)	195	(141-282)	218	(151-316)	62	(46-85)	203	(138-303)	3000	(2194-4334)	262	(262-484)	127	(127-214)
2008	1	(0-3)	29	(18-48)	96	(58-182)	575	(374-1012)	309	(252-393)	200	(152-278)	94	(65-145)	2564	(1974-3558)	134	(134-230)	139	(139-255)
2009	4	(2-8)	93	(58-163)	73	(55-101)	665	(352-1560)	60	(40-95)	150	(126-185)	1	(0-12)	3127	(2560-3935)	108	(108-146)	75	(75-118)
2010	1	(0-4)	20	(13-32)	35	(24-54)	1270	(820-2253)	7	(4-14)	348	(262-485)	83	(48-162)	4606	(3346-7020)	110	(110-3639)	103	(103-174)
2011	16	(10-28)	107	(57-232)	9	(3-34)	2363	(1636-3653)	27	(13-82)	20	(13-32)	804	(540-1251)	3777	(2212-7590)	86	(86-129)	51	(51-88)
2012	3	(1-5)	40	(28-59)	10	(6-16)	342	(243-503)	6	(3-12)	38	(19-75)	94	(32-381)	2893	(2309-3723)	4	(4-102)	87	(87-144)
2013	1	(0-22)	1	(0-20)	267	(185-425)	3	(1-319)	2	(0-29)	35	(20-60)	14	(1-206)	1265	(980-1756)	96	(96-219)	50	(50-167)
2014	20	(12-38)	36	(16-115)	36	(28-49)	852	(556-1406)	158	(99-284)	31	(21-44)	186	(121-301)	6856	(4516-12054)	89	(89-139)	79	(79-121)
2015	7	(4-11)	1	(0-2)	350	(183-831)	352	(199-738)	179	(68-874)	39	(29-54)	13	(4-71)	429	(305-654)	103	(103-204)	96	(96-158)
2016	6	(4-8)	10	(7-14)	45	(29-79)	1787	(927-4260)	265	(168-489)	54	(45-66)	789	(427-1643)	603	(455-820)	231	(231-353)	233	(233-390)
2017	17	(12-25)	20	(14-30)	101	(72-153)	94	(65-142)	473	(407-561)	141	(109-187)	23	(11-54)	2422	(1836-3276)	201	(201-286)	81	(81-142)
2018	15	(11-19)	15	(10-28)	51	(37-72)	3707	(2531-5734)	117	(80-181)	62	(51-78)	1025	(658-1678)	2647	(2156-3335)	190	(190-261)	484	(484-727)
Slope	**0.226**		--0.012		-0.031		0.060		-0.022		-0.036		0.052		-0.025		-0.011		0.044	

Table A6: **Total annual non–target catch estimates (t) (with estimated 95% CIs in parenthesis) for selected categories and main non–target species, by area for the target ling longline fishery. See Table A1 for species code definitions.**

Chimaeras

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	58	(50-70)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)	0	(0-0)	1	(1-2)	54	(43-69)	0	(0-0)
2003–04	34	(28-43)	0	(0-1)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	1	(0-1)	31	(23-42)	0	(0-0)
2004–05	140	(107-184)	1	(0-8)	1	(0-8)	0	(0-0)	0	(0-1)	1	(0-1)	0	(0-1)	1	(0-3)	15	(10-22)	0	(0-0)
2005–06	35	(30-43)	2	(1-2)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-3)	0	(0-0)	1	(0-1)	8	(1-50)	0	(0-0)
2006–07	38	(29-52)	2	(2-4)	0	(0-1)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	10	(6-17)	12	(2-61)	0	(0-1)
2007–08	45	(36-58)	2	(0-9)	1	(0-11)	0	(0-0)	0	(0-1)	1	(0-2)	0	(0-1)	3	(1-6)	247	(176-356)	0	(0-1)
2008–09	67	(56-83)	1	(0-6)	3	(0-19)	0	(0-0)	0	(0-1)	0	(0-3)	0	(0-0)	7	(2-32)	91	(65-133)	0	(0-0)
2009–10	25	(5-141)	0	(0-1)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-1)	1	(0-1)	6	(5-8)	0	(0-0)
2010–11	24	(20-30)	0	(0-2)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-2)	2	(0-16)	1	(0-6)	10	(7-14)	0	(0-0)
2011–12	44	(7-253)	0	(0-1)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	2	(1-3)	1	(0-4)	19	(15-24)	0	(0-0)
2012–13	14	(10-19)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-5)	0	(0-0)	0	(0-0)
2013–14	90	(65-129)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	1	(0-3)	25	(16-41)	0	(0-0)
2014–15	114	(75-193)	0	(0-3)	0	(0-4)	0	(0-0)	0	(0-0)	0	(0-2)	0	(0-0)	3	(0-20)	64	(9-383)	0	(0-0)
2015–16	201	(167-247)	0	(0-3)	1	(0-10)	0	(0-0)	0	(0-0)	0	(0-4)	1	(0-5)	2	(0-14)	103	(14-674)	1	(0-14)
2016–17	157	(114-232)	3	(1-10)	0	(0-5)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-6)	299	(187-508)	0	(0-0)
2017–18	77	(68-90)	0	(0-0)	1	(0-7)	0	(0-0)	0	(0-0)	0	(0-1)	4	(2-6)	0	(0-2)	72	(48-106)	0	(0-7)

Morid cods

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	109	(92-131)	53	(23-139)	74	(40-141)	0	(0-0)	2	(0-23)	22	(2-202)	0	(0-0)	46	(34-66)	40	(32-51)	0	(0-0)
2003–04	59	(46-78)	7	(1-72)	41	(5-352)	0	(0-0)	1	(0-11)	19	(11-32)	7	(3-18)	97	(71-139)	34	(27-44)	0	(0-4)
2004–05	80	(59-115)	7	(1-69)	19	(2-177)	0	(0-0)	1	(0-9)	14	(9-22)	0	(0-6)	10	(5-20)	2	(1-4)	0	(0-1)
2005–06	165	(124-225)	51	(33-91)	388	(216-695)	0	(0-0)	6	(0-70)	72	(7-724)	0	(0-0)	48	(31-81)	29	(3-267)	3	(0-33)
2006–07	114	(71-197)	25	(15-47)	59	(34-109)	0	(0-0)	1	(0-2)	31	(17-61)	0	(0-0)	8	(4-18)	7	(1-66)	1	(0-4)
2007–08	124	(87-186)	9	(1-70)	61	(10-411)	0	(0-0)	1	(0-7)	143	(61-385)	0	(0-3)	104	(43-286)	11	(6-22)	2	(0-38)
2008–09	128	(92-190)	7	(1-76)	63	(6-679)	0	(0-0)	1	(0-19)	15	(1-168)	0	(0-0)	70	(10-521)	40	(21-92)	3	(0-52)
2009–10	338	(36-3125)	7	(1-85)	109	(11-1036)	0	(0-3)	5	(0-57)	8	(1-83)	12	(6-29)	31	(19-58)	169	(106-288)	11	(1-126)
2010–11	884	(590-1432)	33	(3-380)	236	(24-2393)	0	(0-0)	8	(1-92)	109	(15-907)	43	(5-332)	66	(7-679)	47	(25-108)	28	(2-365)
2011–12	121	(14-1042)	4	(0-43)	43	(4-498)	0	(0-0)	2	(0-28)	28	(3-259)	16	(8-33)	20	(4-104)	15	(10-23)	5	(0-63)
2012–13	178	(124-276)	5	(0-59)	53	(5-733)	0	(0-0)	2	(0-33)	31	(3-344)	0	(0-0)	23	(2-264)	0	(0-0)	4	(0-52)
2013–14	230	(168-342)	12	(1-116)	76	(9-691)	0	(0-0)	2	(0-33)	14	(3-87)	2	(0-15)	26	(11-67)	48	(29-90)	5	(0-70)
2014–15	173	(103-338)	7	(1-46)	89	(18-473)	0	(0-4)	4	(0-53)	42	(4-492)	0	(0-0)	33	(3-349)	47	(4-473)	7	(1-85)
2015–16	339	(220-584)	15	(1-164)	18	(8-44)	0	(0-0)	2	(0-32)	96	(21-467)	2	(0-38)	15	(5-53)	49	(6-497)	6	(0-85)
2016–17	85	(63-118)	26	(8-91)	52	(30-90)	0	(0-0)	1	(0-10)	82	(35-198)	0	(0-0)	5	(3-12)	15	(9-25)	2	(0-5)
2017–18	660	(456-1075)	4	(1-16)	431	(47-4164)	0	(0-0)	7	(1-97)	57	(11-333)	38	(13-151)	71	(18-379)	801	(364-1986)	18	(2-244)

Table A7: continued

Rays

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	104	(91-120)	6	(3-14)	26	(15-46)	0	(0-0)	1	(0-12)	4	(0-30)	0	(0-0)	3	(2-5)	208	(179-241)	0	(0-0)
2003–04	81	(65-100)	5	(1-37)	15	(2-115)	0	(0-0)	1	(0-9)	2	(1-4)	2	(1-5)	6	(4-9)	439	(368-522)	0	(0-2)
2004–05	99	(73-139)	10	(1-65)	13	(2-106)	0	(0-0)	1	(0-5)	4	(3-7)	0	(0-4)	7	(3-15)	24	(17-36)	0	(0-1)
2005–06	39	(32-49)	10	(8-15)	20	(13-30)	0	(0-0)	1	(0-15)	4	(1-29)	0	(0-0)	3	(2-4)	15	(2-94)	0	(0-4)
2006–07	92	(63-140)	18	(12-29)	21	(12-36)	0	(0-0)	2	(1-6)	5	(3-10)	0	(0-0)	50	(29-88)	32	(5-208)	1	(0-6)
2007–08	89	(72-111)	26	(5-136)	44	(6-360)	0	(0-0)	6	(1-60)	20	(10-38)	0	(0-2)	15	(7-31)	373	(295-486)	3	(0-38)
2008–09	85	(68-109)	3	(0-24)	11	(1-84)	0	(0-0)	0	(0-6)	1	(0-11)	0	(0-0)	7	(1-34)	45	(33-64)	1	(0-8)
2009–10	40	(6-311)	1	(0-8)	6	(1-47)	0	(0-0)	0	(0-3)	0	(0-2)	1	(1-3)	2	(1-4)	8	(6-11)	0	(0-7)
2010–11	36	(28-48)	2	(0-22)	6	(1-70)	0	(0-0)	0	(0-3)	2	(0-8)	7	(2-33)	2	(0-14)	3	(2-5)	1	(0-6)
2011–12	24	(3-192)	1	(0-5)	3	(0-22)	0	(0-0)	0	(0-2)	1	(0-8)	0	(0-1)	11	(4-26)	4	(3-6)	0	(0-3)
2012–13	55	(33-111)	2	(0-24)	9	(1-100)	0	(0-0)	0	(0-7)	3	(0-36)	0	(0-0)	4	(0-42)	0	(0-0)	0	(0-8)
2013–14	89	(68-116)	5	(1-35)	12	(2-114)	0	(0-0)	1	(0-6)	8	(2-33)	0	(0-2)	6	(2-13)	31	(23-45)	1	(0-9)
2014–15	77	(60-100)	4	(1-9)	17	(4-68)	0	(0-1)	1	(0-11)	3	(0-24)	0	(0-0)	4	(1-35)	35	(5-246)	1	(0-11)
2015–16	216	(174-275)	6	(1-50)	14	(7-28)	0	(0-0)	1	(0-14)	8	(2-25)	1	(0-6)	3	(1-6)	69	(10-537)	2	(0-22)
2016–17	91	(77-110)	11	(4-34)	12	(8-19)	0	(0-0)	1	(0-11)	5	(2-9)	0	(0-0)	1	(0-2)	525	(429-642)	1	(0-4)
2017–18	275	(224-342)	2	(1-5)	55	(8-427)	0	(0-0)	2	(0-19)	10	(3-27)	12	(7-22)	15	(5-43)	28	(16-49)	3	(0-28)

Schedule 6

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	1910	(1677-2190)	3	(2-7)	7	(4-13)	0	(0-0)	2	(0-14)	15	(2-110)	0	(0-0)	32	(25-44)	290	(247-347)	0	(0-0)
2003–04	1485	(1236-1827)	7	(1-51)	19	(3-122)	0	(0-0)	1	(0-12)	7	(4-12)	8	(3-18)	21	(15-29)	581	(486-704)	0	(0-4)
2004–05	1266	(1034-1566)	18	(2-138)	22	(3-140)	0	(0-0)	3	(2-5)	8	(6-11)	1	(0-9)	56	(34-92)	109	(83-146)	0	(0-4)
2005–06	1664	(1344-2113)	29	(20-44)	31	(19-52)	0	(0-0)	3	(0-32)	23	(3-185)	0	(0-0)	9	(7-14)	76	(9-581)	2	(0-17)
2006–07	641	(489-846)	49	(36-70)	34	(22-55)	0	(0-0)	3	(1-5)	7	(5-11)	0	(0-0)	272	(169-451)	73	(11-483)	2	(1-3)
2007–08	1400	(1136-1753)	48	(10-239)	59	(12-308)	0	(0-0)	14	(6-34)	68	(36-131)	0	(0-6)	95	(46-199)	571	(441-756)	14	(1-138)
2008–09	1475	(1292-1697)	8	(1-61)	33	(4-236)	0	(0-0)	5	(1-43)	7	(1-58)	0	(0-0)	69	(18-296)	163	(129-209)	7	(1-70)
2009–10	853	(113-5990)	3	(0-26)	19	(2-161)	0	(0-1)	3	(0-26)	1	(0-11)	5	(3-9)	26	(18-41)	136	(97-196)	7	(1-71)
2010–11	495	(367-699)	13	(1-110)	16	(2-134)	0	(0-0)	1	(0-12)	21	(4-129)	36	(6-215)	43	(5-324)	132	(82-225)	6	(1-71)
2011–12	783	(113-5261)	3	(0-23)	16	(2-138)	0	(0-0)	3	(0-25)	9	(1-73)	4	(2-6)	245	(104-555)	57	(46-72)	8	(1-83)
2012–13	1060	(865-1355)	4	(0-41)	18	(2-174)	0	(0-0)	2	(0-25)	10	(1-112)	0	(0-0)	41	(4-317)	0	(0-0)	4	(0-49)
2013–14	601	(502-729)	14	(2-118)	32	(4-226)	0	(0-0)	3	(0-29)	44	(13-162)	9	(3-31)	39	(23-70)	435	(329-583)	10	(1-101)
2014–15	383	(306-493)	6	(3-14)	22	(5-101)	0	(0-2)	2	(0-19)	8	(1-58)	0	(0-0)	26	(4-166)	140	(18-1061)	4	(0-38)
2015–16	702	(565-892)	8	(1-53)	14	(8-22)	0	(0-0)	2	(0-18)	36	(11-110)	2	(0-17)	22	(12-43)	231	(34-1552)	9	(1-93)
2016–17	2256	(1807-2839)	26	(9-82)	22	(13-36)	0	(0-0)	3	(0-29)	14	(7-28)	0	(0-0)	7	(4-13)	879	(676-1165)	15	(6-40)
2017–18	1773	(1536-2048)	8	(5-14)	92	(13-677)	0	(0-0)	8	(1-73)	41	(17-105)	18	(11-30)	50	(21-115)	142	(96-212)	21	(2-171)

Table A7: continued

Sharks

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	2330	(1979-2786)	21	(8-53)	20	(10-42)	0	(0-0)	2	(0-21)	40	(5-320)	0	(0-0)	63	(45-94)	70	(56-90)	0	(0-2)
2003–04	1723	(1404-2142)	11	(1-88)	39	(5-277)	0	(0-0)	2	(0-15)	33	(21-54)	8	(3-21)	76	(55-105)	41	(33-51)	2	(0-15)
2004–05	1761	(1365-2368)	28	(4-223)	46	(7-363)	0	(0-0)	4	(2-8)	21	(14-33)	1	(0-14)	62	(33-120)	92	(63-140)	1	(0-17)
2005–06	1440	(1221-1707)	49	(37-66)	260	(177-379)	0	(0-0)	7	(1-67)	60	(8-406)	0	(0-0)	29	(22-38)	52	(7-418)	10	(1-86)
2006–07	746	(578-990)	75	(55-107)	70	(46-105)	0	(0-0)	4	(2-6)	31	(22-48)	0	(0-0)	311	(198-505)	41	(6-257)	14	(7-28)
2007–08	1635	(1299-2090)	39	(8-212)	67	(13-308)	0	(0-0)	14	(5-38)	94	(46-205)	0	(0-4)	92	(43-204)	56	(42-78)	28	(3-261)
2008–09	2215	(1797-2786)	14	(2-134)	78	(8-572)	0	(0-0)	6	(1-52)	15	(2-129)	0	(0-0)	134	(24-762)	119	(83-178)	27	(3-298)
2009–10	990	(160-6932)	5	(1-44)	35	(4-272)	0	(0-1)	3	(0-32)	2	(0-14)	4	(3-7)	35	(26-49)	167	(128-223)	24	(3-210)
2010–11	683	(580-801)	10	(2-87)	46	(5-344)	0	(0-0)	5	(1-46)	4	(1-18)	38	(9-156)	41	(6-300)	119	(91-157)	41	(4-375)
2011–12	1115	(147-7779)	5	(1-41)	39	(5-309)	0	(0-0)	6	(1-54)	17	(2-136)	8	(5-12)	251	(103-595)	82	(65-104)	37	(4-355)
2012–13	1053	(827-1431)	5	(0-45)	23	(2-265)	0	(0-0)	2	(0-29)	14	(1-155)	0	(0-0)	52	(6-471)	0	(0-0)	14	(1-163)
2013–14	513	(441-612)	18	(3-135)	76	(10-578)	0	(0-0)	8	(1-67)	54	(17-164)	10	(4-28)	59	(35-101)	561	(440-729)	49	(6-427)
2014–15	345	(253-492)	3	(1-11)	19	(5-70)	0	(0-1)	2	(0-17)	7	(1-57)	0	(0-0)	23	(3-200)	39	(5-330)	10	(1-78)
2015–16	686	(562-862)	8	(1-61)	13	(8-22)	0	(0-0)	2	(0-19)	35	(12-110)	1	(0-14)	30	(15-59)	88	(12-603)	30	(3-268)
2016–17	2355	(1876-3017)	30	(11-87)	12	(7-23)	0	(0-0)	2	(0-25)	39	(18-86)	0	(0-0)	15	(8-31)	105	(77-146)	43	(17-109)
2017–18	1722	(1556-1911)	5	(3-7)	87	(13-725)	0	(0-0)	5	(1-42)	27	(13-58)	11	(8-16)	40	(21-75)	121	(88-163)	41	(5-363)

BSH (Seal shark)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	17	(10-27)	11	(4-28)	34	(14-76)	0	(0-0)	1	(0-4)	1	(0-6)	0	(0-0)	1	(1-3)	26	(17-44)	0	(0-0)
2003–04	4	(2-6)	2	(0-9)	10	(2-39)	0	(0-0)	0	(0-1)	0	(0-1)	1	(0-2)	1	(1-2)	5	(1-22)	0	(0-1)
2004–05	5	(3-8)	3	(1-12)	7	(2-32)	0	(0-0)	0	(0-1)	1	(0-2)	0	(0-0)	1	(0-3)	1	(0-1)	0	(0-0)
2005–06	17	(13-23)	12	(9-16)	50	(32-78)	0	(0-0)	2	(0-11)	2	(1-11)	0	(0-0)	2	(2-4)	6	(1-24)	1	(0-7)
2006–07	49	(27-92)	11	(7-17)	41	(22-79)	0	(0-0)	2	(1-4)	1	(1-2)	0	(0-0)	7	(3-15)	5	(1-23)	5	(2-18)
2007–08	5	(3-8)	2	(0-10)	9	(2-46)	0	(0-0)	0	(0-2)	0	(0-3)	0	(0-0)	1	(0-3)	3	(1-10)	1	(0-6)
2008–09	7	(4-10)	1	(0-5)	9	(2-47)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	1	(0-5)	2	(0-9)	1	(0-6)
2009–10	37	(9-161)	3	(1-13)	50	(10-238)	0	(0-1)	1	(0-7)	1	(0-3)	3	(1-7)	5	(3-11)	11	(7-20)	6	(1-36)
2010–11	12	(9-17)	3	(1-15)	25	(6-102)	0	(0-0)	0	(0-3)	2	(0-8)	2	(0-7)	1	(0-5)	2	(1-4)	4	(1-20)
2011–12	8	(2-34)	1	(0-6)	14	(3-62)	0	(0-0)	0	(0-3)	1	(0-7)	1	(1-1)	1	(0-6)	3	(2-4)	2	(0-13)
2012–13	2	(1-13)	1	(0-7)	6	(1-57)	0	(0-0)	0	(0-1)	0	(0-6)	0	(0-0)	0	(0-4)	0	(0-0)	0	(0-5)
2013–14	16	(11-23)	7	(1-27)	42	(11-163)	0	(0-0)	1	(0-6)	5	(2-15)	0	(0-2)	2	(1-5)	15	(10-23)	4	(1-24)
2014–15	1	(0-11)	1	(0-8)	8	(2-69)	0	(0-0)	0	(0-1)	0	(0-4)	0	(0-0)	0	(0-2)	1	(0-10)	0	(0-6)
2015–16	2	(0-10)	1	(0-8)	7	(2-27)	0	(0-0)	0	(0-1)	0	(0-3)	0	(0-1)	0	(0-1)	1	(0-7)	0	(0-4)
2016–17	3	(2-7)	2	(1-5)	11	(5-26)	0	(0-0)	0	(0-1)	2	(1-5)	0	(0-0)	0	(0-1)	3	(1-8)	0	(0-2)
2017–18	9	(5-14)	4	(1-15)	33	(9-128)	0	(0-0)	0	(0-2)	1	(0-4)	2	(1-3)	1	(0-3)	3	(2-7)	2	(0-9)

Table A7: continued

GSH (Dark ghost shark)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	42	(34-55)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2003–04	17	(12-23)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2004–05	90	(66-132)	2	(0-14)	0	(0-3)	0	(0-0)	0	(0-1)	0	(0-4)	0	(0-0)	1	(0-10)	0	(0-0)	0	(0-0)
2005–06	24	(19-30)	2	(1-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2006–07	40	(27-61)	2	(1-4)	0	(0-1)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	5	(2-11)	0	(0-0)	0	(0-0)
2007–08	44	(30-71)	1	(0-7)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-3)	0	(0-1)	0	(0-0)
2008–09	49	(39-63)	0	(0-2)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-7)	0	(0-0)	0	(0-0)
2009–10	32	(4-200)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2010–11	7	(4-15)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2011–12	10	(1-299)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)	0	(0-0)	0	(0-0)
2012–13	13	(10-19)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)	0	(0-0)	0	(0-0)
2013–14	97	(52-212)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)	0	(0-0)	0	(0-0)
2014–15	107	(72-182)	1	(0-4)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	2	(0-14)	0	(0-3)	0	(0-0)
2015–16	195	(134-313)	0	(0-4)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-1)	1	(0-9)	0	(0-2)	0	(0-2)
2016–17	125	(85-203)	2	(1-8)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)	0	(0-2)	0	(0-0)
2017–18	49	(40-61)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-1)

GSP (Pale ghost shark)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	17	(14-21)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-1)	38	(31-48)	0	(0-0)
2003–04	13	(9-18)	0	(0-0)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	1	(0-1)	29	(22-40)	0	(0-0)
2004–05	35	(23-55)	0	(0-2)	1	(0-5)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-1)	1	(0-2)	14	(9-23)	0	(0-0)
2005–06	9	(7-10)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	5	(2-22)	0	(0-0)
2006–07	9	(7-12)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(1-2)	6	(2-23)	0	(0-0)
2007–08	11	(8-14)	0	(0-2)	1	(0-5)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-5)	179	(135-244)	0	(0-0)
2008–09	16	(12-21)	0	(0-1)	1	(0-8)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	2	(1-9)	62	(44-90)	0	(0-0)
2009–10	10	(3-38)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-1)	0	(0-1)	5	(4-7)	0	(0-0)
2010–11	16	(13-20)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-6)	0	(0-2)	11	(8-14)	0	(0-0)
2011–12	24	(6-102)	0	(0-0)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	2	(1-3)	1	(0-3)	19	(15-24)	0	(0-0)
2012–13	1	(0-25)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)
2013–14	15	(11-20)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-1)	20	(15-28)	0	(0-0)
2014–15	2	(1-6)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	6	(1-30)	0	(0-0)
2015–16	52	(44-61)	0	(0-0)	1	(0-3)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-2)	1	(0-4)	63	(14-299)	0	(0-3)
2016–17	29	(21-41)	1	(0-7)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-2)	201	(141-307)	0	(0-0)
2017–18	31	(26-39)	0	(0-0)	1	(0-3)	0	(0-0)	0	(0-0)	0	(0-0)	4	(2-6)	0	(0-0)	67	(45-99)	0	(0-2)

Table A7: continued

HAK (Hake)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	2	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2003–04	1	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2004–05	1	(1-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2005–06	1	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2006–07	1	(1-2)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2007–08	1	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2008–09	11	(8-15)	0	(0-0)	0	(0-2)	0	(0-0)	0	(0-2)	0	(0-2)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-3)
2009–10	3	(0-20)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-2)
2010–11	39	(17-120)	0	(0-2)	1	(0-14)	0	(0-0)	0	(0-10)	5	(1-32)	0	(0-1)	0	(0-5)	0	(0-1)	1	(0-19)
2011–12	14	(2-63)	0	(0-1)	1	(0-7)	0	(0-0)	0	(0-7)	3	(0-15)	0	(0-0)	1	(0-3)	0	(0-1)	1	(0-10)
2012–13	1	(0-8)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-1)	0	(0-4)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)
2013–14	23	(17-31)	0	(0-1)	1	(0-7)	0	(0-0)	0	(0-5)	2	(1-5)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-7)
2014–15	10	(7-15)	0	(0-1)	1	(0-6)	0	(0-0)	0	(0-6)	2	(0-8)	0	(0-0)	0	(0-1)	0	(0-2)	0	(0-7)
2015–16	3	(2-5)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-1)	1	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)
2016–17	5	(4-7)	0	(0-1)	1	(0-7)	0	(0-0)	0	(0-4)	10	(6-16)	0	(0-0)	0	(0-0)	0	(0-2)	0	(0-4)
2017–18	4	(3-6)	0	(0-1)	1	(0-7)	0	(0-0)	0	(0-3)	2	(1-5)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-3)

HCO (Hairy conger eel)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	1	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2003–04	11	(8-15)	0	(0-1)	3	(1-18)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-2)	2	(1-4)	3	(1-11)	0	(0-0)
2004–05	4	(1-38)	0	(0-2)	1	(0-15)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)	0	(0-1)	0	(0-0)
2005–06	13	(10-19)	1	(0-1)	3	(2-6)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-7)	0	(0-2)	0	(0-0)
2006–07	50	(28-92)	2	(1-3)	12	(6-25)	0	(0-0)	0	(0-2)	0	(0-1)	0	(0-0)	4	(2-11)	1	(0-5)	0	(0-2)
2007–08	60	(42-90)	1	(0-5)	7	(1-32)	0	(0-0)	0	(0-2)	0	(0-1)	0	(0-0)	3	(0-13)	2	(1-6)	0	(0-1)
2008–09	38	(30-47)	0	(0-2)	7	(2-33)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	5	(2-21)	2	(1-3)	0	(0-0)
2009–10	68	(18-264)	0	(0-1)	5	(1-22)	0	(0-0)	0	(0-1)	0	(0-0)	2	(1-3)	2	(2-3)	6	(5-8)	0	(0-2)
2010–11	160	(136-191)	1	(0-3)	10	(2-44)	0	(0-0)	1	(0-9)	0	(0-2)	5	(1-24)	5	(1-21)	6	(4-8)	0	(0-2)
2011–12	57	(14-236)	0	(0-0)	3	(1-14)	0	(0-0)	0	(0-0)	0	(0-0)	1	(1-2)	4	(2-11)	5	(4-7)	0	(0-1)
2012–13	3	(0-59)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)	0	(0-0)	0	(0-0)
2013–14	21	(13-36)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	1	(0-3)	1	(0-1)	0	(0-0)
2014–15	7	(4-12)	0	(0-1)	1	(0-4)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-3)	1	(0-3)	0	(0-0)
2015–16	143	(111-192)	0	(0-2)	5	(1-26)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-3)	3	(0-16)	9	(2-44)	0	(0-11)
2016–17	54	(45-66)	1	(0-7)	1	(1-2)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-3)	6	(4-8)	0	(0-0)
2017–18	57	(50-65)	0	(0-1)	11	(2-54)	0	(0-0)	0	(0-1)	0	(0-1)	4	(2-6)	0	(0-2)	26	(20-37)	1	(0-12)

Table A7: continued

HOK (Hoki)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	0	(0-1)	1	(0-1)	3	(1-6)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2003–04	1	(0-2)	1	(0-3)	3	(1-12)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2004–05	0	(0-4)	0	(0-5)	1	(0-13)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)
2005–06	1	(0-2)	0	(0-0)	2	(1-4)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)
2006–07	1	(0-2)	0	(0-1)	4	(2-10)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)
2007–08	0	(0-1)	0	(0-2)	2	(0-10)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)
2008–09	3	(1-8)	0	(0-2)	3	(1-17)	0	(0-0)	0	(0-2)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-5)
2009–10	1	(0-6)	0	(0-1)	2	(0-17)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-5)
2010–11	2	(1-4)	1	(0-7)	8	(2-38)	0	(0-0)	0	(0-3)	1	(0-6)	0	(0-0)	0	(0-1)	0	(0-0)	2	(0-12)
2011–12	1	(0-4)	0	(0-1)	2	(0-12)	0	(0-0)	0	(0-1)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-3)
2012–13	1	(0-10)	0	(0-5)	2	(0-41)	0	(0-0)	0	(0-2)	0	(0-4)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-5)
2013–14	7	(5-13)	1	(0-6)	6	(1-29)	0	(0-0)	0	(0-3)	1	(0-2)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-5)
2014–15	2	(1-3)	1	(0-2)	9	(4-26)	0	(0-0)	0	(0-3)	1	(0-3)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-4)
2015–16	2	(1-3)	1	(0-3)	3	(2-3)	0	(0-0)	0	(0-2)	1	(0-3)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-3)
2016–17	3	(2-5)	2	(1-6)	6	(4-11)	0	(0-0)	0	(0-3)	2	(1-5)	0	(0-0)	0	(0-0)	0	(0-0)	1	(0-2)
2017–18	5	(4-7)	1	(0-2)	16	(4-67)	0	(0-0)	1	(0-6)	1	(0-5)	0	(0-0)	1	(0-1)	0	(0-0)	1	(0-7)

OSD (Other sharks and dogfish)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	1	(1-2)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	2	(1-3)	3	(1-8)	0	(0-0)
2003–04	5	(4-7)	0	(0-4)	1	(0-6)	0	(0-0)	0	(0-0)	0	(0-1)	1	(0-4)	11	(8-16)	2	(1-5)	0	(0-0)
2004–05	0	(0-2)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-7)	0	(0-1)	0	(0-0)
2005–06	1	(1-2)	0	(0-5)	0	(0-2)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	3	(2-5)	0	(0-3)	0	(0-0)
2006–07	49	(27-90)	2	(1-3)	1	(0-2)	0	(0-0)	0	(0-4)	0	(0-4)	0	(0-0)	14	(7-30)	2	(0-17)	0	(0-2)
2007–08	8	(5-11)	0	(0-1)	0	(0-3)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	2	(0-8)	1	(0-4)	0	(0-0)
2008–09	13	(8-20)	1	(0-10)	2	(0-21)	0	(0-0)	0	(0-2)	0	(0-2)	0	(0-0)	16	(3-100)	19	(9-47)	0	(0-3)
2009–10	9	(1-84)	0	(0-2)	1	(0-6)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-2)	5	(3-9)	2	(1-3)	0	(0-2)
2010–11	37	(22-74)	1	(0-13)	1	(0-18)	0	(0-0)	0	(0-3)	0	(0-3)	3	(0-37)	9	(1-103)	3	(0-39)	0	(0-6)
2011–12	15	(2-139)	0	(0-4)	1	(0-12)	0	(0-0)	0	(0-2)	0	(0-2)	2	(1-3)	11	(4-31)	5	(3-8)	0	(0-4)
2012–13	1	(0-13)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-8)	0	(0-0)	0	(0-0)
2013–14	18	(7-65)	0	(0-6)	0	(0-9)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-2)	9	(1-84)	4	(1-22)	0	(0-1)
2014–15	0	(0-1)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-4)	0	(0-2)	0	(0-0)
2015–16	3	(2-4)	0	(0-2)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-1)	1	(0-12)	2	(0-19)	0	(0-2)
2016–17	4	(3-6)	2	(0-6)	0	(0-1)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	2	(0-13)	29	(15-54)	0	(0-1)
2017–18	6	(4-8)	0	(0-1)	0	(0-3)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-3)	0	(0-1)	0	(0-1)

Table A7: continued

RCO (Red cod)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	130	(104-164)	4	(2-11)	28	(13-60)	0	(0-0)	2	(0-41)	3	(0-27)	0	(0-0)	23	(17-33)	32	(26-40)	0	(0-0)
2003–04	29	(20-42)	2	(0-21)	10	(1-114)	0	(0-0)	1	(0-13)	2	(1-4)	0	(0-2)	46	(31-70)	28	(21-39)	0	(0-4)
2004–05	76	(54-112)	2	(0-19)	3	(0-29)	0	(0-0)	0	(0-7)	2	(1-3)	0	(0-0)	3	(1-6)	1	(1-2)	0	(0-1)
2005–06	51	(37-73)	1	(1-3)	6	(2-14)	0	(0-0)	1	(0-27)	3	(0-31)	0	(0-0)	17	(12-28)	3	(0-26)	0	(0-11)
2006–07	102	(58-185)	4	(2-10)	23	(10-58)	0	(0-0)	1	(0-37)	8	(4-18)	0	(0-0)	6	(3-16)	4	(0-32)	1	(0-29)
2007–08	27	(16-48)	2	(0-13)	6	(1-72)	0	(0-0)	0	(0-13)	55	(23-146)	0	(0-0)	38	(15-92)	4	(2-8)	0	(0-17)
2008–09	80	(56-118)	1	(0-7)	4	(0-51)	0	(0-0)	0	(0-7)	2	(0-22)	0	(0-0)	11	(1-116)	2	(1-6)	0	(0-14)
2009–10	19	(2-185)	0	(0-2)	2	(0-19)	0	(0-0)	0	(0-2)	1	(0-8)	0	(0-0)	15	(10-24)	0	(0-1)	0	(0-6)
2010–11	1	(1-6)	0	(0-3)	1	(0-11)	0	(0-0)	0	(0-1)	3	(0-41)	0	(0-0)	5	(0-67)	0	(0-2)	0	(0-3)
2011–12	14	(1-165)	0	(0-4)	1	(0-19)	0	(0-0)	0	(0-2)	5	(0-50)	0	(0-0)	8	(1-75)	1	(0-1)	0	(0-6)
2012–13	282	(188-461)	3	(0-36)	30	(2-380)	0	(0-0)	4	(0-126)	23	(2-305)	0	(0-0)	22	(2-223)	0	(0-0)	5	(0-111)
2013–14	29	(21-41)	1	(0-7)	2	(0-30)	0	(0-0)	0	(0-3)	2	(0-7)	0	(0-0)	4	(2-7)	2	(0-9)	0	(0-7)
2014–15	335	(174-845)	6	(0-106)	67	(4-1083)	0	(0-6)	3	(0-130)	33	(2-485)	0	(0-0)	31	(2-416)	21	(1-319)	4	(0-170)
2015–16	38	(24-70)	1	(0-9)	1	(0-4)	0	(0-0)	0	(0-3)	22	(6-94)	0	(0-0)	2	(1-7)	2	(0-19)	0	(0-6)
2016–17	63	(44-97)	1	(0-6)	6	(1-37)	0	(0-0)	0	(0-7)	2	(1-7)	0	(0-0)	3	(1-7)	10	(6-18)	0	(0-10)
2017–18	34	(26-47)	0	(0-1)	11	(1-100)	0	(0-0)	0	(0-8)	7	(3-23)	0	(0-0)	32	(11-91)	3	(1-6)	1	(0-12)

RIB (Ribaldo)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	19	(12-31)	7	(2-29)	14	(6-34)	0	(0-0)	0	(0-3)	24	(3-183)	0	(0-0)	17	(11-29)	13	(7-29)	0	(0-0)
2003–04	29	(18-52)	4	(0-32)	30	(4-224)	0	(0-0)	0	(0-1)	21	(10-46)	7	(2-27)	26	(17-46)	21	(6-84)	0	(0-1)
2004–05	10	(5-18)	3	(0-29)	10	(1-94)	0	(0-0)	0	(0-2)	11	(7-22)	0	(0-4)	6	(3-16)	1	(0-3)	0	(0-0)
2005–06	143	(98-218)	45	(29-79)	162	(92-290)	0	(0-0)	1	(0-10)	59	(7-455)	0	(0-0)	16	(11-27)	18	(2-148)	1	(0-9)
2006–07	60	(32-112)	15	(8-30)	21	(12-38)	0	(0-0)	0	(0-1)	12	(7-24)	0	(0-0)	8	(3-22)	2	(0-22)	0	(0-2)
2007–08	123	(76-217)	6	(1-42)	55	(10-315)	0	(0-0)	1	(0-9)	30	(10-99)	0	(0-5)	42	(14-155)	41	(5-334)	1	(0-18)
2008–09	83	(42-206)	7	(1-99)	88	(7-768)	0	(0-0)	0	(0-10)	13	(1-173)	0	(0-0)	52	(7-416)	29	(9-142)	1	(0-19)
2009–10	240	(37-1865)	5	(1-45)	62	(8-472)	0	(0-1)	2	(0-18)	2	(0-26)	16	(7-50)	11	(6-26)	166	(90-363)	5	(0-46)
2010–11	792	(566-1157)	14	(2-110)	98	(10-870)	0	(0-0)	5	(0-43)	35	(4-306)	38	(4-393)	21	(3-176)	34	(20-63)	11	(1-109)
2011–12	76	(11-627)	2	(0-12)	21	(3-175)	0	(0-0)	1	(0-8)	8	(1-70)	15	(8-30)	10	(2-51)	13	(9-21)	2	(0-21)
2012–13	0	(0-8)	0	(0-1)	0	(0-11)	0	(0-0)	0	(0-0)	0	(0-4)	0	(0-0)	1	(0-8)	0	(0-0)	0	(0-0)
2013–14	282	(178-480)	4	(0-41)	39	(5-277)	0	(0-0)	1	(0-7)	16	(2-144)	3	(0-18)	7	(2-26)	28	(15-61)	2	(0-21)
2014–15	5	(1-31)	1	(0-3)	13	(3-52)	0	(0-0)	0	(0-1)	4	(0-31)	0	(0-0)	5	(1-31)	4	(0-38)	0	(0-3)
2015–16	310	(167-738)	6	(1-65)	29	(11-91)	0	(0-0)	1	(0-9)	35	(4-357)	3	(0-64)	17	(3-126)	60	(7-559)	7	(1-111)
2016–17	11	(7-19)	15	(5-43)	24	(14-40)	0	(0-0)	0	(0-1)	31	(14-83)	0	(0-0)	3	(1-7)	18	(2-125)	0	(0-2)
2017–18	639	(422-1035)	4	(1-23)	144	(18-1074)	0	(0-0)	1	(0-11)	13	(3-75)	27	(11-84)	4	(1-32)	229	(104-581)	6	(1-73)

Table A7: continued

RSK (Rough skate)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	1	(0-3)	1	(0-7)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-10)	184	(156-221)	0	(0-0)
2003–04	5	(2-12)	1	(0-21)	0	(0-6)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-3)	3	(1-8)	373	(321-443)	0	(0-0)
2004–05	5	(1-23)	3	(0-47)	0	(0-7)	0	(0-0)	0	(0-3)	0	(0-2)	0	(0-3)	2	(0-6)	31	(19-57)	0	(0-0)
2005–06	3	(1-14)	2	(0-11)	0	(0-3)	0	(0-0)	0	(0-1)	0	(0-2)	0	(0-0)	1	(0-16)	27	(2-384)	0	(0-0)
2006–07	67	(39-123)	9	(6-15)	2	(0-34)	0	(0-0)	1	(0-15)	0	(0-1)	0	(0-0)	14	(7-26)	29	(3-317)	0	(0-12)
2007–08	8	(5-13)	2	(0-32)	0	(0-10)	0	(0-0)	0	(0-6)	0	(0-3)	0	(0-0)	1	(0-5)	302	(244-385)	0	(0-5)
2008–09	6	(2-15)	1	(0-10)	0	(0-5)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	1	(0-12)	50	(35-80)	0	(0-2)
2009–10	0	(0-4)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	4	(2-9)	0	(0-0)
2010–11	2	(1-5)	0	(0-5)	0	(0-2)	0	(0-0)	0	(0-1)	0	(0-1)	3	(0-17)	0	(0-4)	2	(1-4)	0	(0-2)
2011–12	0	(0-4)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-3)	2	(1-3)	0	(0-0)
2012–13	1	(0-37)	0	(0-7)	0	(0-3)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-9)	0	(0-0)	0	(0-1)
2013–14	24	(14-41)	2	(0-28)	1	(0-12)	0	(0-0)	0	(0-3)	0	(0-5)	0	(0-1)	5	(1-20)	32	(23-47)	0	(0-6)
2014–15	5	(1-36)	1	(0-8)	0	(0-6)	0	(0-0)	0	(0-2)	0	(0-2)	0	(0-0)	1	(0-25)	48	(4-728)	0	(0-4)
2015–16	14	(8-28)	1	(0-24)	0	(0-10)	0	(0-0)	0	(0-3)	0	(0-4)	0	(0-4)	1	(0-15)	57	(5-754)	0	(0-5)
2016–17	21	(16-28)	8	(2-34)	1	(0-3)	0	(0-0)	0	(0-6)	1	(0-12)	0	(0-0)	2	(0-27)	491	(414-595)	0	(0-11)
2017–18	7	(4-11)	1	(0-1)	1	(0-10)	0	(0-0)	0	(0-2)	0	(0-2)	1	(1-3)	0	(0-1)	11	(5-26)	0	(0-3)

SCH (School shark)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	46	(39-53)	4	(2-8)	4	(2-8)	0	(0-0)	2	(0-6)	3	(1-12)	0	(0-0)	6	(4-7)	0	(0-1)	0	(0-0)
2003–04	45	(36-55)	2	(1-8)	4	(1-17)	0	(0-0)	1	(0-3)	2	(1-4)	0	(0-0)	6	(4-8)	0	(0-1)	0	(0-1)
2004–05	30	(23-39)	3	(1-12)	2	(1-9)	0	(0-0)	1	(1-2)	2	(1-3)	0	(0-0)	1	(1-2)	0	(0-0)	0	(0-1)
2005–06	27	(21-34)	4	(3-7)	5	(3-9)	0	(0-0)	1	(0-5)	3	(1-10)	0	(0-0)	2	(2-4)	0	(0-0)	1	(0-3)
2006–07	29	(17-48)	6	(4-10)	3	(2-7)	0	(0-0)	1	(0-2)	1	(1-2)	0	(0-0)	8	(3-17)	0	(0-0)	1	(0-2)
2007–08	94	(69-131)	9	(2-33)	11	(3-46)	0	(0-0)	4	(1-12)	5	(3-11)	0	(0-0)	13	(6-29)	0	(0-2)	6	(1-27)
2008–09	84	(70-102)	2	(0-12)	9	(2-45)	0	(0-0)	2	(0-10)	1	(0-8)	0	(0-0)	11	(2-53)	0	(0-2)	4	(1-22)
2009–10	101	(21-469)	2	(0-11)	11	(2-54)	0	(0-0)	3	(0-14)	1	(0-3)	0	(0-3)	9	(6-14)	0	(0-2)	8	(1-48)
2010–11	11	(7-16)	1	(0-4)	1	(0-6)	0	(0-0)	0	(0-2)	1	(0-3)	0	(0-0)	1	(0-6)	0	(0-0)	2	(0-13)
2011–12	27	(6-128)	1	(0-4)	2	(0-13)	0	(0-0)	1	(0-5)	1	(0-6)	0	(0-0)	4	(1-15)	0	(0-1)	3	(1-20)
2012–13	17	(10-32)	1	(0-4)	2	(0-11)	0	(0-0)	0	(0-3)	1	(0-5)	0	(0-0)	2	(0-13)	0	(0-0)	1	(0-9)
2013–14	13	(9-18)	1	(0-6)	2	(0-8)	0	(0-0)	0	(0-2)	2	(1-6)	0	(0-0)	2	(1-4)	0	(0-0)	2	(0-12)
2014–15	14	(11-19)	1	(0-3)	5	(2-13)	0	(0-0)	1	(0-5)	1	(0-4)	0	(0-0)	3	(1-11)	0	(0-0)	2	(0-10)
2015–16	26	(21-31)	2	(0-7)	3	(2-5)	0	(0-0)	1	(0-4)	4	(2-8)	0	(0-0)	3	(2-4)	0	(0-1)	4	(1-18)
2016–17	72	(55-97)	11	(3-39)	10	(4-22)	0	(0-0)	2	(0-10)	4	(2-8)	0	(0-0)	3	(2-6)	1	(0-3)	9	(4-20)
2017–18	27	(22-33)	1	(1-3)	7	(2-32)	0	(0-0)	1	(0-4)	2	(1-5)	0	(0-1)	3	(1-7)	0	(0-1)	4	(1-19)

Table A7: continued

SND (Shovelnose dogfish)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	9	(5-15)	1	(0-4)	3	(1-7)	0	(0-0)	0	(0-1)	1	(0-8)	0	(0-0)	4	(3-6)	0	(0-2)	0	(0-0)
2003–04	12	(7-23)	2	(0-13)	15	(3-72)	0	(0-0)	0	(0-1)	2	(1-4)	0	(0-0)	19	(12-31)	1	(0-8)	0	(0-1)
2004–05	3	(1-18)	1	(0-9)	3	(0-23)	0	(0-0)	0	(0-0)	1	(0-4)	0	(0-0)	2	(0-9)	0	(0-0)	0	(0-0)
2005–06	84	(52-138)	19	(12-33)	157	(85-306)	0	(0-0)	2	(0-13)	13	(3-60)	0	(0-0)	12	(8-20)	2	(0-12)	2	(0-15)
2006–07	24	(13-45)	15	(8-29)	36	(19-73)	0	(0-0)	1	(0-6)	4	(2-10)	0	(0-0)	15	(3-72)	0	(0-4)	3	(1-11)
2007–08	13	(9-19)	5	(1-29)	22	(4-117)	0	(0-0)	1	(0-6)	8	(4-16)	0	(0-0)	7	(3-18)	2	(0-10)	2	(0-14)
2008–09	0	(0-3)	0	(0-1)	0	(0-6)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-2)	0	(0-0)	0	(0-0)
2009–10	10	(2-59)	1	(0-5)	7	(1-40)	0	(0-0)	0	(0-1)	0	(0-0)	0	(0-0)	3	(2-5)	0	(0-2)	1	(0-9)
2010–11	152	(109-222)	9	(1-48)	79	(13-447)	0	(0-0)	3	(0-24)	7	(1-38)	0	(0-4)	12	(2-66)	3	(0-19)	18	(2-115)
2011–12	19	(3-144)	1	(0-6)	11	(1-78)	0	(0-0)	0	(0-3)	1	(0-7)	0	(0-1)	8	(1-62)	0	(0-4)	3	(0-28)
2012–13	2	(0-29)	0	(0-3)	1	(0-24)	0	(0-0)	0	(0-0)	0	(0-2)	0	(0-0)	1	(0-20)	0	(0-0)	0	(0-3)
2013–14	35	(23-54)	3	(1-17)	25	(5-125)	0	(0-0)	1	(0-4)	2	(1-8)	0	(0-0)	7	(3-17)	5	(2-9)	4	(1-23)
2014–15	2	(0-17)	0	(0-2)	2	(0-19)	0	(0-0)	0	(0-0)	0	(0-2)	0	(0-0)	1	(0-10)	0	(0-1)	0	(0-3)
2015–16	148	(78-322)	7	(1-46)	80	(13-464)	0	(0-0)	1	(0-14)	6	(1-33)	0	(0-0)	9	(3-43)	5	(1-34)	15	(2-124)
2016–17	5	(2-15)	3	(1-16)	2	(1-8)	0	(0-0)	0	(0-0)	0	(0-1)	0	(0-0)	1	(0-2)	0	(0-2)	0	(0-2)
2017–18	129	(87-212)	6	(1-39)	97	(16-539)	0	(0-0)	1	(0-11)	3	(1-16)	0	(0-2)	3	(1-13)	4	(1-20)	10	(2-69)

SPD (Spiny dogfish)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	1998	(1690-2438)	1	(0-3)	3	(2-7)	0	(0-0)	0	(0-5)	4	(1-38)	0	(0-0)	25	(18-40)	30	(23-39)	0	(0-0)
2003–04	1522	(1214-2011)	3	(0-25)	8	(1-69)	0	(0-0)	0	(0-5)	6	(3-11)	5	(2-17)	19	(13-29)	34	(27-44)	0	(0-2)
2004–05	1546	(1186-2154)	10	(1-103)	12	(1-115)	0	(0-0)	1	(0-21)	3	(2-6)	1	(0-11)	50	(26-102)	63	(44-101)	0	(0-2)
2005–06	1598	(1260-2052)	6	(4-9)	4	(2-9)	0	(0-0)	0	(0-5)	4	(0-46)	0	(0-0)	5	(3-7)	16	(2-132)	0	(0-3)
2006–07	480	(354-670)	23	(15-35)	14	(8-27)	0	(0-0)	1	(0-2)	3	(2-5)	0	(0-0)	193	(115-344)	28	(3-210)	1	(0-25)
2007–08	1629	(1231-2230)	17	(3-104)	31	(5-176)	0	(0-0)	8	(2-37)	20	(8-56)	0	(0-4)	56	(22-137)	68	(49-101)	4	(0-68)
2008–09	1937	(1570-2469)	4	(0-47)	22	(2-189)	0	(0-0)	3	(0-35)	3	(0-38)	0	(0-0)	71	(13-383)	76	(54-115)	4	(0-66)
2009–10	972	(95-8786)	2	(0-19)	9	(1-97)	0	(0-1)	1	(0-17)	0	(0-4)	3	(1-7)	10	(7-19)	141	(92-224)	3	(0-51)
2010–11	409	(302-558)	5	(0-57)	5	(1-67)	0	(0-0)	0	(0-6)	4	(0-38)	21	(4-129)	24	(3-213)	85	(53-142)	1	(0-19)
2011–12	1123	(121-11226)	2	(0-18)	11	(1-114)	0	(0-0)	2	(0-25)	4	(0-37)	3	(2-6)	214	(88-534)	50	(38-65)	4	(0-74)
2012–13	1013	(797-1384)	1	(0-18)	8	(1-109)	0	(0-0)	1	(0-16)	3	(0-36)	0	(0-0)	24	(2-223)	0	(0-0)	1	(0-34)
2013–14	536	(432-683)	6	(1-51)	15	(2-143)	0	(0-0)	1	(0-19)	7	(2-34)	9	(2-40)	19	(10-39)	369	(262-535)	3	(0-48)
2014–15	281	(201-417)	2	(1-7)	5	(1-34)	0	(0-1)	0	(0-8)	2	(0-19)	0	(0-0)	15	(2-132)	40	(5-340)	1	(0-14)
2015–16	483	(369-664)	2	(0-20)	3	(1-7)	0	(0-0)	0	(0-4)	5	(1-22)	0	(0-8)	8	(3-20)	45	(6-426)	1	(0-13)
2016–17	2405	(1816-3213)	5	(1-21)	4	(1-11)	0	(0-0)	0	(0-7)	3	(1-7)	0	(0-0)	4	(2-11)	103	(74-152)	1	(0-6)
2017–18	1869	(1497-2404)	7	(3-16)	51	(5-364)	0	(0-0)	4	(0-43)	13	(4-45)	7	(4-18)	24	(9-78)	175	(98-318)	9	(1-147)

Table A7: continued

SPE (Sea perch)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	90	(79-103)	5	(2-11)	41	(24-74)	0	(0-0)	1	(0-6)	1	(0-15)	0	(0-0)	0	(0-1)	3	(2-5)	0	(0-0)
2003–04	152	(125-192)	1	(0-10)	4	(0-37)	0	(0-0)	0	(0-2)	0	(0-1)	0	(0-0)	0	(0-1)	6	(4-8)	0	(0-0)
2004–05	151	(117-202)	3	(0-27)	5	(1-62)	0	(0-0)	1	(0-1)	2	(1-3)	0	(0-0)	0	(0-1)	2	(1-5)	0	(0-0)
2005–06	174	(140-219)	5	(3-8)	14	(9-24)	0	(0-0)	1	(0-10)	2	(0-19)	0	(0-0)	0	(0-1)	1	(0-13)	0	(0-2)
2006–07	72	(51-104)	10	(6-17)	14	(9-24)	0	(0-0)	1	(0-2)	2	(1-4)	0	(0-0)	16	(7-38)	3	(0-27)	1	(0-1)
2007–08	98	(76-132)	6	(1-45)	4	(1-25)	0	(0-0)	5	(2-14)	0	(0-1)	0	(0-0)	1	(0-2)	12	(7-21)	1	(0-7)
2008–09	107	(93-126)	1	(0-7)	4	(0-33)	0	(0-0)	0	(0-3)	0	(0-3)	0	(0-0)	0	(0-4)	1	(0-2)	0	(0-3)
2009–10	297	(19-5639)	1	(0-26)	7	(0-113)	0	(0-0)	0	(0-7)	0	(0-3)	0	(0-0)	0	(0-3)	1	(0-30)	0	(0-16)
2010–11	94	(79-115)	1	(0-11)	4	(0-43)	0	(0-0)	0	(0-3)	1	(0-7)	0	(0-0)	0	(0-2)	0	(0-2)	0	(0-7)
2011–12	25	(2-473)	0	(0-2)	0	(0-8)	0	(0-0)	0	(0-1)	0	(0-1)	0	(0-0)	0	(0-0)	0	(0-2)	0	(0-1)
2012–13	106	(75-169)	1	(0-11)	6	(0-73)	0	(0-0)	1	(0-7)	1	(0-12)	0	(0-0)	1	(0-8)	0	(0-0)	0	(0-6)
2013–14	87	(71-109)	2	(0-19)	5	(1-52)	0	(0-0)	0	(0-4)	1	(0-5)	0	(0-0)	0	(0-1)	2	(0-20)	0	(0-5)
2014–15	117	(85-172)	0	(0-2)	3	(1-10)	0	(0-0)	0	(0-4)	0	(0-4)	0	(0-0)	0	(0-2)	1	(0-14)	0	(0-3)
2015–16	224	(183-275)	3	(0-27)	5	(3-7)	0	(0-0)	1	(0-15)	4	(1-12)	0	(0-0)	1	(0-3)	9	(1-87)	2	(0-17)
2016–17	173	(146-209)	4	(2-10)	5	(4-7)	0	(0-0)	1	(0-14)	7	(3-13)	0	(0-0)	1	(0-2)	19	(14-27)	1	(0-1)
2017–18	163	(138-195)	2	(1-4)	22	(2-192)	0	(0-0)	1	(0-13)	2	(1-7)	0	(0-0)	2	(0-6)	7	(1-62)	1	(0-14)

SSK (Smooth skate)

Fishing year	CHAT		COOK		EAST		NORTH		PUYS		SQUAK		STEW		SUBA		WCNI		WCSI	
2002–03	76	(65-91)	4	(1-18)	10	(3-39)	0	(0-0)	1	(0-4)	4	(1-14)	0	(0-0)	11	(5-29)	3	(2-5)	0	(0-0)
2003–04	74	(57-100)	2	(1-10)	9	(2-33)	0	(0-0)	0	(0-2)	2	(1-5)	1	(0-2)	4	(2-7)	3	(1-6)	0	(0-1)
2004–05	69	(53-92)	4	(1-16)	7	(2-26)	0	(0-0)	1	(0-3)	3	(2-5)	0	(0-1)	2	(1-5)	1	(0-1)	0	(0-0)
2005–06	38	(31-47)	9	(6-12)	22	(14-34)	0	(0-0)	2	(0-9)	4	(1-15)	0	(0-0)	3	(2-4)	1	(0-4)	0	(0-2)
2006–07	60	(42-89)	9	(5-14)	20	(12-34)	0	(0-0)	2	(1-6)	5	(3-9)	0	(0-0)	14	(8-26)	1	(0-4)	1	(0-4)
2007–08	87	(66-119)	12	(3-48)	26	(7-97)	0	(0-0)	3	(1-21)	17	(8-36)	0	(0-1)	10	(4-24)	6	(1-26)	2	(0-12)
2008–09	68	(56-87)	1	(0-7)	6	(1-31)	0	(0-0)	0	(0-3)	1	(0-5)	0	(0-0)	3	(1-15)	1	(0-4)	0	(0-3)
2009–10	79	(22-267)	1	(0-6)	13	(3-49)	0	(0-0)	1	(0-7)	1	(0-3)	1	(1-2)	4	(2-5)	2	(1-3)	2	(0-10)
2010–11	42	(33-55)	2	(0-8)	7	(2-29)	0	(0-0)	0	(0-3)	3	(1-11)	1	(0-4)	1	(0-6)	0	(0-1)	1	(0-5)
2011–12	57	(17-204)	1	(0-6)	10	(2-38)	0	(0-0)	1	(0-6)	4	(1-16)	0	(0-1)	7	(4-13)	1	(1-2)	1	(0-8)
2012–13	57	(33-107)	1	(0-8)	8	(2-40)	0	(0-0)	0	(0-4)	3	(1-17)	0	(0-0)	2	(0-14)	0	(0-0)	0	(0-3)
2013–14	62	(49-79)	3	(1-10)	9	(2-36)	0	(0-0)	1	(0-3)	6	(2-18)	0	(0-1)	2	(1-4)	1	(1-2)	1	(0-4)
2014–15	76	(61-95)	2	(0-8)	8	(3-26)	0	(0-0)	1	(0-5)	3	(1-11)	0	(0-0)	2	(0-8)	1	(0-4)	1	(0-4)
2015–16	207	(163-267)	5	(1-18)	14	(7-26)	0	(0-0)	1	(0-8)	8	(3-22)	0	(0-2)	2	(1-4)	3	(1-9)	1	(0-9)
2016–17	71	(54-94)	4	(1-13)	8	(5-14)	0	(0-0)	0	(0-2)	3	(1-7)	0	(0-0)	0	(0-1)	1	(0-5)	0	(0-2)
2017–18	286	(234-359)	6	(2-18)	88	(24-291)	0	(0-0)	4	(1-21)	13	(5-33)	8	(4-15)	10	(4-28)	7	(3-14)	4	(1-27)

Table A8: Total annual discard estimates (t) and estimated 95% CIs for selected categories and main non–target species for the target ling longline 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	Chimaera		Morid cods		Rays		Schedule 6		Sharks		BSH		GSH		GSP		HAK		HCO		HOK	
2002–03	52	(39-75)	66	(54-82)	61	(54-71)	1159	(1001-1337)	1512	(1284-1815)	106	(70-166)	35	(21-72)	16	(12-21)	2	(1-3)	1	(0-2)	1	(0-3)
2003–04	46	(32-72)	86	(66-119)	70	(57-88)	1037	(873-1268)	994	(830-1214)	39	(27-60)	15	(9-28)	23	(15-37)	2	(1-6)	22	(17-31)	3	(1-18)
2004–05	19	(14-27)	17	(12-24)	25	(17-37)	2605	(2034-3463)	3185	(2470-4371)	22	(14-35)	4	(3-7)	10	(7-17)	2	(1-5)	8	(2-47)	0	(0-3)
2005–06	1	(1-2)	36	(24-59)	22	(14-40)	1006	(819-1250)	1408	(1179-1719)	100	(76-138)	1	(0-3)	0	(0-1)	1	(1-3)	20	(15-27)	0	(0-1)
2006–07	4	(3-8)	41	(27-65)	45	(32-63)	1933	(1462-2599)	1702	(1384-2163)	113	(75-171)	6	(3-14)	1	(0-1)	1	(0-4)	20	(13-33)	2	(1-5)
2007–08	6	(4-10)	81	(45-169)	62	(50-78)	1720	(1402-2221)	1483	(1222-1847)	7	(4-13)	1	(1-2)	6	(3-13)	4	(2-17)	30	(22-42)	1	(0-2)
2008–09	19	(14-26)	40	(28-64)	24	(19-33)	1611	(1337-1958)	2010	(1638-2516)	26	(17-42)	14	(9-27)	4	(3-6)	6	(4-9)	37	(29-46)	2	(1-5)
2009–10	1	(1-2)	110	(73-168)	20	(14-30)	2464	(1840-3521)	2577	(1996-3620)	158	(101-264)	1	(1-3)	1	(1-1)	3	(1-9)	57	(43-75)	1	(0-4)
2010–11	9	(7-12)	187	(123-299)	10	(7-14)	416	(293-649)	601	(498-737)	77	(52-123)	4	(2-8)	5	(3-6)	18	(6-89)	166	(134-216)	2	(1-5)
2011–12	3	(2-3)	45	(30-72)	13	(7-25)	1613	(1290-2087)	2014	(1610-2576)	38	(26-59)	1	(0-23)	2	(1-3)	9	(6-15)	54	(42-71)	1	(1-3)
2012–13	1	(0-2)	76	(50-121)	10	(5-22)	72	(57-92)	70	(54-93)	9	(1-166)	1	(0-2)	0	(0-2)	1	(0-13)	2	(0-32)	1	(0-14)
2013–14	16	(11-27)	44	(33-58)	15	(11-23)	1942	(1429-2754)	1817	(1398-2435)	70	(46-114)	4	(3-9)	12	(7-25)	11	(6-18)	12	(8-18)	7	(3-18)
2014–15	68	(44-120)	338	(191-647)	17	(10-30)	348	(246-542)	317	(232-451)	2	(1-18)	51	(30-97)	4	(2-11)	2	(1-4)	8	(5-14)	2	(1-5)
2015–16	379	(219-813)	45	(29-76)	15	(10-26)	481	(370-649)	579	(444-808)	15	(6-49)	214	(114-483)	45	(30-74)	3	(1-11)	158	(121-215)	1	(1-2)
2016–17	6	(4-11)	88	(47-207)	16	(12-22)	1149	(899-1505)	1426	(1121-1873)	46	(24-102)	2	(1-8)	3	(1-6)	17	(5-98)	12	(8-21)	4	(2-6)
2017–18	5	(4-6)	81	(56-121)	34	(26-44)	2312	(1793-3245)	1758	(1458-2179)	69	(39-135)	2	(2-3)	2	(2-3)	1	(1-2)	43	(37-52)	5	(4-8)
Slope		0.010		0.052		-0.081		-0.050		-0.061		-0.067		0.001		-0.017		0.060		0.086		0.129

Fishing year	OSD		RCO		RIB		RSK		SCH		SND		SPD		SPE		SSK	
2002–03	5	(4-8)	59	(45-83)	13	(9-19)	11	(9-13)	11	(9-14)	13	(8-23)	1160	(983-1403)	8	(8-12)	24	(24-37)
2003–04	25	(19-33)	65	(46-104)	48	(29-91)	23	(18-30)	10	(7-15)	12	(6-25)	854	(706-1044)	9	(9-14)	25	(25-53)
2004–05	2	(0-6)	13	(9-21)	6	(4-11)	3	(2-6)	6	(4-10)	4	(2-15)	3417	(2578-4798)	8	(8-14)	14	(14-34)
2005–06	5	(4-7)	5	(3-11)	20	(14-33)	2	(0-52)	7	(2-51)	56	(32-104)	929	(745-1187)	6	(6-23)	11	(11-28)
2006–07	24	(14-42)	33	(18-74)	13	(9-21)	8	(5-13)	8	(5-16)	39	(25-63)	1613	(1183-2277)	8	(8-20)	30	(30-63)
2007–08	16	(10-27)	29	(12-105)	63	(33-147)	18	(12-28)	10	(7-19)	104	(62-178)	1708	(1376-2174)	3	(3-5)	56	(56-101)
2008–09	55	(37-92)	19	(12-30)	37	(19-89)	2	(1-3)	7	(6-9)	0	(0-7)	1952	(1584-2481)	4	(4-6)	21	(21-37)
2009–10	9	(6-14)	15	(9-29)	87	(54-158)	0	(0-0)	29	(20-44)	27	(14-57)	3161	(2235-4669)	2	(2-91)	28	(28-51)
2010–11	90	(49-181)	1	(1-6)	124	(83-202)	1	(0-2)	2	(1-4)	233	(135-430)	379	(283-530)	5	(5-8)	8	(8-16)
2011–12	20	(13-30)	1	(0-2)	25	(17-38)	0	(0-0)	6	(2-31)	11	(4-42)	2112	(1692-2725)	0	(0-12)	25	(25-46)
2012–13	1	(0-13)	101	(65-168)	1	(0-16)	0	(0-2)	1	(0-13)	4	(0-88)	65	(50-92)	9	(9-18)	6	(6-30)
2013–14	18	(7-69)	16	(11-23)	19	(14-28)	5	(3-12)	2	(1-8)	122	(70-239)	2507	(1796-3778)	5	(5-9)	12	(12-28)
2014–15	1	(0-2)	359	(211-678)	29	(12-102)	7	(3-32)	1	(0-4)	4	(1-16)	254	(176-400)	5	(5-20)	6	(6-14)
2015–16	5	(4-7)	33	(15-97)	11	(7-20)	10	(4-47)	1	(1-2)	25	(12-63)	457	(346-641)	9	(9-18)	7	(7-20)
2016–17	2	(1-3)	17	(9-41)	55	(14-400)	8	(6-12)	3	(1-10)	25	(11-70)	1307	(958-1921)	3	(3-9)	5	(5-13)
2017–18	13	(6-34)	8	(6-12)	32	(22-51)	5	(2-13)	1	(0-1)	92	(42-245)	2281	(1696-3311)	1	(1-3)	25	(25-47)
Slope	-0.058		-0.013		0.009		-0.054		**-0.166**		0.064		-0.049		-0.052		-0.071	

APPENDIX B: QMS species list

Table B1: Complete list of QMS species codes as at 01 October 2018, 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 (Fish, Invertebrate); common and scientific names; and total observed catch (t) in the ling longline fishery between 2003 and 2018. * 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	Obs catch (t)
PTO*	2010	Fish	Patagonian toothfish	*Dissostichus eleginoides*	0.5
ATT	2004	Fish	Kahawai	*Arripis trutta A. xylabion*	<0.1
BWS*	2004	Fish	Blue shark	*Prionace glauca*	2
GSC	2004	Inv	Giant spider crab	*Jacquinotia edwardsii*	0.1
HOR	2004	Inv	Horse mussel	*Atrina zelandica*	<0.1
KIC	2004	Inv	King crab	*Lithodes murrayi Neolithodes brodiei*	<0.1
MAK*	2004	Fish	Mako shark	*Isurus oxyrinchus*	0.5
POS*	2004	Fish	Porbeagle shark	*Lamna nasus*	4.2
RBM	2004	Fish	Rays bream	*Brama brama*	1.5
RSN	2004	Fish	Red snapper	*Centroberyx affinis*	<0.1
SCC	2004	Inv	Sea cucumber	*Stichopus mollis*	<0.1
SCI	2004	Inv	Scampi	*Metanephrops challengeri*	<0.1
SPD*	2004	Fish	Spiny dogfish	*Squalus acanthias*	2615.7
STN*	2004	Fish	Southern bluefin tuna	*Thunnus maccoyii*	<0.1
SWO*	2004	Fish	Broadbill swordfish	*Xiphias gladius*	1
KIN*	2003	Fish	Kingfish	*Seriola lalandi*	<0.1
RSK*	2003	Fish	Rough skate	*Zearaja nasuta*	474
SSK*	2003	Fish	Smooth skate	*Dipturus innominatus*	260.2
PAD	2002	Inv	Paddle crab	*Ovalipes catharus*	<0.1
QSC	2002	Inv	Queen scallop	*Zygochlamys delicatula*	0.1
SPR	2002	Fish	Sprats	*Sprattus antipodum S. muelleri*	0.1
SUR	2002	Inv	Kina	*Evechinus chloroticus*	<0.1
GSP	1999	Fish	Pale ghost shark	*Hydrolagus bemisi*	220.9
CDL	1998	Fish	Cardinalfish	Epigonidae	<0.1
FRO	1998	Fish	Frostfish	*Lepidopus caudatus*	<0.1
GSH	1998	Fish	Ghost shark	*Hydrolagus novaezealandiae*	113.7
RBY	1998	Fish	Rubyfish	*Plagiogeneion rubiginosum*	<0.1
RIB	1998	Fish	Ribaldo	*Mora moro*	579.7
SPE	1998	Fish	Sea perch	*Helicolenus* spp.	255.1
TRU	1998	Fish	Trumpeter	*Latris lineata*	1
WWA	1998	Fish	White warehou	*Seriolella caerulea*	0.1
SCA	1992	Inv	Scallop	*Pecten novaezelandiae*	<0.1
SQU	1987	Inv	Arrow squid	*Nototodarus sloanii* & *N. gouldi*	<0.1
BAR	1986	Fish	Barracouta	*Thyrsites atun*	<0.1
BAS	1986	Fish	Bass groper	*Polyprion americanus*	11.4
BCO	1986	Fish	Blue cod	*Parapercis colias*	1.1
BNS	1986	Fish	Bluenose	*Hyperoglyphe antarctica*	30.5
BOE	1986	Fish	Black oreo	*Allocyttus niger*	<0.1
BYX	1986	Fish	Alfonsino, long-finned beryx	*Beryx splendens* & *B. decadactylus*	0.3
GIZ	1986	Fish	Giant stargazer	*Kathetostoma* spp.	0.9
GUR	1986	Fish	Gurnard	*Chelidonichthys kumu*	<0.1
HAK	1986	Fish	Hake	*Merluccius australis*	30
HAP	1986	Fish	Hapuku	*Polyprion oxygeneios*	24.7
HOK	1986	Fish	Hoki	*Macruronus novaezelandiae*	6.1
HPB	1986	Fish	Hapuku & bass	*Polyprion oxygeneios* & *P americanus*	10.8
LIN	1986	Fish	Ling	*Genypterus blacodes*	11451.5
NMP	1986	Fish	Tarakihi	*Nemadactylus macropterus* & *N. rex*	0.4
RCO	1986	Fish	Red cod	*Pseudophycis bachus*	210.4
RSO	1986	Fish	Gemfish	*Rexea* spp.	1.2
SCH*	1986	Fish	School shark	*Galeorhinus galeus*	134.9
SNA	1986	Fish	Snapper	*Pagrus auratus*	0.1
SOR	1986	Fish	Spiky oreo	*Neocyttus rhomboidalis*	<0.1
SPO*	1986	Fish	Rig	*Mustelus lenticulatus*	0.2
SSO	1986	Fish	Smooth oreo	*Pseudocyttus maculatus*	0.1
SWA	1986	Fish	Silver warehou	*Seriolella punctata*	<0.1
WAR	1986	Fish	Common warehou	*Seriolella brama*	<0.1

APPENDIX C: Model convergence diagnostics

Figure C1: Convergence diagnostics (MCMC trace plots) for estimation of QMS species non-target catch. Top, annual non-target catch; bottom, model parameters (area, year, gear type, year-area interaction).

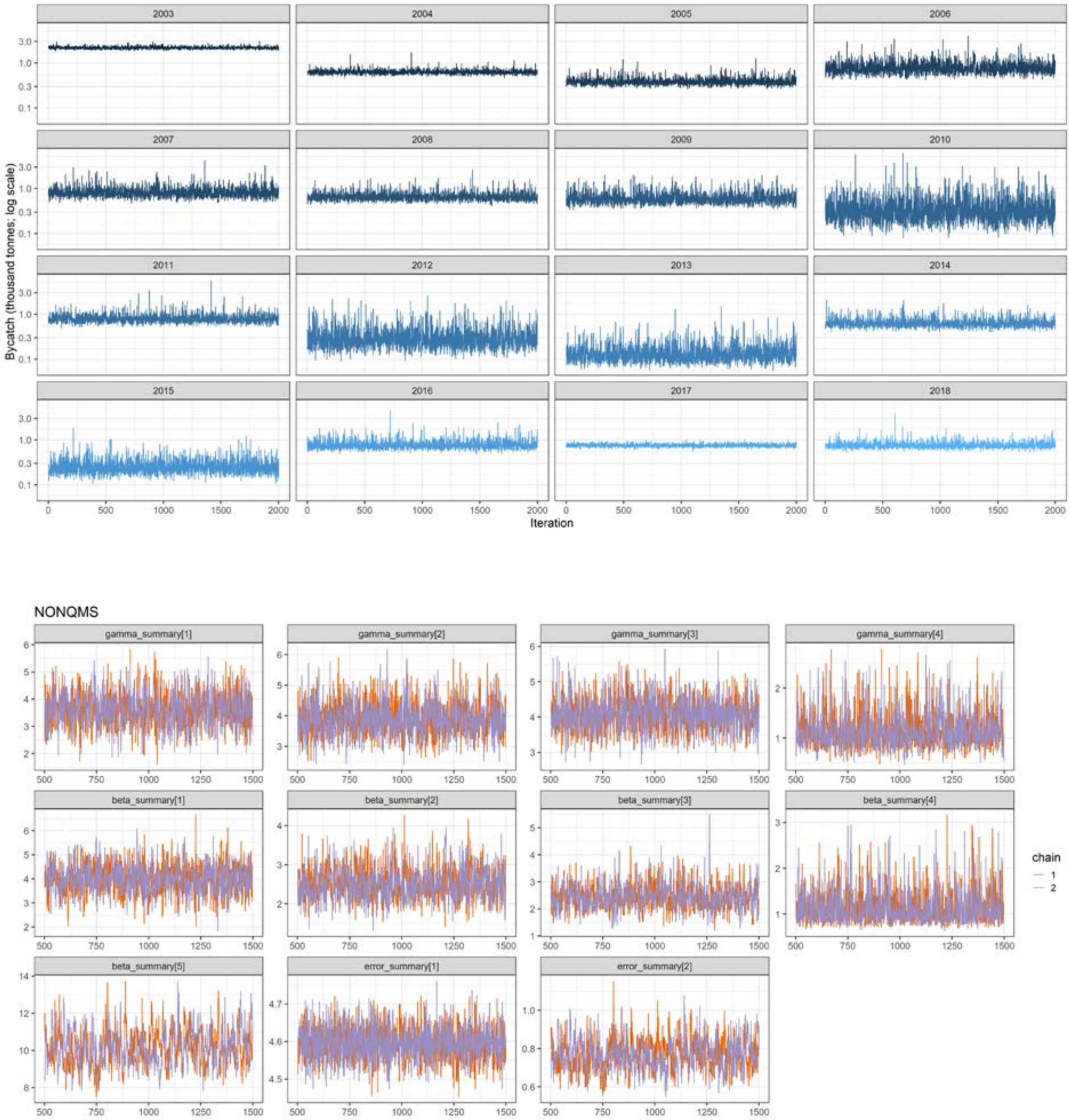

Figure C2: Convergence diagnostics (MCMC trace plots) for estimation of non-QMS species non-target catch. Top, annual non-target catch; bottom, model parameters (area, year, gear type, year-area interaction).

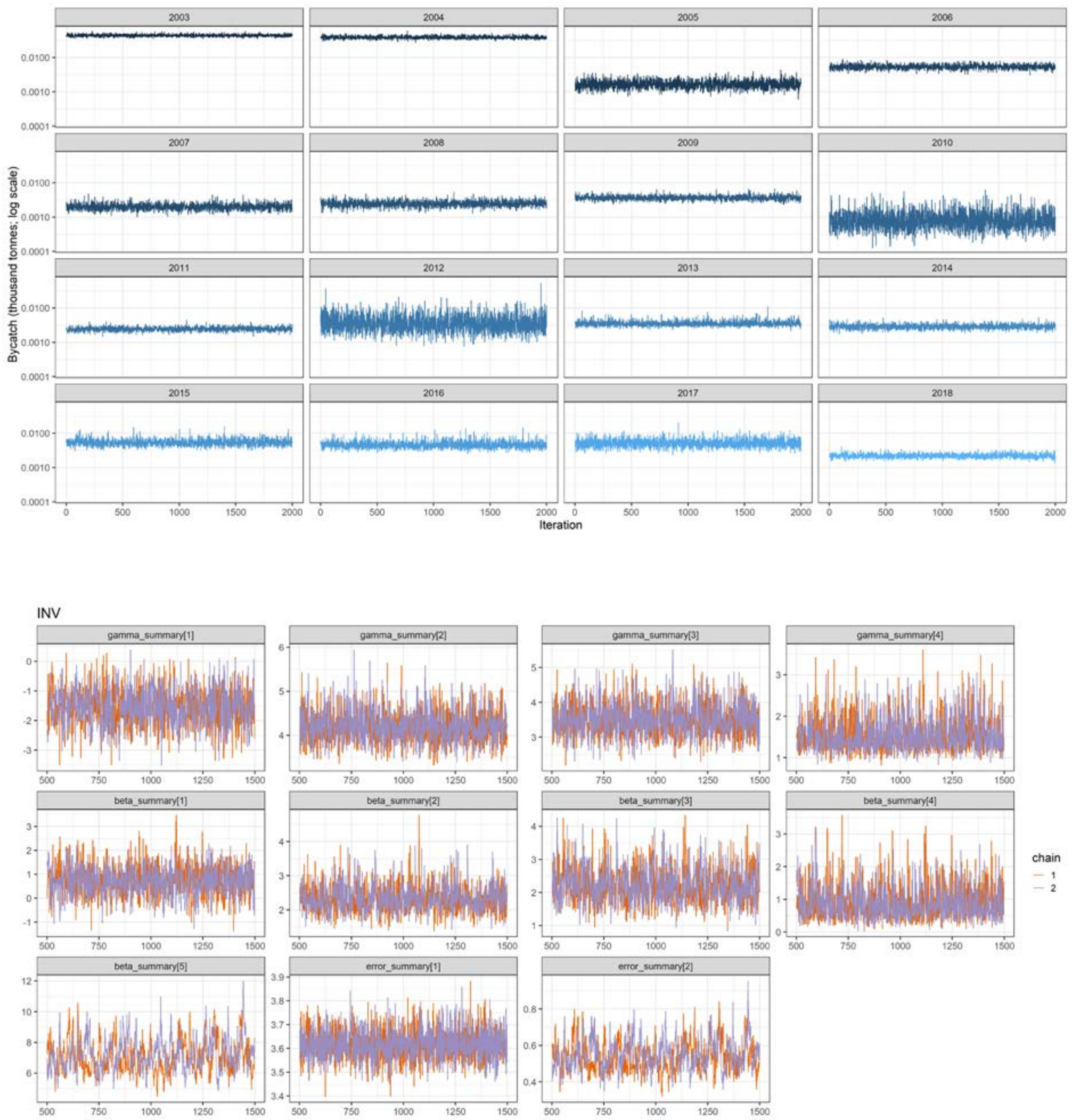

Figure C3: Convergence diagnostics (MCMC trace plots) for estimation of INVERTEBRATE species non-target catch. Top, annual non-target catch; bottom, model parameters (area, year, gear type, year-area interaction).

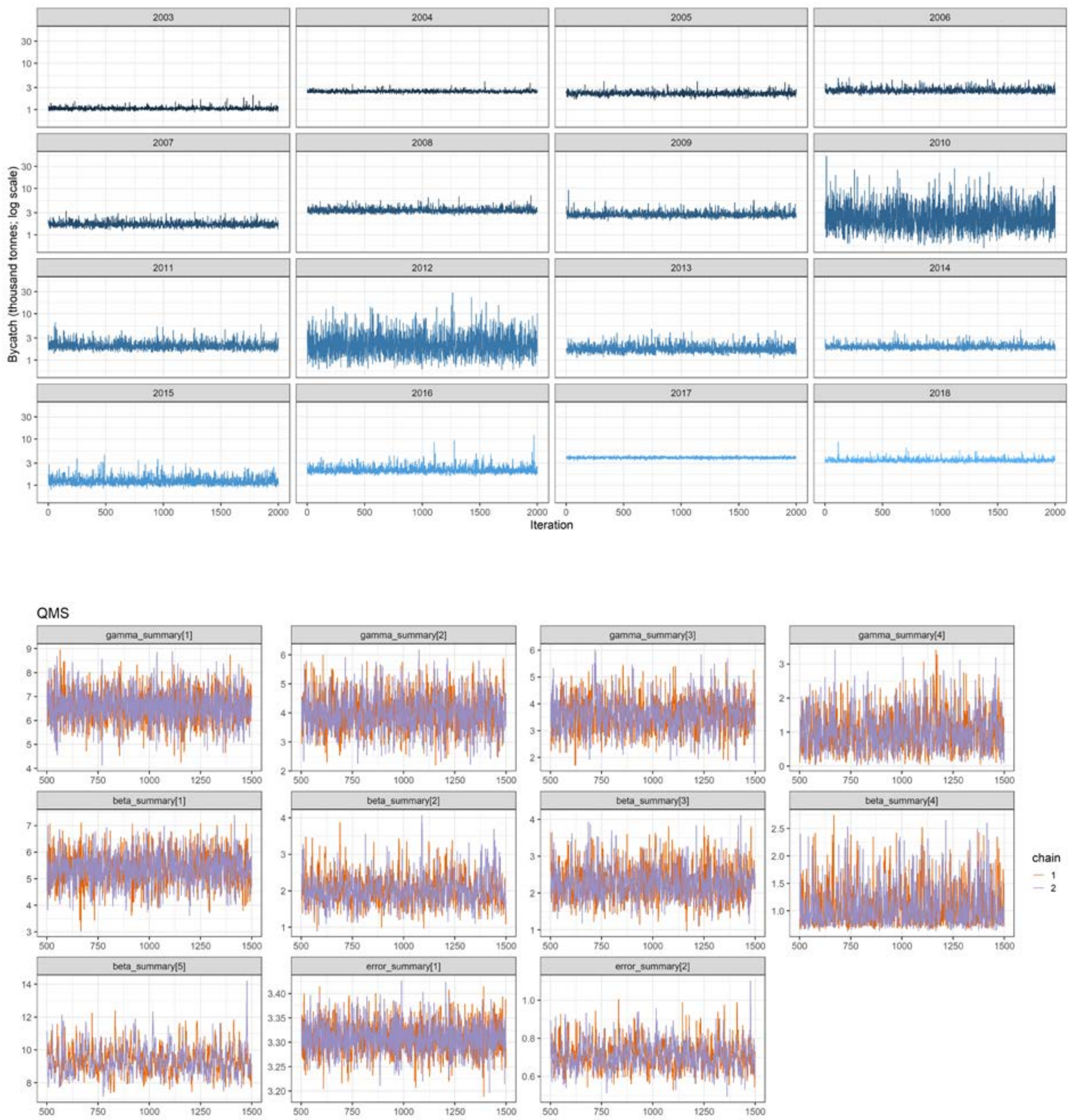

Figure C4: Convergence diagnostics (MCMC trace plots) for estimation of QMS species discards. Top, annual non-target catch; bottom, model parameters (area, year, gear type, year-area interaction).

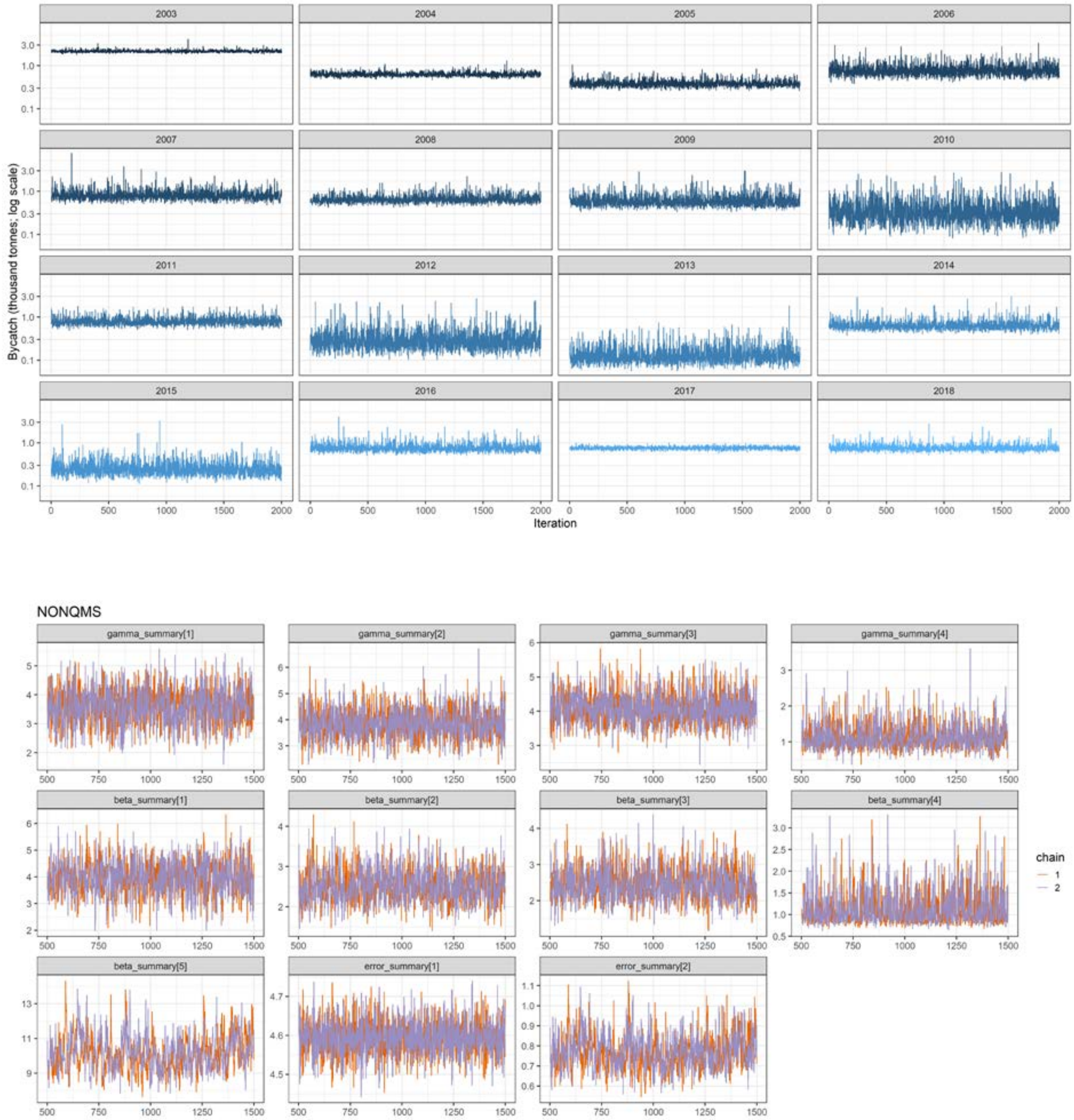

Figure C5: Convergence diagnostics (MCMC trace plots) for estimation of non-QMS species discards. Top, annual non-target catch; bottom, model parameters (area, year, gear type, year-area interaction).

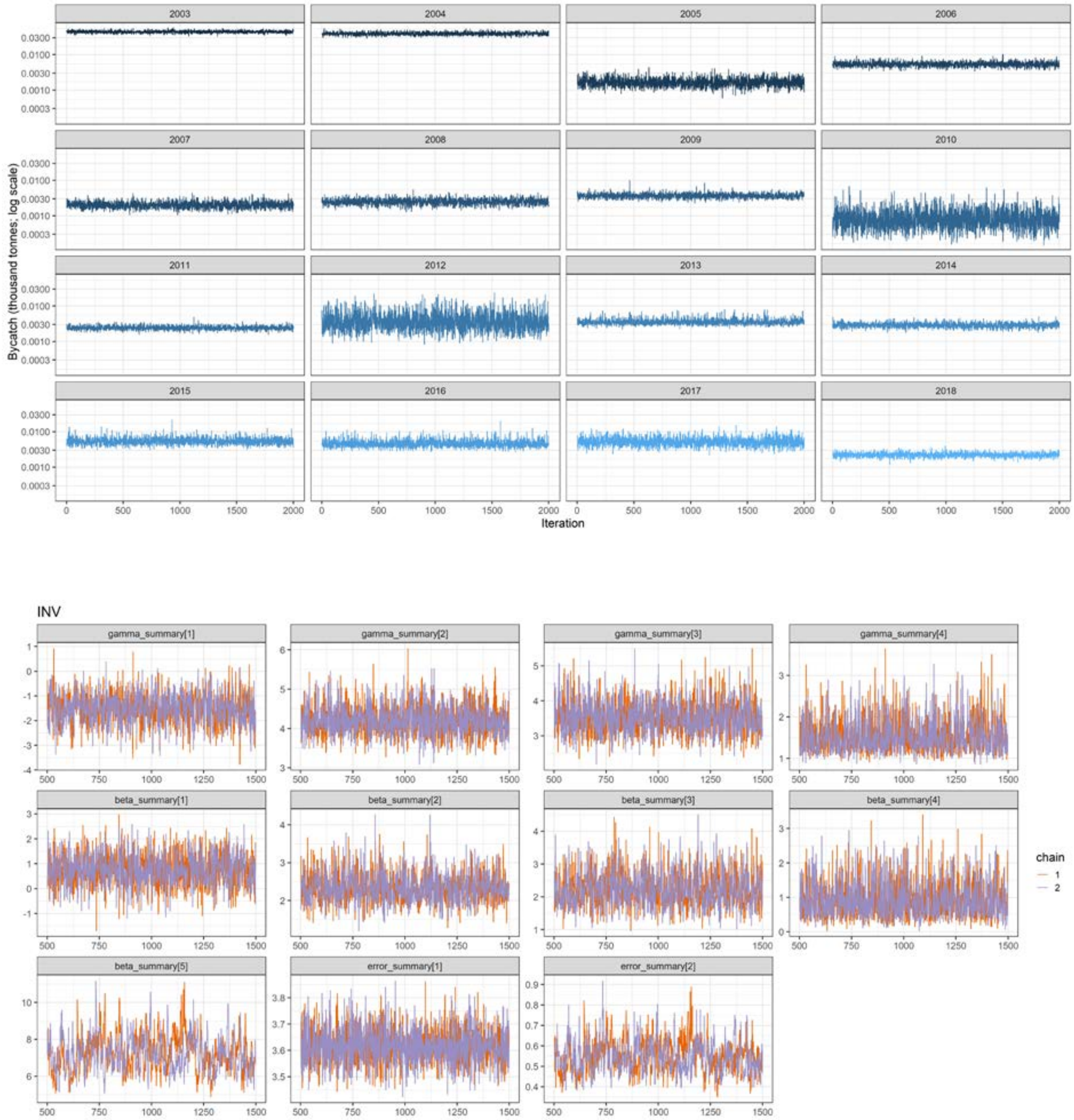

Figure C6: Convergence diagnostics (MCMC trace plots) for estimation of INVERTEBRATE species discards. Top, annual non-target catch; bottom, model parameters (area, year, gear type, year-area interaction).