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Non-target fish and invertebrate catch and discards in New Zealand hoki, hake, ling, silver warehou, and white warehou trawl fisheries from 2002–03 to 2021–22

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Plain language summary

Most fishing methods catch target and non-target (unwanted) species, and unwanted catch may be returned to the sea in some cases.

Fishers and observers record catches of target and non-target species, and the amount of catch returned to the sea (discards).

Total non-target catch and discards for key species and species groups reported in the hoki, hake, ling, silver warehou, and white warehou (HHLSW) fishery from fishing years 2003 to 2022 were estimated with a statistical model.

Hoki and other target species make up most of the catch in this fishery, and key non-target species inluded javenlinfish, rattails, and sharks.

Gemfish showed a significant increasing trend in the amount of non-target catch reported, and sharks and slickheads showed significant decreasing trends.

The amount of catch that is discarded compared with the target catch is lower for this combined fishery than for other fisheries that are monitored.

Monitoring levels of catch and discards is important for understanding the impact of fishing on the environment.

EXECUTIVE SUMMARY

Finucci, B.[1]; Anderson, O.F.[1]; Edwards, C.T.T.[2] (2024). Non-target fish and invertebrate catch and discards in New Zealand hoki, hake, ling, silver warehou, and white warehou trawl fisheries from 2002–03 to 2021–22.

***New Zealand Aquatic Environment and Biodiversity Report No. 330.* 127 p.**

Commercial fisheries catch and effort data and observer records of catch and discards, provided by Fisheries New Zealand, were used to estimate the level of non-target catch and discards in the hoki, hake, ling, silver warehou, and white warehou target trawl fisheries between 2002–03 and 2021–22. These data represented 309 525 tows from 192 vessels. Two modelling methods were used for the assessments: a two-part binomial/lognormal model method used in several recent assessments; and a grid-based extension of the standard method that utilises a finer spatial structure to enable estimation of spatial catch rates at any resolution and to incorporate the effects of spatial autocorrelation in the observer data. Estimates of annual catch and discards were made for broad categories of catch, including: all Quota Management System (QMS) species combined; all non-QMS fish species combined; and all non-QMS invertebrate species combined. For the standard method, membership of these groups was adjusted each year, where necessary, to match the year-of-entry of species into the QMS. Separate estimates of annual catch were also made for key individual non-target species.

Hoki accounted for about 73% of the total estimated catch from the observed tows in the target fisheries for the five species since 2002–03. The remainder of the observed catch comprised ling (5.9%), hake (5.7%), silver warehou (3.9%), javelinfish (2.0%), unspecified rattails (1.6%), spiny dogfish (1.5%), and white warehou (1.1%), plus a range of other (mainly non-QMS) species including various species of sharks, skates and dogfishes, rattails, and other bony fishes. Arrow squid was the ninth most common non-target species by weight (0.5% of the catch) and the only invertebrate in the top 30 non-target taxa. Other invertebrate groups frequently observed included warty squid and a range of sponges, echinoderms, crustaceans, and molluscs.

Estimates of non-target catch and discards from the two methods were mostly similar, with model diagnostics for the revised model indicating good fits to the data and confidence that this method can make accurate predictions. However, the report primarily focuses on estimates from the standard method as they are currently more readily comparable with those from previous assessments. Total estimated annual non-target catch ranged from about 15 000 to 30 000 t in the five years since the last assessment and was considerably lower in the most recent years (from 2019–20), likely reflective of reduced fishing effort during the COVID pandemic. Non-target catch during this period comprised lower levels of QMS species (6800–12 200 t) than non-QMS fish species (9200–17 500 t). Estimated total annual discards since 2016–17 have ranged from 2700 to 7300 t and were mainly non-QMS fish species.

Discarding of target species (hoki, hake, ling, silver warehou, white warehou) was generally low but highly variable, ranging from 11 t to about 2650 t, with no more than 100 t reported annually since 2016–17. Discards of QMS species and non-QMS fish species followed a similar pattern to that of non-target catch (for the years in common) and have declined over time. Discards of non-QMS species, and total discarding declined significantly over the 20-year period. Of the non-target catch species/species groups examined, one species (gemfish) showed a significant increasing trend in non-target catch over time, and two species groups (sharks and slickheads) showed significant decreasing trends over time.

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[2] CEscape Consulting Services, New Zealand.

The annual discards ratio (kilogram of discards/kilogram of target species catch) was highest in early years of the time period (between 0.07 and 0.12), peaking in 2008–09 at 0.17 and has declined since to estimates generally between 0.03 and 0.05. The overall average across the 20-year period (2002–03 to 2021–22) was 0.07. This is similar to previous estimates for this combined fishery, and relatively low compared with long-term average rates for most other fisheries that are monitored.

1. INTRODUCTION

The Fisheries New Zealand Annual Operational Plan for Deepwater Fisheries for 2022–23 includes Environment Outcome Management Objective 6 to "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 2022). 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 trawl fisheries for: jack mackerel (*Trachurus* spp.); orange roughy (*Hoplostethus atlanticus*) and oreos (Oreosomatidae); scampi (*Metanephrops challengeri*); arrow squid (*Nototodarus* spp.); and the ling longline fishery (Finucci et al. 2020, Finucci et al. 2022, Anderson & Finucci 2022, Anderson et al. 2023). The most recent assessment of non-target catch and discards in the hoki (*Macruronus novaezelandiae*), hake (*Merluccius australis*), ling (*Genypterus blacodes*), silver warehou (*Seriolella punctata*), and white warehou (*Seriolella caerulea*) combined fisheries covered the years 1990–91 to 2016–17 (Anderson et al. 2019).

The hoki fishery has been New Zealand's largest by volume, with total reported catches of 91 000–141 000 t per year for the fishing years 2016–17 to 2021–22 (Fisheries New Zealand 2023). The hake, ling, silver warehou, and white warehou trawl fisheries are considerably smaller, but together accounted for 30 000–40 000 t of landed fish per year. Total reported catches in 2021–22 were 91 668 t of hoki, 3154 t of hake, 16 920 t of ling, 8580 t of silver warehou, and 700 t of white warehou (Fisheries New Zealand 2023). Trawl fisheries for silver warehou and white warehou operate in similar areas to the hoki, hake, and ling fisheries and use the same vessel fleet and similar gear types, and so the target fishery definition was expanded in recent assessments to include all five species.

Hoki are widely distributed throughout the Exclusive Economic Zone (EEZ), mainly between 200 and 800 m depth (Fisheries New Zealand 2023). The commercial fisheries operate in four main areas: two spawning fisheries, which are centred off the west coast of the South Island (WCSI) and in Cook Strait during the winter months (July–early September); and two non-spawning fisheries, on the Chatham Rise and in the Sub-Antarctic during the remainder of the year when hoki are in their dispersed phase (Ballara & O'Driscoll 2017). Smaller spawning fisheries occur in the Puysegur area and off the east coast of the South Island. The hoki fishery operates throughout the year using a mixture of head-and-gut vessels, fillet vessels, and whole fish ice vessels. An increasing number of vessels also have meal plants. There are also management controls that may contribute to spatial variability in non-target catch and discards. These include restrictions limiting the fishing grounds accessible to vessels longer than 46 m and Operational Procedures for Hoki Fisheries, implemented by the Deepwater Group (who represent industry shareholders) from 1 October 2009. The Operational Procedures aim to manage and monitor fishing effort within four industry management areas, where there is thought to be high abundance of juvenile hoki (Narrows Basin of Cook Strait, Canterbury Banks, Mernoo Bank, and Puysegur Bank). These areas are closed to hoki target trawling by vessels larger than 28 m, and there is increased monitoring when targeting species other than hoki. There is also a general recommendation that vessels move from areas where catches of juvenile hoki (defined as less than 55 cm total length) comprise more than 20% of the hoki catch by number.

Hake are widely distributed throughout the middle depths (50–1010 m) of the New Zealand EEZ, mostly south of 40° S. The main fisheries are on the WCSI, the Chatham Rise, and the Sub-Antarctic, where hake are taken by large trawlers, often as non-target catch in hoki target fisheries, although target fisheries exist in each of these areas (Horn & Dunn 2007). The largest hake fishery is off the WCSI where the catch is a mixture of direct targeting and non-target catch from the hoki fishery. Catches have been variable due to management changes over time including changes to the hake and hoki Total Allowable Commercial Catch (TACC), changes in fishing practices such as gear used, tow duration, and strategies to limit hake non-target catch in the hoki target fishery (Devine 2009). In some years, particularly earlier in the 1990–91 to 2016–17 period, there was a hake target fishery off the WCSI in

September after the peak of the hoki fishery, and non-target catch levels of hake early in the fishing season in some years were relatively high (Ballara 2015). In the Sub-Antarctic and the Chatham Rise, hake were caught mainly as non-target catch by trawlers targeting hoki, although targeting for hake does occur.

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

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

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

Since the first estimates of annual non-target catch and discards in the hoki trawl fishery (Clark et al. 2000), the methodology has been progressively refined and estimates regularly updated (Anderson et al. 2001, Anderson & Smith 2005, Ballara et al. 2010, Ballara & O'Driscoll 2015, Anderson et al. 2019). The most recent assessment provided estimates of non-target catch and discards for the period 2002–03 to 2016–17, using a statistical model approach for the first time in this fishery (Anderson et al. 2019).

From the most recent assessment, estimates of total annual non-target catch between 1990–91 and 2016–17 have ranged from about 17 500 t to 49 000 t, and total annual discards between 2002–03 and 2016–17 ranged from 5000 t to 25 000 t (Anderson et al. 2019). The principal non-target catch species were javelinfish (*Lepidorhynchus denticulatus*), unspecified rattails (Macrouridae), and spiny dogfish (*Squalus acanthias*). The main species discarded were spiny dogfish, unspecified rattails, javelinfish, hoki, and shovelnose dogfish (*Deania* spp). Estimates of the rate of discarding varied from 0.03 kg of discarded fish for every 1 kg of target species catch in 2015–16 to 0.17 kg in 2008–09, with an overall value of 0.05 kg for the 1990–91 to 2016–17 period.

1.1 Objectives

This report is an output from the Fisheries New Zealand research project BYC2021-03 "Non-target catch monitoring and quantification in deepwater fisheries" which has the following objectives.

Overall objective:

To estimate the composition of catch (including non-target fish catch and discards of target and non-target fish species) in deepwater fisheries.

Specific objectives for year 2 (of 3)

1. Estimate catch composition in the target deepwater trawl fisheries for hoki, hake, ling, silver warehou, and white warehou combined. This should include an estimation of the quantity of non-target fish species caught, and the target and non-target fish species discarded, in a format that meets management needs. Estimated rates and amounts of non-target catch and discards in these fisheries are to be compared with previous estimates to identify trends over time.

Discussions were held between project and Fisheries New Zealand staff with agreements made on further details of the analysis, as follows:

a. Estimates of non-target catch and discards would be made for only the fishing years since 2002–03. This date is subsequent to the introduction of updated observer logbooks (and the possibility to re-assign discard information to individual tows) and finer resolution Fisheries New Zealand 3-letter taxon codes.

b. In the standard method used, the allocation of species to the broad categories of catch assessed (QMS species, non-QMS fish species, non-QMS invertebrate species) will take into account their date of entry into the QMS, thus altering the composition of each category from year to year.

c. A development of the model structure will be made that takes into account spatial autocorrelation in the data, providing a separate set of results to that of the standard method. This requires that no adjustments are made to the composition of the catch categories, as in (b) above, therefore this analysis will exclude the years before 2004–05 after which there were few relevant additions to species managed under the QMS.

d. In addition to the species groups QMS, non-QMS fish, non-QMS invertebrates (see Section 2.1.1 for definitions), separate estimates will be made for Schedule 6 species, sharks, slickheads, morid cods, rattails, and protected coral species, as well as a range of the main individual species, if data are sufficient and model convergence can be achieved.

e. Analyses will be stratified by the standard areas applied to previous analyses, and also by gear type (midwater and bottom trawl) to reflect the high use of midwater trawl gear that is particular to this fishery in some regions – especially the west coast South Island.

1.2 Definitions

For this study *non-target catch* is equivalent to *bycatch* and includes all fish and invertebrates caught that were not either hoki, hake, ling, silver warehou, or white warehou whether or not they were discarded (McCaughran 1992). The definition therein 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 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) and any off-cuts from processed fish. Catches in various categories that were not the subject of this analysis were removed from the initial data extract: e.g., seaweed, birds, marine mammals, reptiles, and rubbish. Data were analysed by fishing year (1 October to 30 September), for convenience occasionally referred to in figures as the year-ending, for example, 2011 for the 1 October 2010 to 30 September 2011 fishing year.

2. METHODS

2.1 Observer data

Government (currently Fisheries New Zealand) observers have been making detailed tow-by-tow records of catch by species or species group for a portion of the fleet in this fishery in every fishing year since 1990–91. The planned 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 of 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).

There is a considerable amount of observer data available for this analysis, with about 1250–5800 observed trawls annually. Some changes in recording and database construction for observer data also occurred in the early 2000s, at about the same time that the offshore fishing fleet consolidated to its current size and composition, with the result that discard information could more readily be assigned to individual tows, and improvements in taxonomic identification became possible with the introduction of a range of finer resolution 3-letter Fisheries New Zealand codes along with various identification guides. For these reasons, it was agreed to restrict the calculation of non-target catch and discards to the 2002–03 to 2021–22 period, because this corresponds to a period of greater consistency in fishery characteristics and fishery data.

2.1.1 Data preparation and grooming

Datasets were prepared from the Fisheries New Zealand Centralised Observer Database *cod*, based on separate extracts of all observed trawls targeting hoki, hake, ling, silver warehou, and white warehou for the period 2002–03 to 2021–22. These datasets contain a complete set of catch by species for all relevant trawls. Catches in various species categories that were not relevant to this analysis were removed from the initial extracts: e.g., seaweed, birds, marine mammals, reptiles, and rubbish.

All records in the observer datasets were run through a set of checks and operations to ensure consistency, to correct, or aid correction of, erroneous values where possible, to remove records with missing values in critical fields if necessary, and to derive additional variables that were used to describe patterns in variability of non-target catch and discards.

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

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

Fishing depth was calculated from the average of the recorded start and finish net depths where possible. Unusually shallow or deep fishing depth and bottom depth values were set to the average value for other trawls on the day, where possible, and otherwise trimmed to a minimum of 100 m and a maximum of

1000 m. For records where one or both of these values was not recorded, bottom depth was taken from the remaining value or from the seabed depth, if recorded. According to the trawl-path codes recorded by observers, about 93% of trawls were recorded as being on the seabed at all times, most of the remainder being midwater or a combination of midwater and bottom trawling. Most trawl paths (59%) incorporated a U-turn, zigzag, or closed circle/loop; while most of the rest (37%) followed a straight line or constant depth contour.

Observers estimated the amounts "total greenweight on surface" and "total greenweight on board", and these would sometimes differ if fish were lost from the net, either at or below the surface, but also simply because the observer may revise their estimate of the total catch once the net was aboard. Losses of fish from the net come about through a mixture of burst cod-ends, burst windows/escape panels, and rips in the belly of the net. Valid differences in these values were interpreted here as lost fish and included as part of the discards from the trawl, with corrections made for any obvious recording errors. For example, where the recorded value for "total greenweight on board" was greater than "total greenweight on surface" the weight of fish lost was set to zero unless it was clearly due to a transposition of the two values. These and any other differences in the two recorded values were interpreted as valid fish losses only if they were accompanied by an appropriate code identifying the cause of the loss. Genuine observed cases of lost fish were rare in these fisheries, occurring in only 413 observed tows, and in total accounting for about 0.23% of the estimated greenweight at the surface.

By using the grooming processes described above there was no need to delete any records, so the analyses for each fishery were therefore based on records of all observed target tows available for the period. Observer data were available from 101 trawl vessels, ranging in length from 15 to 104 m. Information about the presence of a meal plant on each vessel was also extracted from the *cod* database. No fishing vessel or fishing company was identified in this report.

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

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

- QMS: All QMS species combined (fish and invertebrate), excluding the target species. The composition of this category expanded over time as species were added to the QMS (Table B1, Appendix B); observers recorded 71 non-target QMS fish species and 17 non-target QMS invertebrate species.
- Non-QMS fish: All non-QMS fish species combined. The composition of this category contracted over time as species were added to the QMS (Table B1); observers recorded 430 species which were non-QMS species at some time during the study period.
- Non-QMS invertebrates: 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 374 such species.
- Schedule 6 species: QMS species which can be returned to the sea under certain circumstances. These comprise RSK, SCH, SPO, SSK, BWS, MAK, POS, SPD, KIN, PTO, STN, SWO (see relevant sections of the Fisheries Act 1996 for more details).

- Rattails (all species, Family Macrouridae): BAC, BJA, CAS, CBA, CBI, CBO, CCO, CCR, CCX, CDX, CEX, CFA, CFE, CFX, CGX, CHY, CIN, CIX, CJX, CKA, CKE, CKX, CLE, CMA, CMI, CMU, CMX, COL, COM, CPI, CRD, CSE, CSL, CSP, CSU, CTH, CTR, CVY, CXH, GAO, GRV, HAN, HYM, JAV, MCA, MHO, MLA, MRC, NBU, NES, NNA, NPU, NZC, NZK, OMU, PIN, RAT, SQM, TRX, TVI, VNI, WGR, WHR, WHX.
- Sharks (Chondrichthyes); all sharks, dogfishes, skates, rays, chimaeras (comprises 97 species codes).
- Morid cods: BRC, DCO, GGC, GGL, GNO, GRC, GRG, HJO, LAE, LEG, LEV, LPI, LPS, MOD, PCO, PLU, PTH, RCO, RIB, ROC, SBR, SMC, VCO.
- Corals: ATP, BOO, BTP, CAY, CBR, CHR, CIR, CLG, CLL, COB, COF, COO, COR, CRE, CRY, CTP, CUP, DDI, DEN, ERO, ERR, FUG, GDU, GOC, IRI, ISI, JAA, LEI, LIL, LLE, LPP, LPT, LSE, MIN, MOC, MTL, NAR, OVI, PAB, PAN, PLE, PLL, PML, PMN, PRI, PTP, SIA, STI, STL, STP, STS, SVA, THO, TPT, TRH.
- Individual species/species complexes that comprised the main observed non-target species, i.e., BAR, BOE, BYX, GIZ, GSH, GSP, JAV, JMA, LDO, RIB, RSO, SBW, SND, SPD, SPE, SQU.

The above abbreviations and group names (QMS, non-QMS fish, non-QMS invertebrates) are used throughout the remainder of this report along with standard Fisheries New Zealand species codes (see Tables A1, A2, and B1 or http://marlin.niwa.co.nz to match codes to species scientific and common names). Non-target catch was estimated for all species/species group codes, but discards were only estimated for target species, QMS, non-QMS fish, non-QMS invertebrate, and all species combined.

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

2.2 Commercial fishing return data

Catch and effort, daily processed, and landed data were obtained from the Fisheries New Zealand catch and effort Enterprise Data Warehouse as extract 14842. The data consisted of all fishing and landing events associated with a set of fishing trips that reported any positive catch or landing of hoki, hake, ling, silver warehou, and white warehou (HOK, HAK, LIN, SWA, WWA) between 1 October 2002 and 30 September 2022. This included all fishing recorded on Trawl Catch, Effort and Processing Returns (TCEPRs); Trawl Catch Effort returns (TCERs); Catch, Effort and Landing Returns (CELRs), Electronic Reporting System (ERS) (since 2018), including high seas versions of these forms. Data were groomed for errors using simple checking and imputation algorithms developed in the statistical software package 'R' (R Core Team 2022). Tow positions, trawl length and duration, fishing speed, and depths were all groomed, primarily employing median imputation and range checks to identify and deal with missing or unlikely values and outliers. These records, representing 309 525 target tows, were assigned to the areas defined in Figure 1 using the start position coordinates.

The primary use of the commercial catch data was to scale up observed non-target catch and discard amounts to the entire fishery, but they were also used to directly estimate total annual non-target catch without the need for any scaling; this was possible because both the total catch and target species catch (unless the species catch was not included in the top 5–8 species by weight and therefore generally small[3]) were recorded for each tow. These alternative estimates are provided here for comparison with the observer-based estimates. Note that, because only the top five or eight species by weight were recorded, it is not possible to estimate the total non-target catch of individual species or species groups with this method.

[3] Since the introduction of ERS reporting, vessels greater than 28 m in length must report the top 5 QMS species and the top 3 non-QMS species at a minimum. Vessels equal to or less than 28 m in length must report at least the top 8 species (QMS or non-QMS) since 2007–08.

2.3 Stratification

Fishing area, used as a predictor variable, has proven to be an important driver of non-target catch and discard rates in all New Zealand offshore fisheries examined and is becoming increasingly useful in these analyses for providing breakdowns by standardised fishery areas (e.g., Anderson & Finucci 2022). The set of standard areas used in the Aquatic Environment and Biodiversity Annual Review 2019–20 (Fisheries New Zealand 2020) was adopted for this study (see Figure 1). Given that the sub-Antarctic hoki fishery straddles some of the standard area boundaries, specifically STEW, SUBA, and AUCK, data from these areas were aggregated in the standard model set-up to estimate a single coefficient for these areas combined. Each record in the observer and commercial effort datasets was assigned to the sets of areas described above using reported start position data or General Statistical Area. The numbers of observed trawls in each area over the years examined in this report are given in Table 1.

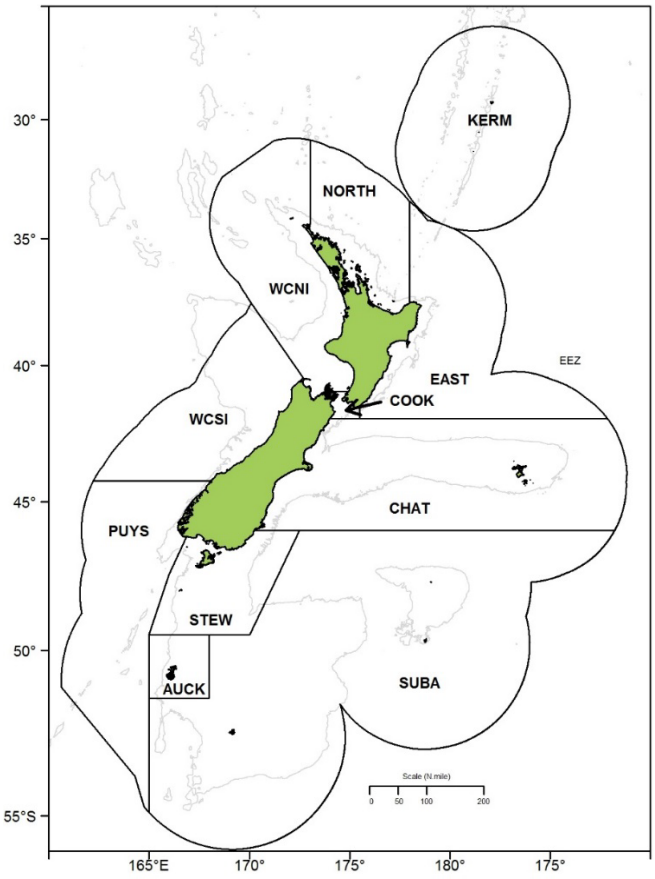


Figure 1: Areas used for estimation of total non-protected fish and invertebrate non-target catch in offshore fisheries: KERM, Kermadec region; NORTH, Northern North Island; WCNI, West coast North Island; EAST, East coast North Island; COOK, Cook Strait; WCSI, West coast South Island; CHAT, Chatham Rise; PUYS, Puysegur; STEW, Stewart-Snares shelf; AUCK, Auckland Islands; SUBA, sub-Antarctic. The grey lines indicate the 1000 m isobath.

From empirical explorations of the data, it was clear that net type (midwater versus bottom trawl) was an important determinant of non-target catch and discards, and vessel class was important for discards. Vessels were divided into three classes: large "Soviet-class" trawlers of any flag state or ownership (BATM); other foreign owned vessels (FOVs); and domestic vessels. Importantly, any vessels that were reflagged to New Zealand were retained in the FOV category. With the recent changes to legislation requiring all vessels to be flagged to New Zealand, the proportion of effort from vessels of this class (known from this and previous studies to produce substantially greater discards) has declined (Figure 2). These additional covariates (net-type and vessel class) were therefore included in models.

Table 1: Number of observed trawls (bottom trawl (BT)/midwater trawl (MW) for WCSI) that targeted hoki, hake, ling, silver warehou, or white warehou by area (see Figure 1 for area boundaries) and fishing year, where 2003 is 2002–03, etc.

Fishing year	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI (BT)	WCSI (MW)	Total
2003	42	905	133	9	0	66	461	126	0	399	553	2 694
2004	17	602	128	0	0	67	174	114	0	421	961	2 484
2005	2	813	139	1	0	67	176	14	1	264	828	2 305
2006	5	770	65	0	1	53	398	2	0	509	644	2 447
2007	3	887	224	7	0	47	463	13	6	147	530	2 327
2008	61	872	200	0	0	12	544	136	0	409	386	2 620
2009	48	733	168	0	0	42	571	128	1	126	586	2 403
2010	6	746	356	3	3	59	810	18	1	437	362	2 801
2011	36	881	89	1	4	40	532	59	0	352	328	2 322
2012	11	1 030	192	2	0	88	605	39	6	432	629	3 034
2013	28	1 733	198	0	0	129	1 350	127	1	856	1 394	5 816
2014	44	1 304	229	21	29	61	1 162	189	0	773	1 471	5 283
2015	31	765	404	51	81	83	904	61	0	895	1 719	4 994
2016	29	1 224	157	1	23	106	609	21	3	652	1 476	4 301
2017	35	1 120	125	29	42	67	543	76	5	1 035	868	3 945
2018	61	1 101	211	5	36	87	1 173	414	6	1 177	1 288	5 559
2019	35	1 177	245	1	31	116	578	135	1	497	1 226	4 042
2020	22	1 289	226	11	91	27	692	194	17	800	1 172	4 541
2021	71	1 821	85	1	27	58	803	174	3	509	754	4 306
2022	36	1 556	232	4	34	118	888	171	5	557	1 057	4 658

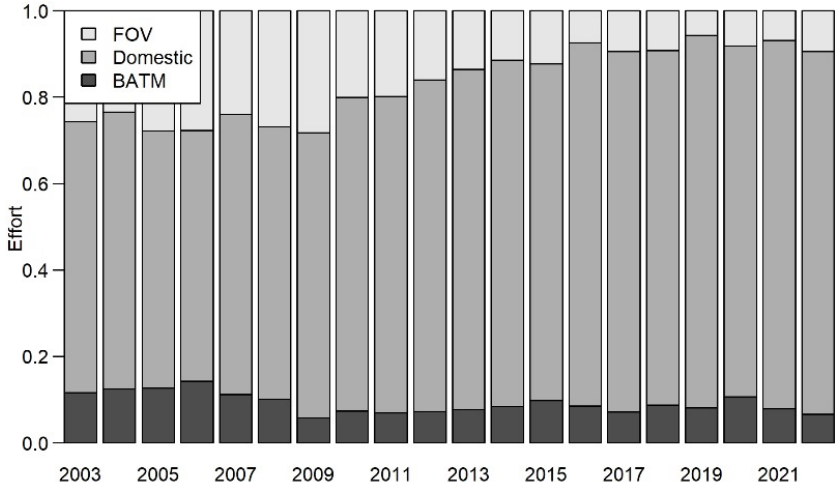


Figure 2: Annual proportion of effort by vessel class in the hoki, hake, ling, silver warehou, and white warehou trawl fishery. See text above for explanation of the legend codes; note that FOV includes any vessels reflagged to New Zealand during this period; BATM is a Russian acronym translating to Big Autonomous Trawler Reefer.

2.4 Calculation of non-target catch and discards

The first statistical model-based analysis of this fishery used a two-part, binomial/log-normal statistical model (Anderson & Edwards 2018) and the same statistical approach has been applied in subsequent analyses of other fisheries (e.g., Finucci et al. 2020, Finucci et al. 2022, Anderson & Finucci 2022, Anderson et al. 2023). The model made specific assumptions regarding the spatial and temporal structure of the fishery, estimating the catch rate and non-target catch and discards per year, per region and with the ability to include fishing method or other discrete covariates. We apply this same

methodology here, referred to hereafter as the 'standard method.' We also introduce and implement a new 'revised method.' Although the standard model included estimated area coefficients, these were treated as independent fixed effects. The revised model was designed to estimate spatial catch rates at any resolution, with spatial structure defined by a grid of cells, and with each grid cell coefficient treated as a spatially correlated random effect. This allows a better description of the data at a finer spatial resolution. In introducing this revised model, we sought in the current work to demonstrate consistency with the standard approach, in anticipation of adopting the revised model for future work.

In the following description of the methods, we use the subscript notation *i* to refer to the fishing event (tow) and the notation *j* to refer to the stratum. The stratum refers to any unique combination of fixed-effect covariate values, e.g., for the standard model a unique combination of the year, statistical area, and vessel category.

Standard method

In this method, a model is fitted to tow-by-tow observer sampling data (using the notation X_{ij} to refer to the catch per tow, with catch recorded in kilograms) using a Bayesian estimation framework. Estimated parameters are then used to predict the catch for unobserved commercial fishing effort.

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

$$n_j \approx r_j + o_j$$

with the approximation necessary because of occasional errors in recording of the effort (i.e., instances in which $o_j > n_j$).

The number of observed non-zero tows is fitted using a binomial likelihood, *B*(). To increase the speed of computation, the proportion of non-zero tows θ_j is estimated using the summed data. For example, for stratum *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 modelled on a tow-by-tow basis, which is necessary for estimation of the standard error term σ_j (i.e., aggregation of the data would lead to underestimation of the variance in the catch rate per tow). Using a log-normal distribution *LN*(), for observer record *i*:

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

For each model part, linear regressions are used to define the parameters of each respective statistical distribution. For the binomial model part, the regression equation is:

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

where $\boldsymbol{x}_j^{\mathrm{T}}$ represents a row of discrete covariates from the design matrix, and $\boldsymbol{\gamma}$ is a vector of estimated coefficients (fixed effects). For the log-normal model part, the mean of the log of the non-zero catch rate (μ_{ij}) is defined as:

$$\mu_j = \beta_0 + \boldsymbol{x}_j^{\mathrm{T}}.\boldsymbol{\beta}.$$

where $\boldsymbol{\beta}$ is a vector of estimated coefficients (fixed effects). The expected catch rate per event is:

$$\mathrm{E}[X_{ij}] = \theta_j . \exp(\mu_j + \sigma_j^2/2)$$

For the current analysis, discrete covariates included in the design matrix $\boldsymbol{x}_j^{\mathrm{T}}$ were limited to the fishing gear (midwater or bottom trawl), fishing year, and statistical area or region (Figure 1). For discards estimation, a vessel category fixed effect was also included (BATM, FOV, or Domestic).

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

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

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).

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 stratum (i.e., using the sum of the unobserved effort). For stratum j, the residual effort is:

$$r_j = \max(n_j - c_j, 0).$$

At this aggregated scale, it is necessary for the model to predict values for:

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

which is the summed catch across unobserved effort for a given strata. Model outputs can be generated as the posterior of expected values:

$$\mathrm{E}[Z_j] = \sum_{i=1}^{r_j} \mathrm{E}[X_{ij}]$$

or using posterior prediction, for which we use the notation:

$$\tilde{Z}_{j(p)} = \sum_{i=1}^{r_j} \tilde{X}_{ij(p)}$$

where p refers to a sample from the posterior distribution. Posterior predictive simulation 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 for $\tilde{Y}_{j(p)}$ tows, catches are predicted from the log-normal model part:

$$\tilde{X}_{ij(p)} \sim LN(\mu_{j(p)}, \sigma^2_{(p)})$$

and summed. We can report catches obtained from both the expected and posterior predicted values. Since the observed catches X_{ij} are treated as known, this gives the total predicted catch per stratum as:

$$\text{Expected Catch}_j = \mathrm{E}[Z_j] + \sum_{i=1}^{o_j} X_{ij}$$

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

Coefficients were given standard normal prior densities:

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

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:

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

Revised method

For the revised model, spatial random effects are estimated per grid cell, with the subscript *k*. In addition, the σ standard error term is defined more explicitly as a hierarchical spatial random effect. The statistical distributions as described for the standard model are used, but the regression parameters are as follows in the revised model:

$$\text{logit}(\theta_{jk}) = \gamma_0 + \boldsymbol{x}_j^{\intercal}.\boldsymbol{\gamma} + \phi_k^{[\theta]}$$

$$\mu_{jk} = \beta_0 + \boldsymbol{x}_j^{\intercal}.\boldsymbol{\beta} + \phi_k^{[\mu]}$$

$$\sigma_{jk} = \sigma_0 + \boldsymbol{x}_j^{\intercal}.\boldsymbol{\delta} + \phi_k^{[\sigma]}$$

with discrete covariates in $\boldsymbol{x}_j^{\intercal}$ limited to the fixed effects (which in this case are non-spatial), and spatial effects defined by the parameters $\left\{\phi_k^{[\theta]}, \phi_k^{[\mu]}, \phi_k^{[\sigma]}\right\}$. These were given multivariate normal priors:

$$\phi_k^{[.]} \sim MVN(0, \boldsymbol{\Sigma}^{[.]})$$

where the covariance matrices $\left\{\Sigma^{[\theta]}, \Sigma^{[\mu]}, \Sigma^{[\sigma]}\right\}$, allow correlation between neighbouring spatial strata, with estimated correlation parameters ρ and precision τ. Treating the spatial effects in this way increases

the identifiability of the model and therefore allows a higher spatial resolution to be estimated. The precision is given the prior:

$$\tau \sim Gamma(2, 2)$$

whilst ρ was given a uniform prior between zero and one.

For the current project, we adopted an areas-as-cells approach, in which the 'cell' was equivalent to the non-target catch area assumed by the standard model. This allowed direct comparison of outputs between the two models. A point of difference with the standard model is that the revised model does not currently allow a spatio-temporal interaction, due to the potentially higher spatial resolution and the large number of parameters this would require. A year/area interaction is presumed to better accommodate changes to the species composition of some of the species groups being modelled, since addition or removal of species will change the spatial distribution of the group. The year/area interaction can be used in the standard method to account for this but has not been included in the revised model. The pragmatic solution applied was to exclude the earliest two years (2002–03 and 2003–04) from the analysis, after which there have been few relevant additions of species to the QMS, and the groups are mostly consistent among years. Nevertheless, catches were adjusted by year-of-entry to the QMS (i.e., assigning species to the QMS, non-QMS fish, and non-QMS invertebrate categories based on the list of QMS species current for that year) for the standard model (as agreed with Fisheries New Zealand), but unadjusted for the revised model (i.e., using the groups defined currently to assign catches throughout the historical time series). Both models were run without a year/area interaction.

To improve computational efficiency, an aggregated prediction of the catches was performed, similar to that introduced by Edwards & Mormede (2023).

Given the number of positive tows:

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

we can predict the sum of the catches directly using:

$$\tilde{Z}_{jk(p)} \sim LN(m_{jk(p)}, v^2_{jk(p)})$$

where:

$$v^2_{jk} = \ln\left(\left(\exp\left(\sigma^2_{jk}\right) - 1\right).\frac{1}{n} + 1\right)$$

$$m_{jk} = \ln\left(n.\exp\left(\mu_{jk}\right)\right) - \frac{v^2_{jk}}{2} + \frac{\sigma^2_{jk}}{2}$$

and $n = \tilde{Y}_{jk(p)}$ is the simulated number of non-zero catch events. This adjustment is justified intuitively, because when predicting aggregated catches, the uncertainty associated with this prediction should decrease as the aggregated effort increases. Equivalent expected values were also generated to compare with posterior predicted catches, as described for the standard model.

Three revised model structures were investigated. 1) An areas-as-grid model in which each of the regions in Figure 1 is treated as a 'grid cell.' This allowed the revised model to replicate the spatial assumptions of the standard model; 2) a grid model in which equal-area grids are defined and coefficients estimated per cell with predicted catches summed across cells; 3) a grid model with vessel random effects. For the discards, we included vessel category as a fixed effect for the areas-as-grid model, to match the covariates included in the standard model. Formal model comparisons using the expected log-posterior density (ELPD) were used to select the appropriate model.

Estimation and model diagnostics

For both models, Bayesian estimation was performed in the R-package **rstan** (Stan Development Team 2019). All model runs were initialised with parameters at their maximum penalised likelihood values and consisted of at least two Markov chain Monte Carlo (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% equal-tailed credibility interval (see Appendix C).

Total estimated non-target catches and discards for each model were generated, and the outputs from both models could be compared to validate the revised model. In addition, further model diagnostics were constructed to evaluate performance of the revised model. These included spatial plots comparing annual empirical (observed) non-target catch and discard values with the posterior predicted values generated by the model. One-to-one plots comparing the sum of empirical and predicted catch per year and grid cell were also provided. These plots illustrate the degree to which the revised model can accurately predict the empirical data, and the level of confidence with which it is able to predict the catch from the unobserved component of the commercial fleet, and therefore predict the total non-target catch per species group. Additionally, alternative illustrations of the same diagnostics are provided, plotted as bar-graphs over time; these include the expected catches from the model fit to test correspondence with, and therefore validation of, the posterior prediction used to generate the model outputs.

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.

To highlight overall patterns of change over time, locally weighted regression lines were calculated and are shown on plots for the main categories. In addition, to provide an indication as to the long-term trend in annual estimates, linear regressions (with lognormal errors) were also fitted using standard method estimated non-target catch/discard values from 2002–03 onwards as input data. The direction and steepness of the slopes of these regressions were determined and the significance of the difference in slopes from zero (indicating no trend) was determined from the *t*-statistic of the estimated coefficients and associated standard errors.

3. RESULTS

3.1 Distribution and representativeness of observer data

A considerable amount of data was collected over the 20-year period that observers have operated in this fishery; the nearly 73 000 observed tows (by 101 vessels) is considerably greater than that achieved in any other New Zealand fishery (Table 2). The annual level of observer coverage in relation to overall effort in the fishery was variable but has generally increased over time, from 9–16% before 2006–07, 18–22% until 2011–12, and 25–40% thereafter, with the highest observer coverage (42%) occurring in 2021–22. Across the time series, an average of 30% of the catch has been observed (Table 2). The areas with the highest observer coverage included the west coast South Island (WCSI, both midwater and bottom trawls), the Stewart-Snares shelf (STEW), the Auckland Islands (AUCK), and the Sub-Antarctic (SUBA). Coverage was moderate on Chatham Rise (CHAT) and off Puysegur (PUYS), and lowest in fisheries with smaller vessels (areas NORTH, EAST, and WCNI) (Table 3).

The spatial distribution of target trawl fishing effort for hoki, hake, ling, silver warehou, and white warehou between 1 October 2002 and 30 September 2022 is shown for all commercial tows and all observed tows in Figure 3. Observer coverage was well spread across the main target species fisheries in WCSI, CHAT, STEW, AUCK, and SUBA, with little coverage of the smaller fisheries around the

North Island. To assess spatial observer coverage more objectively, a comparison of the latitude and longitude of observed tows with all commercial tows recorded with position data was produced using density plots (Figure 4). These plots show that the spread of observed tows over the longitudinal and latitudinal extent of the fishery was well matched for all years combined, although observer coverage in regions centred between 40° S and 45° S (relating to effort in the WCSI, COOK, and CHAT fisheries) were slightly under-represented in recent years (since 2017–18) (Figure 4).

Table 2: Summary of effort and estimated catch (t) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for observed tows and overall, by fishing year. Trips include those with any tows that targeted any of the five target species. HHLSW = hoki, hake, ling, silver warehou, white warehou.

Fishing year	Number of tows		Number of vessels		Number of trips*		HHLSW catch		Percentage observed	
	Observed	All	Observed	All	Observed	All	Observed	All	Catch	Tows
2002–03	2 694	29 865	33	117	45	1 430	22 090	207 863	10.6	9.0
2003–04	2 484	25 137	32	110	38	1 436	19 987	163 008	12.3	9.9
2004–05	2 305	17 849	32	98	43	885	19 739	131 706	15.0	12.9
2005–06	2 447	15 181	28	94	40	895	24 815	125 175	19.8	16.1
2006–07	2 327	14 902	35	83	51	812	24 464	125 394	19.5	15.6
2007–08	2 620	13 906	31	81	53	840	25 741	108 783	23.7	18.8
2008–09	2 403	12 759	35	80	58	835	26 684	110 040	24.2	18.8
2009–10	2 801	12 942	35	86	62	994	32 295	119 165	27.1	21.6
2010–11	2 322	13 284	27	82	53	1 005	27 648	130 605	21.2	17.5
2011–12	3 034	13 662	32	85	68	998	39 376	141 684	27.8	22.2
2012–13	5 816	14 365	30	79	128	999	71 876	147 417	48.8	40.5
2013–14	5 283	15 829	32	78	124	1 103	67 347	161 251	41.8	33.4
2014–15	4 994	16 360	35	81	120	1 155	69 292	176 117	39.3	30.5
2015–16	4 301	14 963	31	87	99	1 178	52 543	151 343	34.7	28.7
2016–17	3 945	15 380	36	79	107	1 186	46 775	155 539	30.1	25.7
2017–18	5 559	15 867	46	80	121	1 099	61 593	149 599	41.2	35.0
2018–19	4 042	13 857	44	75	103	455	48 909	126 497	38.7	29.2
2019–20	4 541	11 424	40	72	101	225	55 180	113 242	48.7	39.7
2020–21	4 306	10 822	38	72	110	231	53 412	112 540	47.5	39.8
2021–22	4 658	11 171	40	69	91	188	54 952	105 056	52.3	41.7
All years	72 882	309 525	101	192	1 538	17 787	844 717	2 762 025	30.6	23.5

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

Table 3: Summary statistics for the HOK, HAK, LIN, SWA, and WWA target trawl fishery, by area, for the period 2002–03 to 2021–22, including observer/vessel coverage. Data for midwater (MW) and bottom (BT) tows are shown separately for WCSI due to the high level of midwater fishing in this area.

Area	Median vessel length (m)	Total effort		Percent of tows with position data	Percent of tows by vessels not observed
		Number of tows	Percent of tows observed		
AUCK	66.0	2 089	29.8	99.9	0.7
CHAT	64.5	111 369	19.2	99.7	1.7
COOK	42.0	38 889	9.8	91.9	5.3
EAST	29.0	5 783	2.5	98.0	16.8
NORTH	21.2	4 868	8.3	97.7	13.5
PUYS	64.0	7 568	18.4	93.8	20.5
STEW	66.0	39 218	34.3	100.0	2.0
SUBA	66.0	7 484	29.5	99.3	0.7
WCNI	29.3	667	8.4	89.8	13.0
WCSI(BT)	64.0	39 109	28.8	98.3	4.1
WCSI(MW)	42.8	26 662	68.4	92.4	4.3

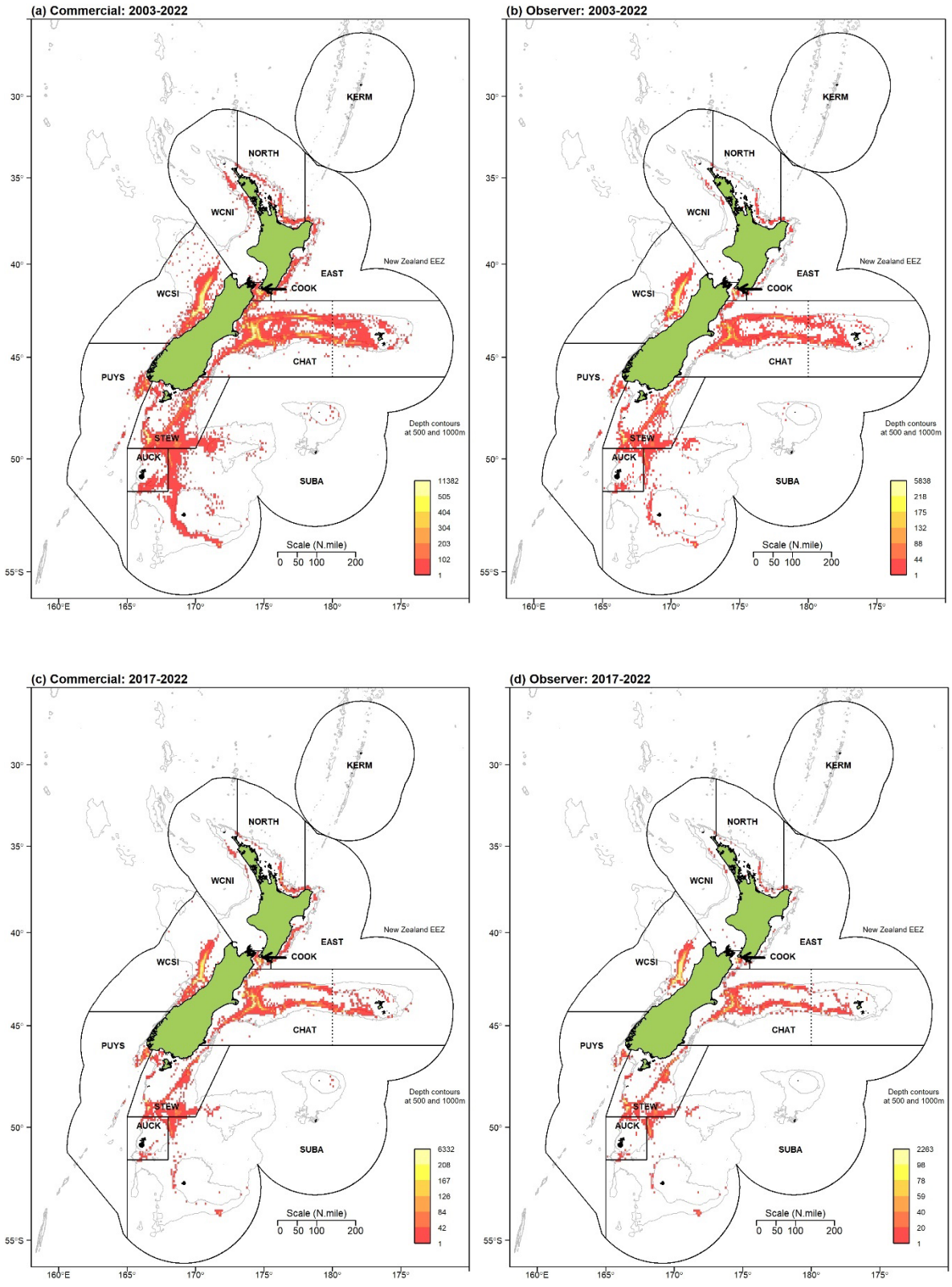


Figure 3: Density plots showing the distribution of all commercial HOK, HAK, LIN, SWA, and WWA target trawls with recorded position data (a, c) and all such tows recorded by observers (b, d), for fishing years 2002–03 to 2021–22 (a, b) and for the five years since the last assessment (c, d). The legend indicates the average number of tows per year in each 0.2° cell; solid lines mark the outer boundary of the Exclusive Economic Zone (EEZ) and areas used in the analyses; the grey lines show the approximate 500 and 1000 m isobaths.

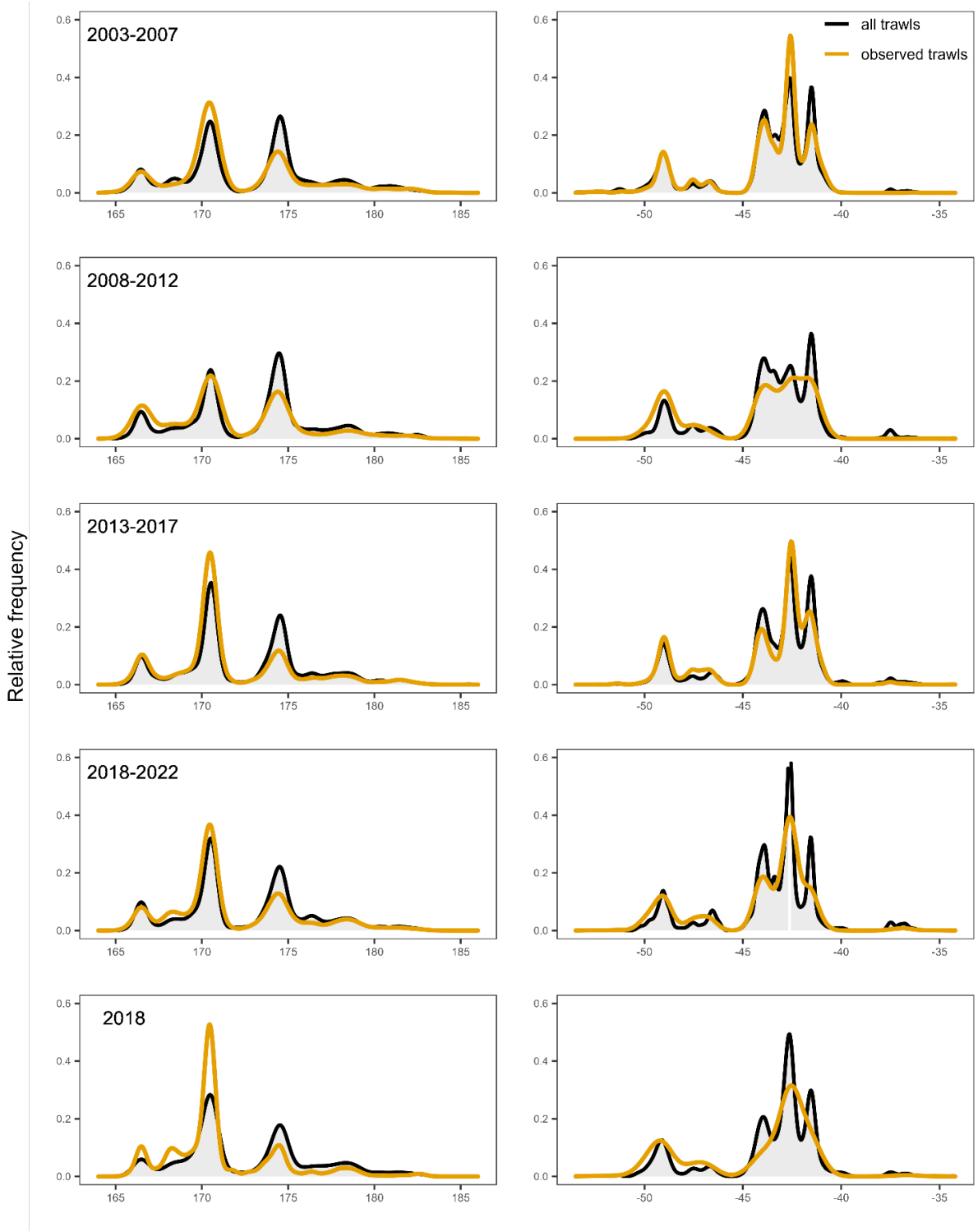


Figure 4: **Comparison of start positions (latitude and longitude) of observed tows (yellow) with those of all commercial tows (black) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery, by grouped time periods between 2002–03 and 2021–22, for individual fishing years from 2017–18 onwards, and for 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 (continued on next page).**

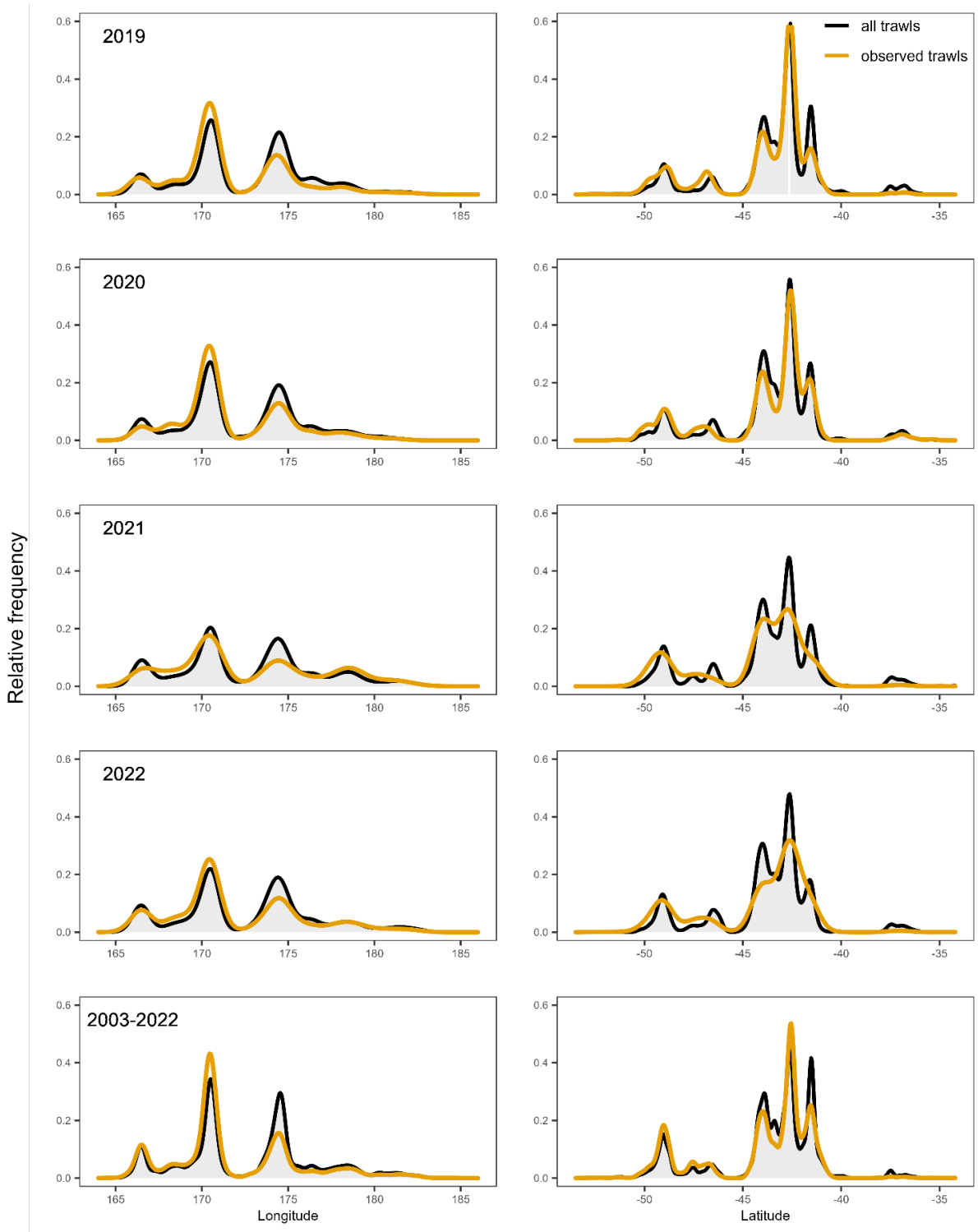


Figure 5: Continued.

Comparisons made between vessel sizes in the commercial fleet and the observed portion showed that, across all years, vessels between 50 and 100 m in length were well observed, vessels smaller than 50 m were generally under-observed, and vessels greater than 100 m were over-observed (Figure 5). Since 2016–17, mid-sized vessels (50 to 76 m in length) tend to be over-represented by observer coverage and the smallest vessels were consistently under-represented (Figure 6). Vessel size is strongly linked to fishing area; the larger vessels were mainly associated with the larger and/or more distant fisheries (areas AUCK, CHAT, WCSI, SUBA, STEW) whereas the smaller fisheries around the North Island (including COOK) were fished mainly by smaller vessels (see Table 3). There are also operational rules and a code of practice for the hoki fishery that impact past and present fleet fishing patterns including: foreign owned vessels (prior to 1 May 2016) and all vessels longer than 46 m may not fish anywhere inside the 12-mile Territorial Sea (this includes much of the hoki spawning area in the Hokitika Canyon (WCSI) and most of the area from there south to the Cook Canyon, as well as the spawning area in Cook Strait); and targeting restrictions which apply to vessels over 28 m in several areas where small hoki are in high abundance (Ballara & O'Driscoll 2018).

The spread of observer effort throughout each fishing year was compared with the spread of total effort in the fishery by applying a density function to the numbers of tows per day (Figure 7). Although this fishery operates year-round, there is a significant seasonal component to it, with a strong peak of effort centred around the June–September spawning period of hoki on the west coast South Island, Cook Strait, and smaller grounds off the east coast South Island and Puysegur. Generally, observer effort was closely matched to overall effort, and the spawning period was relatively over-sampled.

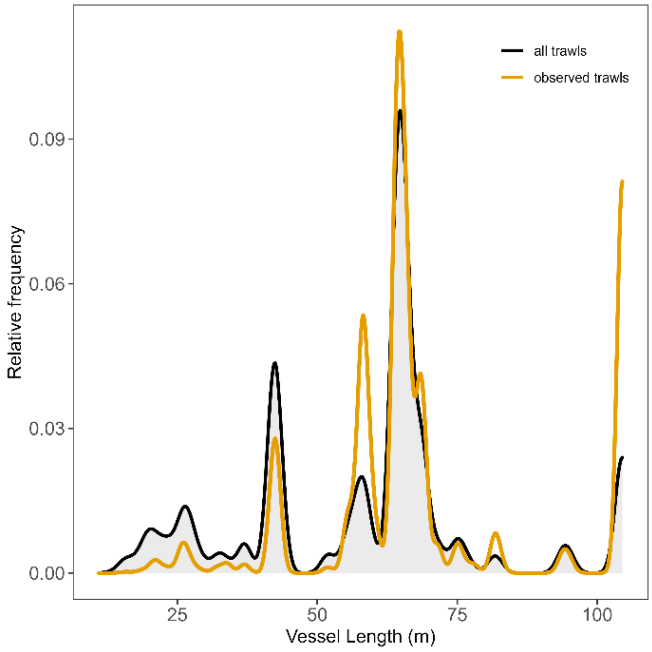


Figure 6: Comparison of vessel length (m) for observed tows (yellow) vs. all recorded commercial tows (black) for all years combined for fishing years from 2002–03 to 2021–22 in the HOK, HAK, LIN, SWA, and WWA target trawl fishery. The relative frequency of the numbers of tows was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.

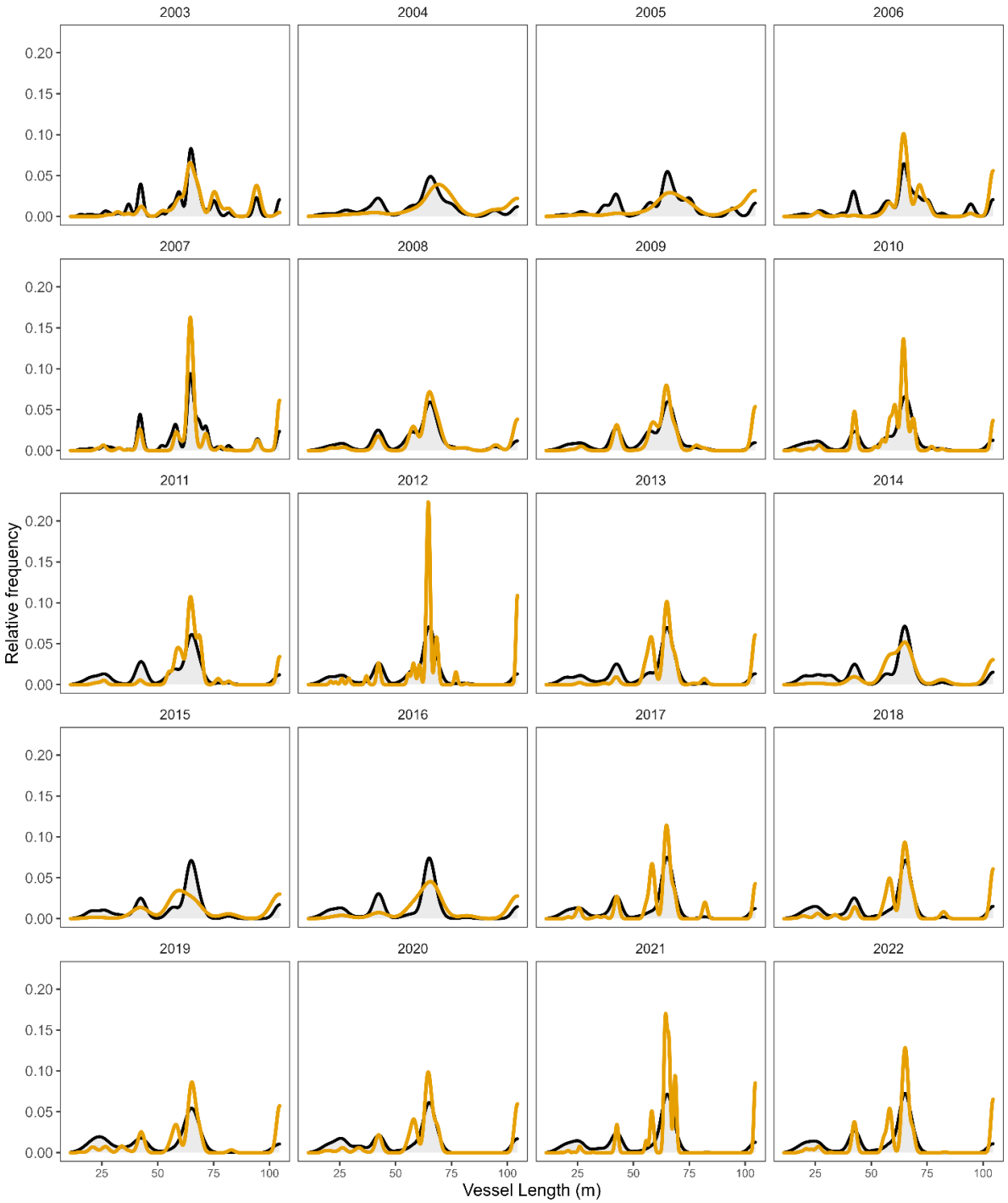


Figure 7: Comparison of vessel length (m) for observed tows (yellow) vs. all recorded commercial tows (black) for fishing years from 2002–03 to 2021–22 in the HOK, HAK, LIN, SWA, and WWA target trawl fishery. The relative frequency of the numbers of tows was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.

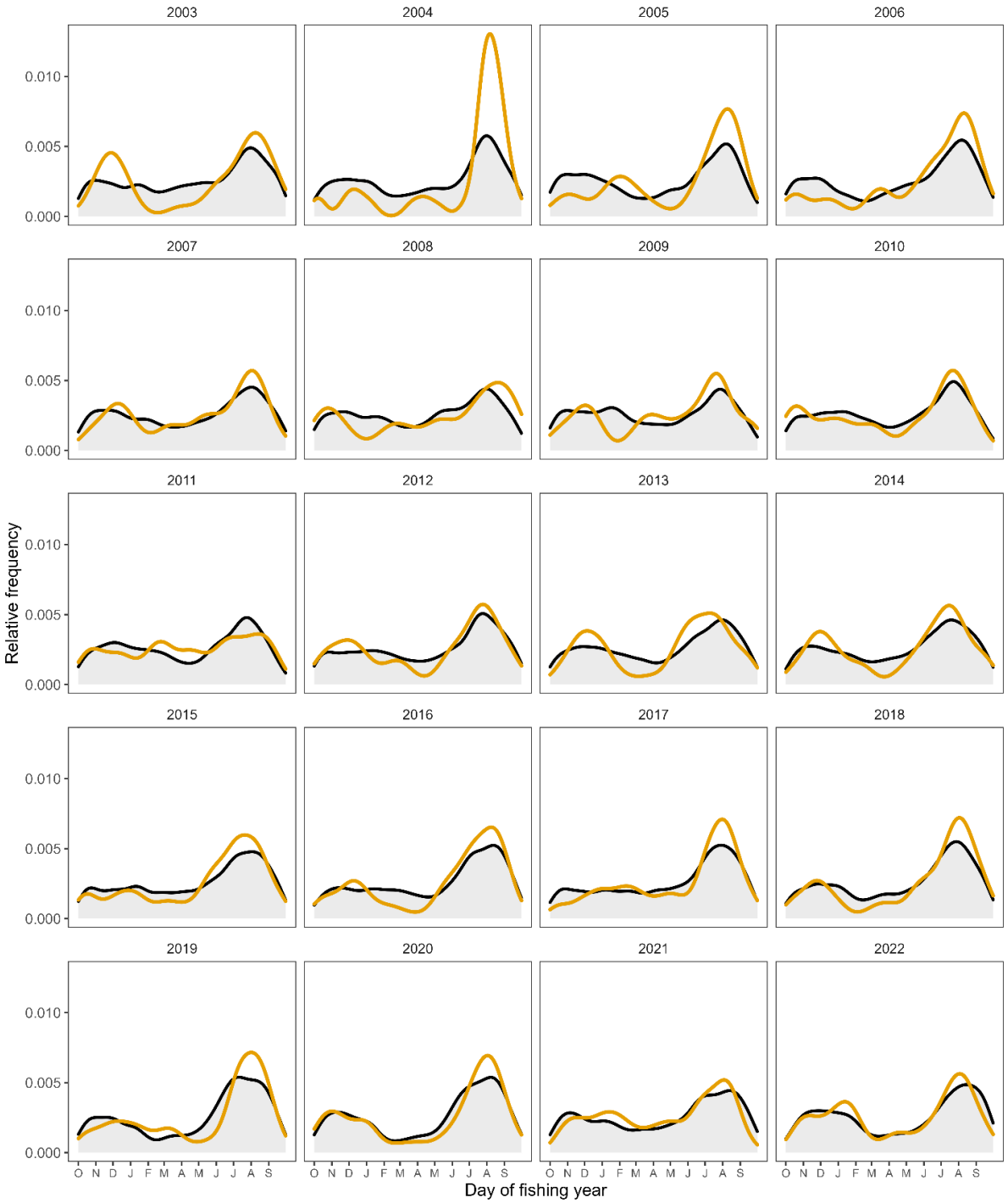


Figure 8: **Comparison of the temporal spread of observed tows (yellow) vs. all recorded commercial tows (black) for fishing years from 2002–03 to 2021–22 in the HOK, HAK, LIN, SWA, and WWA target trawl fishery. The relative frequency of the numbers of tows was calculated from a density function which used linear approximation to estimate frequencies at a series of equally spaced points.**

3.2 Non-target catch data

3.2.1 Overview of raw non-target catch data

Over 900 non-target species or species groups were identified by observers in the target trawl fishery, most being non-commercial species, including invertebrate species, caught in low numbers (see summaries in Appendix A Tables A1–A8, and Figure 8). Hoki accounted for about 73% of the total at-sea estimated catch from all observed tows targeting HOK, HAK, LIN, SWA, and WWA between 1 October 2002 and 30 September 2022. The other main catch species were ling (5.9%), hake (5.7%), silver warehou (3.9%), javelinfish (2.0%), unspecified rattails (1.6%), spiny dogfish (1.5%), and white warehou (1.1%) (Figure 8). Of these, spiny dogfish (55%), javelinfish (32%), and unspecified rattails (36%) were the fish species with the largest rate of observed discarding in this fishery. Other species frequently caught and often discarded included shovelnose dogfish (*Deania* spp), Baxter's lantern dogfish (*Etmopterus granulosus*), silverside (*Argentina elongata*), leafscale gulper shark (*Centrophorus squamosus*), and silver dory (*Cyttus novaezealandiae*). Of the invertebrates, arrow squids (*Nototodarus sloanii* and *N. gouldi*) were the ninth most common non-target species by weight (0.5% of the total catch) and were the only invertebrates in the top 30 non-target taxa. As valuable quota species, they were mostly retained. Other squids and octopuses, sponges, echinoderms, and crabs were the other main invertebrate non-target groups caught, all at less than 0.05% of the total catch, and most of these were discarded (see Table A2 for a list of the main observed invertebrate non-target species).

Exploratory plots were prepared to examine non-target catch per tow (plotted on a log scale) with respect to other relevant available parameters, including depth, duration, vessel, fishing year, month, area, target species, and gear method (Figures 9–12). Plots were prepared using data from all fishing years (i.e., 2002–03 to 2021–22) and by species category (ALL species, QMS species, non-QMS fish, and non-QMS invertebrates).

Total non-target catch per tow was highly variable between tows, ranging from 0 to 109 kg (Figure 9). Trawling was mostly (95%) at bottom depths of 250–750 m, but some fishing was shallower than 200 m and deeper than 900 m. Total non-target catch per tow increased slightly with increasing bottom depth and increased with increasing tow duration. Most tows (97%) were less than 10 hours in duration, but longer tows were often made, and some were over 15 h. There were large differences in non-target catch between the 32 vessels represented by more than 500 records before tows with no non-target catch were removed, with medians ranging from about 110 kg per tow to 2438 kg per tow, but there was no clear difference in non-target catch with vessel size. There was no trend in total annual non-target catch per tow annually, but there was some monthly variation, with a reduction of non-target catch during the months of June to August. There were some differences in non-target catch levels among the areas examined: median non-target catch was lowest in COOK (about 105 kg per tow) and midwater fishing in WCSI (about 283 kg per tow), but similar amongst the remaining areas (793 to 1720 kg per tow). Overall, there was lower non-target catch from midwater tows than from bottom tows, and non-target catch was greater when targeting silver warehou and white warehou than when targeting hoki, hake, and ling.

Patterns of non-target catch for QMS species in relation to these variables were similar to those for total non-target catch (Figure 10). Non-target catch of non-QMS fish species also showed similar patterns to total non-target catch and QMS species non-target catch, for most of the fishery parameters examined (Figure 11). However, non-QMS fish species non-target catch per tow increased more strongly with depth than in the other catch categories, the nominated target species had less influence, and the difference in non-target catch per tow for gear method was more pronounced (with less in midwater). Non-QMS invertebrate species non-target catch showed an initial decline in catch rates with depth, then increased beyond 500 m (Figure 12). Non-target catch rates (which comprise mostly fish species) increased with depth and there was no annual or monthly trend. Non-QMS invertebrate catch rates were higher for tows not targeting hoki and in the southern-most areas (PUYS, STEW, SUBA).

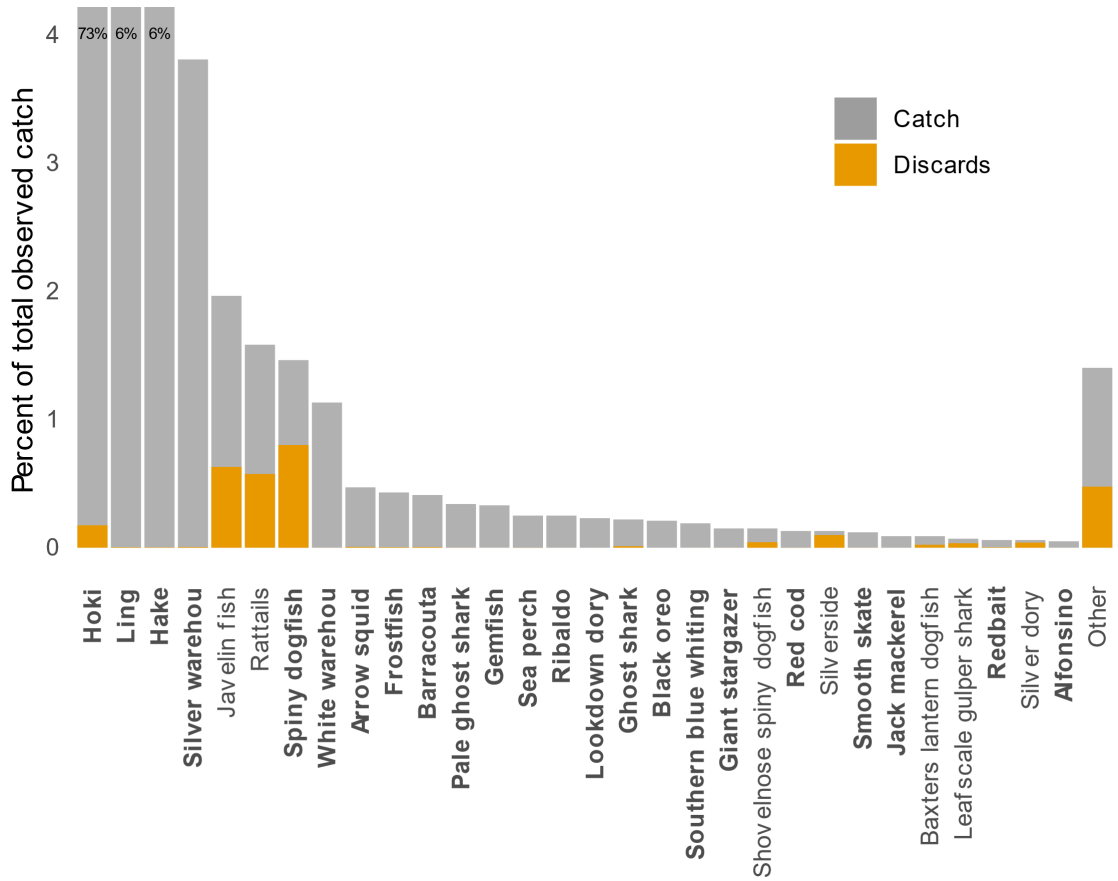


Figure 9: Percentage of the total catch contributed by the top 30 non-target species in the observed portion of the HOK, HAK, LIN, SWA, and WWA target trawl fishery for fishing years 2002–03 to 2021–22 (grey) and the percentage discarded (yellow). The Other category is the sum of all non-target species representing 1.4% of the total catch. Names in bold are QMS species (see text).

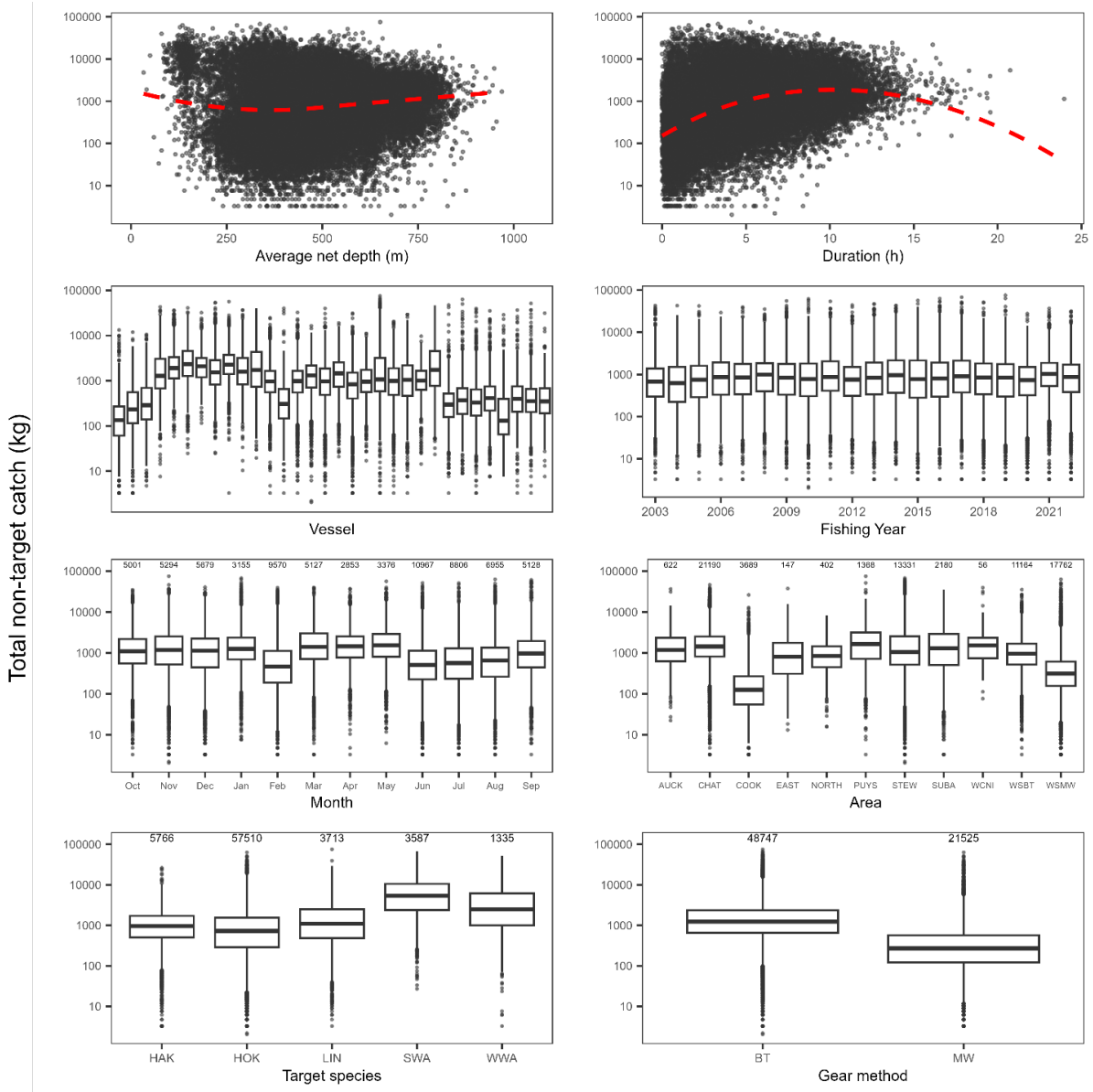


Figure 10: Total observed non-target catch (all species) in kilograms (kg) per tow plotted against selected variables in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for the fishing years 2002–03 to 2021–22, on a log scale. The red dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Average depth is the average of the start and finish depths at each end of the tow. See Figure 1 for area codes. WSBT and WSMW refer to WCSI(BT) and WCSI(MW), respectively.

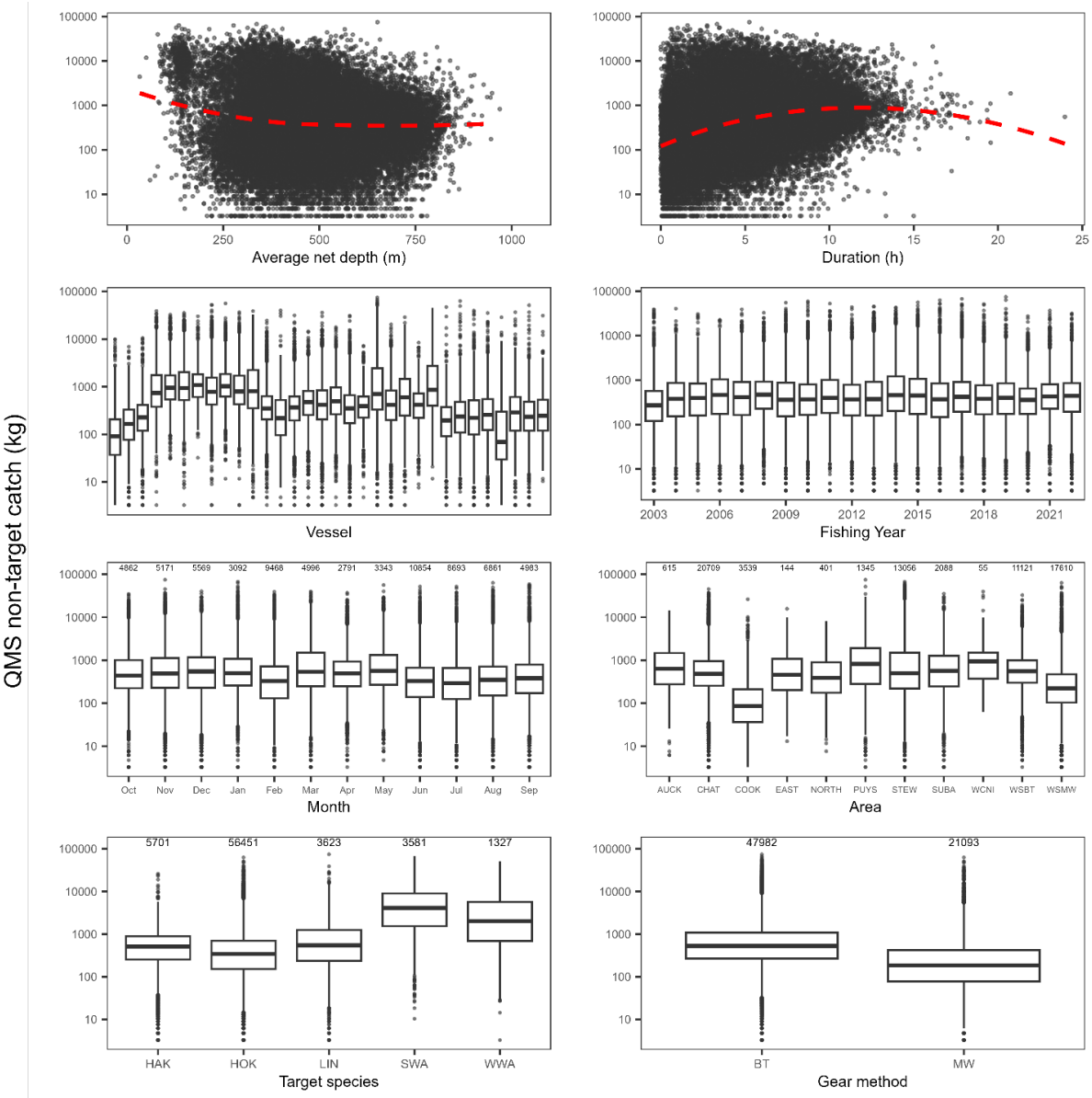


Figure 11: QMS observed non-target catch (all species) in kilograms (kg) per tow plotted against selected variables in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for the fishing years 2002–03 to 2021–22, on a log scale. The red dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Average depth is the average of the start and finish depths at each end of the tow. See Figure 1 for area codes. WSBT and WSMW refer to WCSI(BT) and WCSI(MW), respectively.

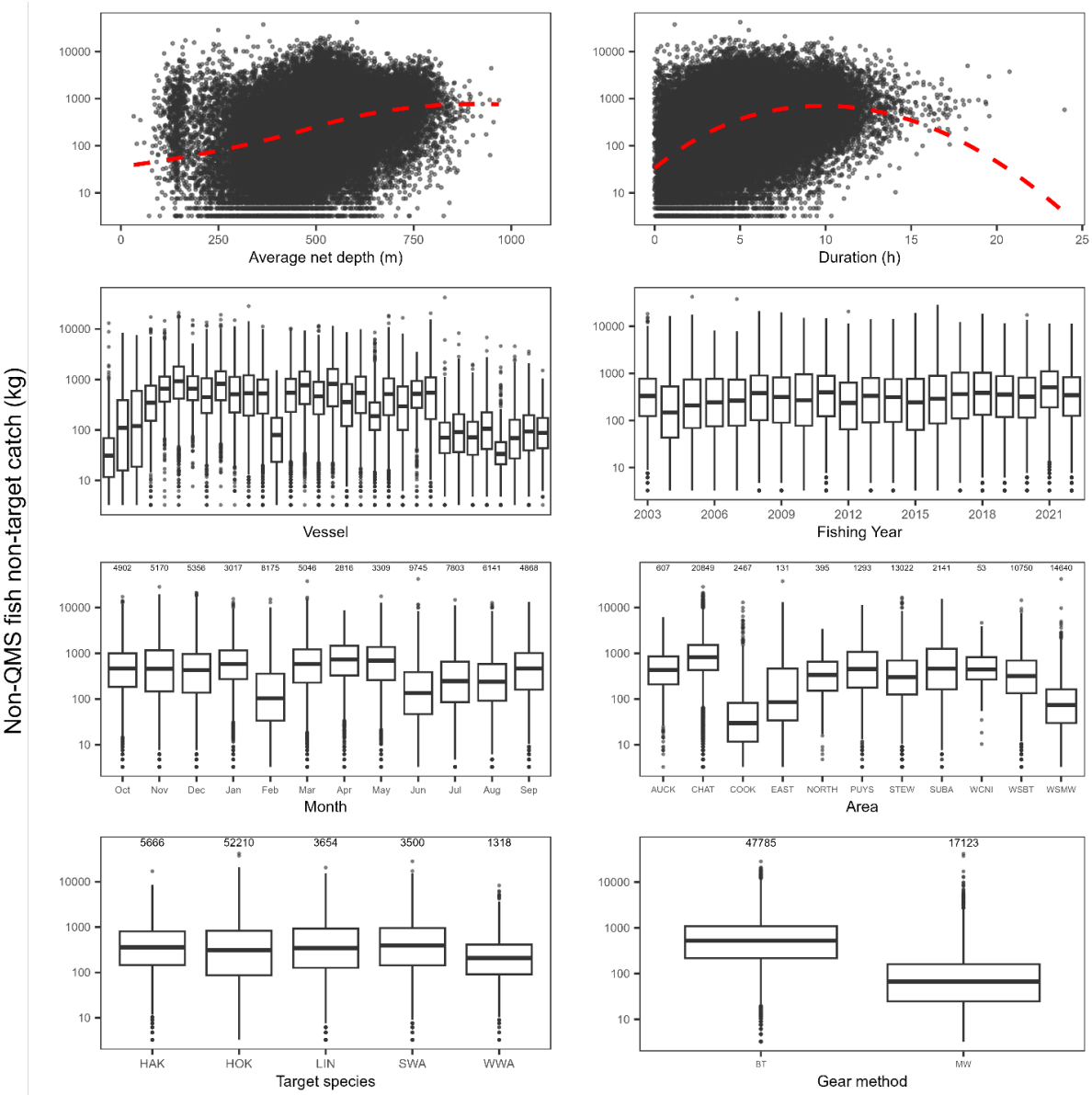


Figure 12: Non-QMS fish observed non-target catch (all species) in kilograms (kg) per tow plotted against selected variables in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for the fishing years 2002–03 to 2021–22, on a log scale. The red dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Average depth is the average of the start and finish depths at each end of the tow. See Figure 1 for area codes. WSBT and WSMW refer to WCSI(BT) and WCSI(MW), respectively.

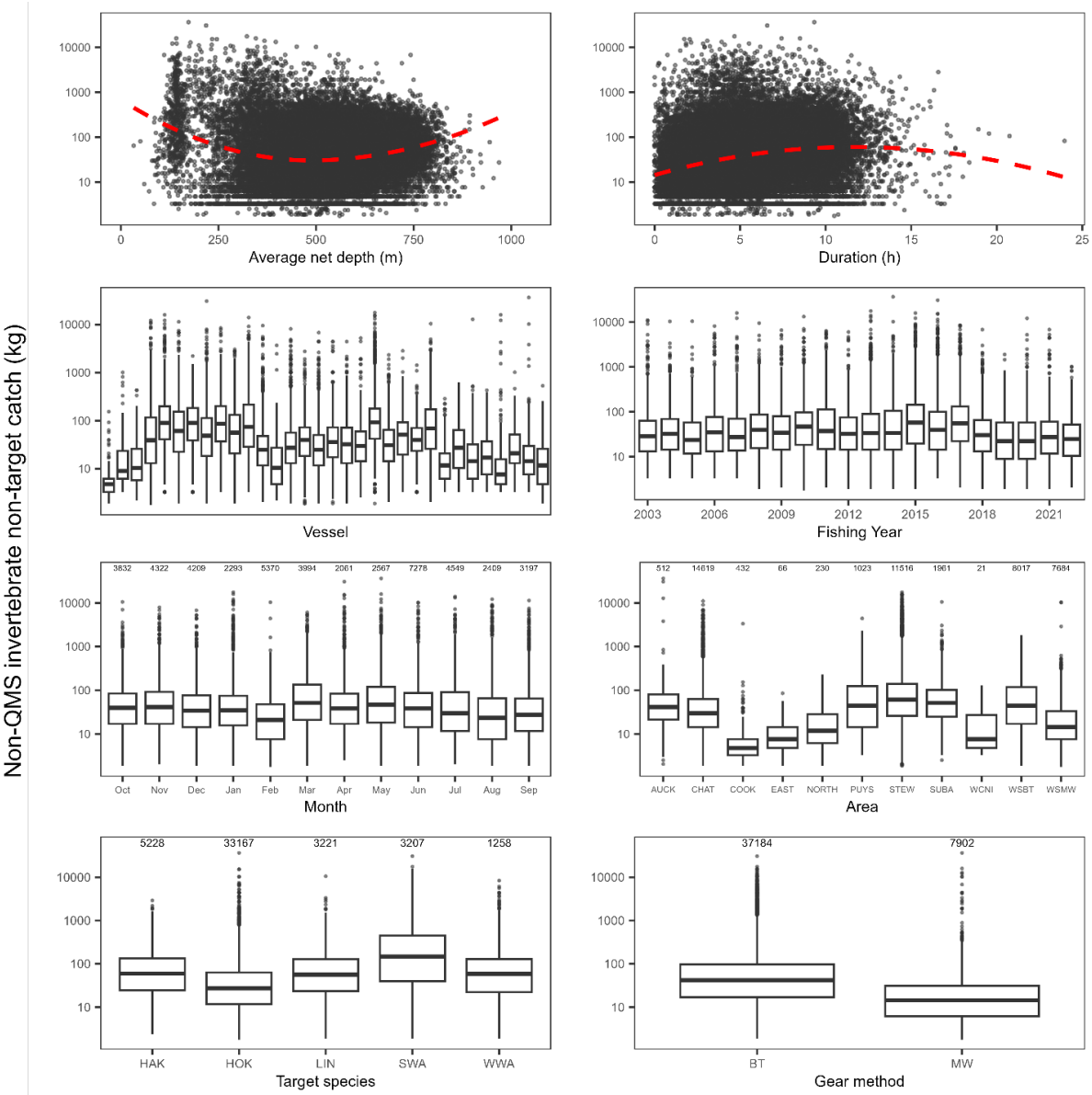


Figure 13: Non-QMS invertebrate observed non-target catch (all species) in kilograms (kg) per tow plotted against selected variables in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for the fishing years 2002–03 to 2021–22, on a log scale. The red dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Average depth is the average of the start and finish depths at each end of the tow. See Figure 1 for area codes. WSBT and WSMW refer to WCSI(BT) and WCSI(MW), respectively.

3.3 Discard data

3.3.1 Overview of raw discard data

The most commonly discarded (by weight) non-target species in the observed hoki, hake, ling, silver warehou, and white warehou fishery were spiny dogfish, of which almost 55% was discarded in the period since 1 October 2002 (Table A1, Figure 8). Of the other major non-target groups in the fishery, javelinfish (32%) and other (unspecified) rattails (36%) were also substantially discarded. Only about 0.5% of target species catch was discarded. Of the invertebrate species caught, most were non-QMS species and were discarded (see Table A2). Unexpectedly low levels of discarding for some invertebrate species, e.g., floppy tubular sponge (*Hyalascus* sp.) (2%) and smooth deepsea anemones (Actinostolidae) (<1%) are probably due to poor recording in the processing section of the observer forms and, in reality, were most likely to have been very close to 100% discarded.

Levels of discards per tow also showed some variability by species category (Figures 13–16). Total discard rates varied between 0 and 50 t per tow and showed an increasing trend with increased tow duration, but there was no apparent relationship between discards and gear depth (Figure 13). Discards were highly variable between the 32 vessels with more than 500 records, with larger vessels generally discarding less per tow than smaller vessels (probably due to greater use of meal plants in large vessels). There was an increasing trend in discards over time, from 2005–06 to 2016–17, but the trend has remained stable since. As with non-target catch, total discards were lower during the winter months (June to August) during the hoki spawning period. Median discard rates were low for the fishing effort in area EAST and for midwater trawls in WCSI than in other areas; discard rates were highest for bottom trawling in WCSI and SUBA. Discard rates were greatest when targeting silver warehou and lowest when targeting hoki. Overall, there were lower discard levels associated with midwater trawls than bottom trawls. Differences among vessel categories were pronounced, with the highest discard rates associated with foreign owned or chartered vessels and the lowest with BATM vessels (which are all installed with meal plants). Discarding was lower where meal processing occurred.

Patterns of discards for QMS species differed from those for total discards in that discard rates reduced with increasing net depth, there was little increase in discards with increasing tow duration, and there was less variability among areas, gear method (bottom trawl or midwater), and when a meal plant was present (Figure 14). Patterns of discards for non-QMS fish species were more similar to those for total discards, as this category is the main contributor to total discards (Figure 15). Discards of non-QMS invertebrate species varied little with depth and increased slightly with tow duration, and there was little change in annual medians through the period (Figure 16). There was considerable variation among areas, with low discard rates for the smaller fisheries around the North Island (COOK, EAST, NORTH, and WCNI) and higher rates in the southern STEW and SUBA areas. Discarding rates were similar amongst the target species, and slightly higher for bottom trawls, foreign owned or chartered vessels, and when a meal plant was absent.

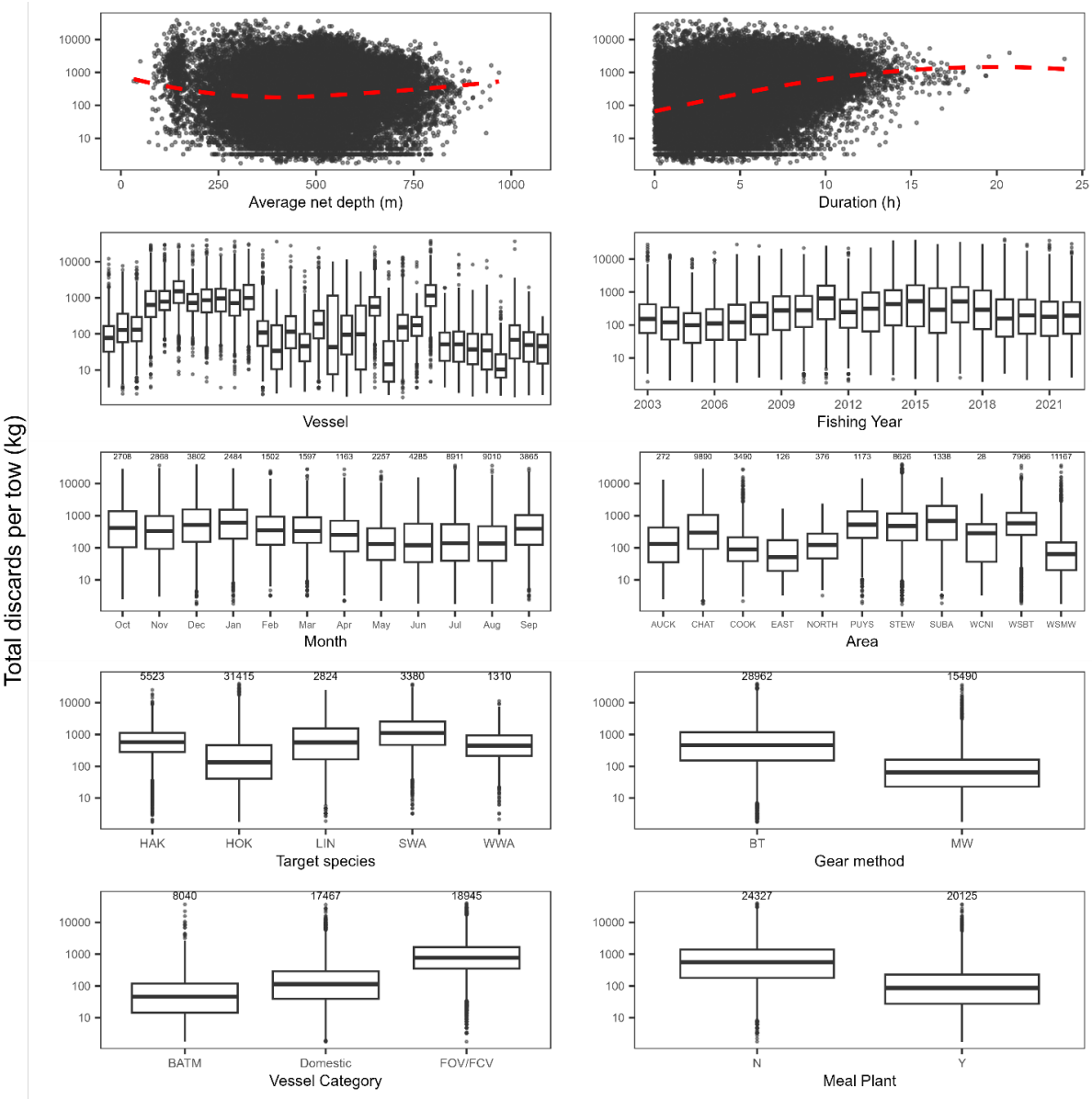


Figure 14: Total observed discards (all species) in kilograms (kg) per tow plotted against selected variables in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for the fishing years 2002–03 to 2021–22, on a log scale. The red dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Vessel categories: BATM, large Soviet-class trawler; FOV/FCV, Foreign Owned/Chartered vessel. Average depth is the average of the start and finish depths at each end of the tow. See Figure 1 for area codes. WSBT and WSMW refer to WCSI(BT) and WCSI(MW), respectively.

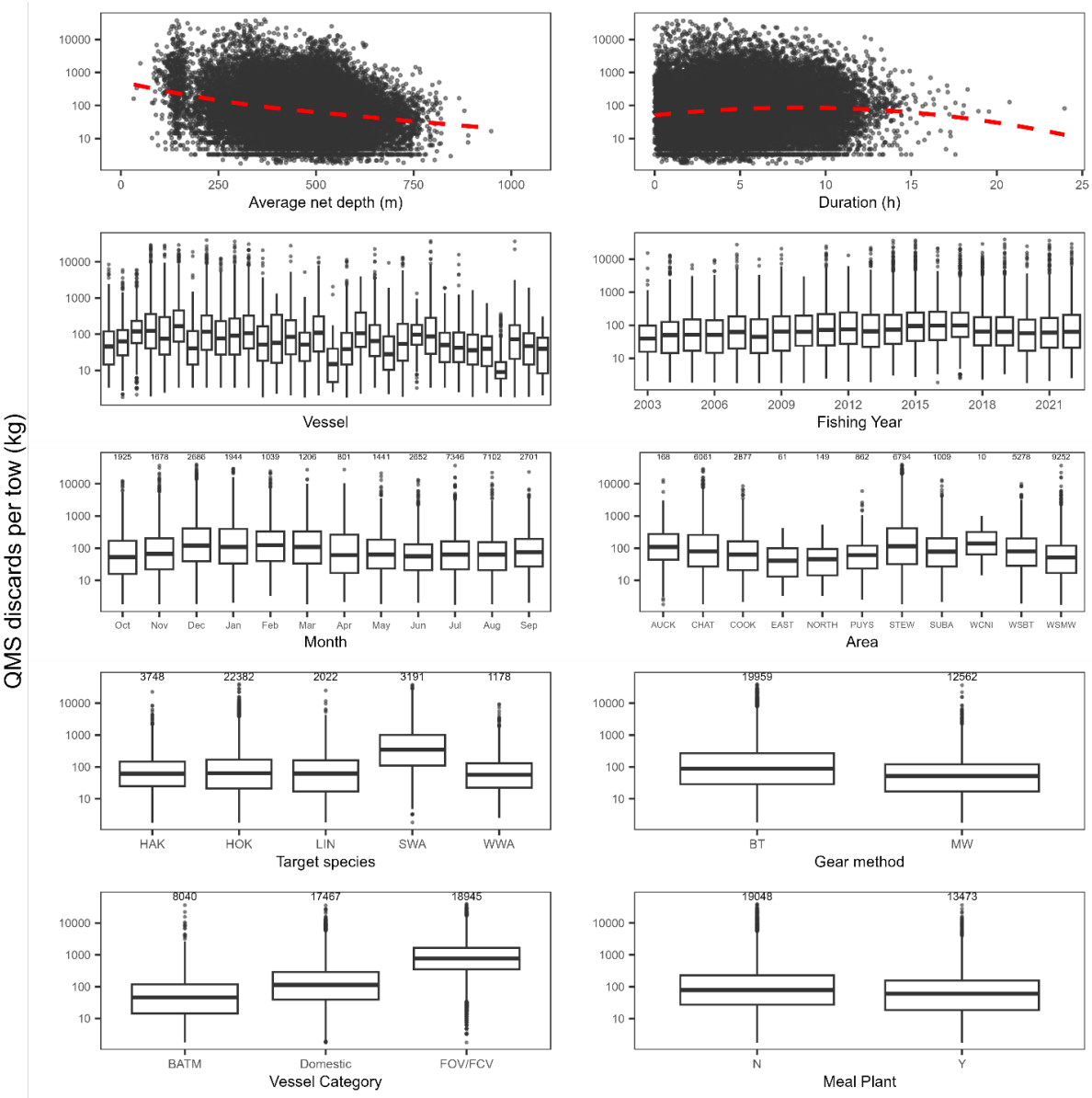


Figure 15: QMS (adjusted) species discards in kilograms (kg) per tow plotted against selected variables in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for the fishing years 2002–03 to 2021–22, on a log scale. The red dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Vessel categories: BATM, large Soviet-class trawler; FOV/FCV, Foreign Owned/Chartered vessel. Average depth is the average of the start and finish depths at each end of the tow. See Figure 1 for area codes. WSBT and WSMW refer to WCSI(BT) and WCSI(MW), respectively.

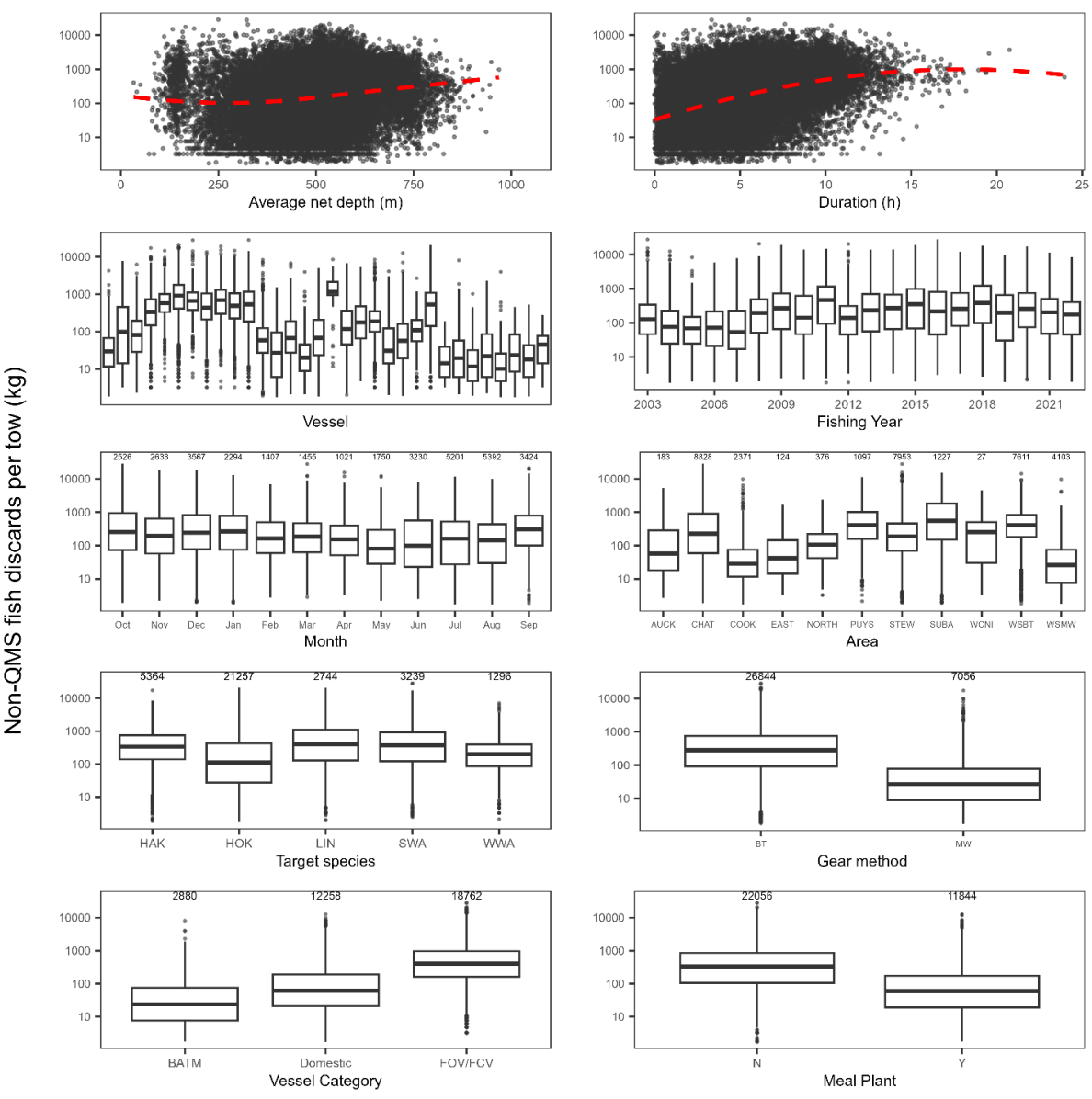


Figure 16: Non-QMS fish (adjusted) species discards in kilograms (kg) per tow plotted against selected variables in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for the fishing years 2002–03 to 2021–22, on a log scale. The red dashed lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Vessel categories: BATM, large Soviet-class trawler; FOV/FCV, Foreign Owned/Chartered vessel. Average depth is the average of the start and finish depths at each end of the tow. See Figure 1 for area codes. WSBT and WSMW refer to WCSI(BT) and WCSI(MW), respectively.

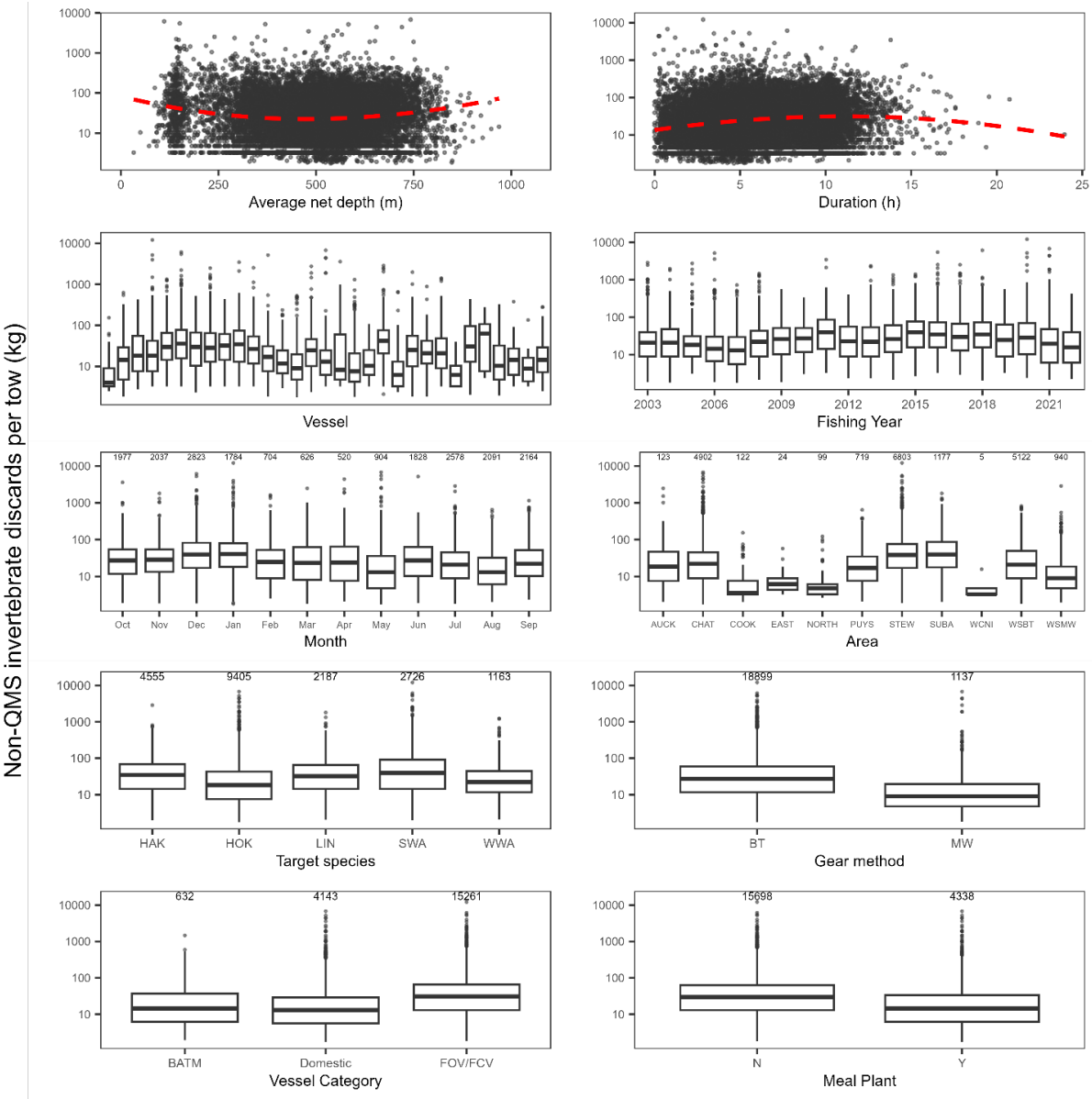


Figure 17: Non-QMS invertebrate (adjusted) species discards in kilograms (kg) per tow plotted against selected variables in the HOK, HAK, LIN, SWA, and WWA target trawl fishery for the fishing years 2002–03 to 2021–22, on a log scale. The dashed red lines in the scatterplots represent mean fits (using a locally weighted regression smoother) to the data. The box and whisker plots show medians and lower and upper quartiles in the box, whiskers extending up to 1.5 × the interquartile range, and outliers individually plotted. The numbers above the plots indicate the number of records (tows) associated with that level of the variable. In the vessel plot, vessels are ordered by size, from shortest to longest (only those with over 50 records shown). Vessel categories: BATM, large Soviet-class trawler; FOV/FCV, Foreign Owned/Chartered vessel. Average depth is the average of the start and finish depths at each end of the tow. See Figure 1 for area codes. WSBT and WSMW refer to WCSI(BT) and WCSI(MW), respectively.

3.4 Annual non-target catch levels

Estimated non-target catch in the hoki, hake, ling, silver warehou, and white warehou target trawl fishery for each of the main catch categories (QMS, non-QMS fish, non-QMS invertebrate, and Total) are shown in Figure 17 and Table 4 (using the standard method). The expected log pointwise predictive density (ELPD) model selection outputs are reported in Table 5 and identify the best fitting model used to produce the revised estimates reported in Table 6.

QMS species

The trend in non-target catch of QMS species was relatively stable from 2002–03 to 2011–12, with about 15 000–20 000 t of catch estimated annually across all years except 2003–04 (26 425 t). From 2012–13, QMS species non-target catch steadily increased to 2014–15 to nearly 28 000 t and declined thereafter. The lowest amount (6789–9603 t) of QMS species non-target catch was estimated in the most recent years (2019–20 onwards). These lower catches are likely reflective of the COVID-19 pandemic. The declining trend in estimated non-target catch of QMS species was considered statistically significant (Table 7).

Non-QMS fish species

The trend in non-target catch of non-QMS fish species was variable between 2002–03 and 2013–14, ranging from 8484 (2011–12) to 24 915 t (2002–03). Non-target catch of non-QMS fish species was relatively high and consistent between 2014–15 and 2017–18, with 16 000–17 500 t of catch estimated annually. As for the non-target catch of QMS species, non-target catch of non-QMS fish species was considerably lower from 2019–20 onward, with 8583–9369 t of catch estimated annually. The declining trend in estimated non-target catch of non-QMS fish species was not considered statistically significant (Table 7).

Non-QMS invertebrate species

Non-target catch of non-QMS invertebrate species was much lower than QMS and non-QMS fish species, with generally no more than 1000 t estimated annually (and a maximum of 1647 t in 2014–15). The trend in catch was similar to that of QMS fish species and was relatively stable to 2013–14. Catch increased and was relatively higher between 2014–15 and 2016–17 and remained at low levels (about 300 t or less annually) thereafter. The declining trend in estimated non-target catch of QMS invertebrate species was considered statistically significant (Table 7).

Total non-target catch

The trend in total non-target catch was variable. In the first two years of the time series, estimated non-target catch was high (43 000 t), followed by relatively consistent estimates from 27 549 to 32 088 t annually between 2004–05 and 2009–10. The trend was followed by two years of decline, and a steady increase in estimated catch from 21 539 t in 2011–12 to 47 961 t in 2014–15. Total non-target catch declined thereafter, with the lowest amount of non-target catch (14 738 t) estimated in 2019–20. The declining trend in estimated total non-target catch was not considered statistically significant (Table 7).

There have been four methods used to estimate non-target catch in this fishery (Ballara & O'Driscoll 2015, Anderson et al. 2019, this study). In overlapping years, the standard statistical methods (both the previous iteration and the current version) and the revised method explored here provided consistently similar annual estimates of total, QMS, and non-QMS non-target catch (Figure 18). The revised model worked particularly well for annual estimates of non-QMS fish non-target catch. The revised model produced annual estimates of non-target catch that were slightly higher than the standard statistical methods in the most recent years of the time series (since 2019–20), but the trend of these estimates mirrored that of the statistical method. The modelling methods provided higher estimates of annual non-target catch for all groups compared to estimates from the ratio method, where years overlapped.

The estimated annual non-target catch in each of the standard areas, for each catch category, is shown in Figure 19 and in more detail (with confidence intervals) in Table A4. Most non-target catch was taken from three main areas, CHAT, STEW, and WCSI (bottom trawl and mid-water trawl). QMS and

non-QMS fish non-target catch were mostly recorded from CHAT whereas non-QMS invertebrate non-target catch was recorded mainly from STEW from 2007–08 until 2016–17, and then in roughly equal amounts from STEW and CHAT thereafter. Very little non-target catch was reported from smaller areas, including AUCK, COOK, EAST, and SUBA. The proportion of non-target catch from each area has remained relatively consistent over time. Total annual non-target catch calculated directly from commercial catch and effort forms (estimated total catch minus any estimated catch of the target species) was consistently lower than estimates based on observer data (31–73%) and below the 95% confidence intervals in all years (Figure 20). Estimates were relatively comparable (84%) in the 2019–20 fishing year (Table 8).

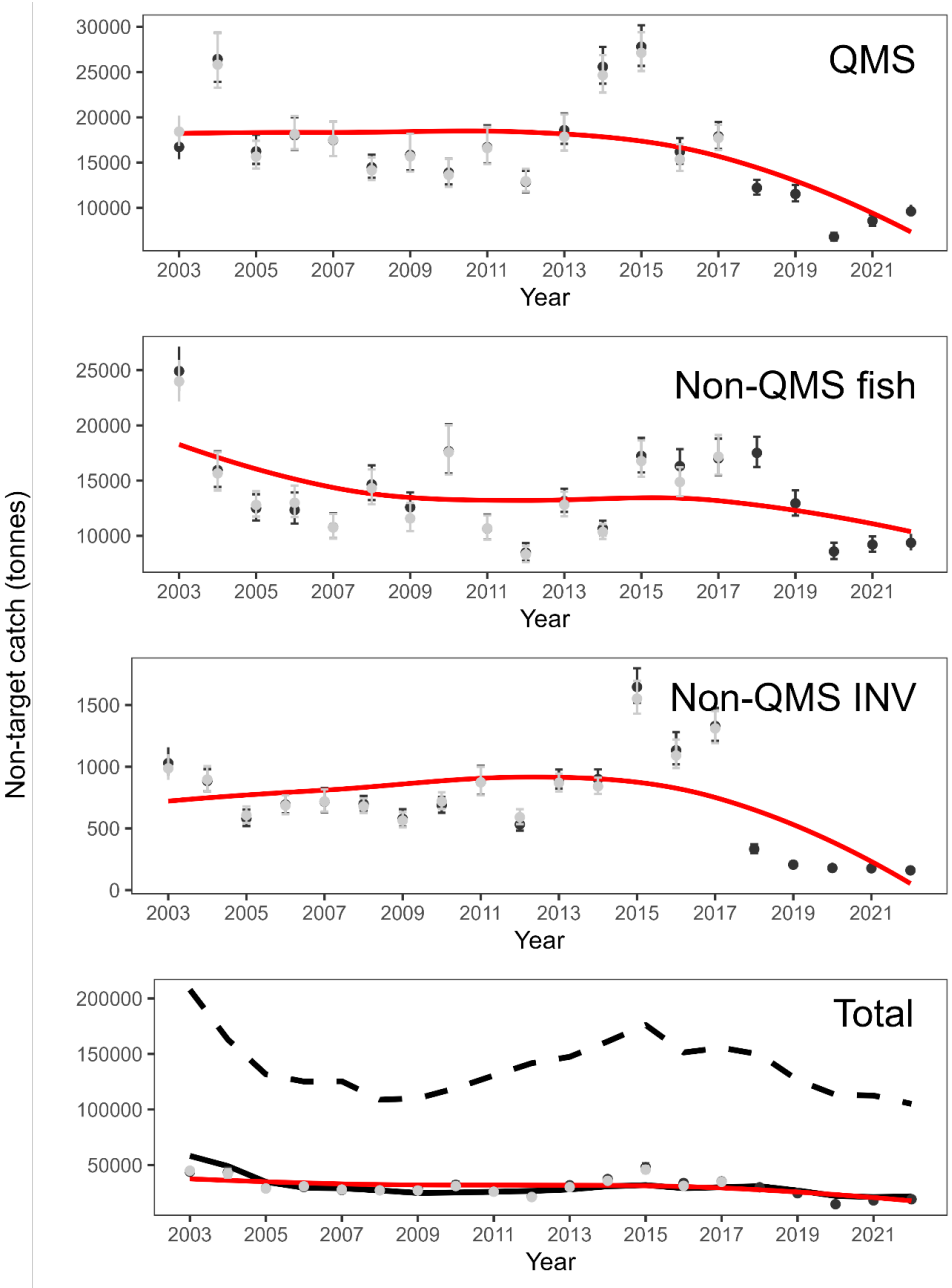


Figure 18: Annual estimates of non-target catch in the HOK, HAK, LIN, SWA, and WWA target trawl fishery, by species category, for 2002–03 to 2021–22 (black dots), based on the standard model method. Also shown (in grey) are earlier estimates of non-target catch calculated for 2002–03 to 2016–17 (Anderson et al. 2019). Error bars indicate 95% confidence intervals. The red lines show the fit of a locally weighted polynomial regression to annual non-target catch. In the bottom panel the solid black line shows the total annual reported landings of target catch, and the dashed line shows annual effort (number of tows), scaled to have mean equal to that of total non-target catch.

Table 4: Standard method estimates of total annual non-target catch (t) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery, by species category and fishing year; 95% confidence intervals in parentheses

Fishing year	QMS		Non–QMS fish		Non–QMS Inv.		Total	
2002–03	16 722	(15 373–18 218)	24 915	(23 092–27 124)	1 029	(926–1 158)	43 963	(41 157–47 096)
2003–04	26 425	(23 904–29 353)	15 952	(14 430–17 649)	885	(802–981)	43 444	(39 731–47 564)
2004–05	16 229	(14 849–18 065)	12 502	(11 396–13 762)	581	(519–652)	29 139	(27 081–31 446)
2005–06	18 021	(16 407–20 011)	12 341	(11 118–13 925)	693	(623–780)	30 193	(27 846–32 926)
2006–07	17 479	(15 725–19 510)	10 773	(9 780–12 031)	717	(631–828)	27 549	(25 436–29 830)
2007–08	14 466	(13 306–15 871)	14 654	(13 233–16 381)	698	(643–764)	27 978	(26 051–30 082)
2008–09	15 840	(14 132–18 300)	12 585	(11 350–13 935)	578	(513–656)	28 676	(26 326–31 359)
2009–10	13 886	(12 586–15 411)	17 655	(15 642–20 120)	689	(627–756)	32 088	(29 399–35 073)
2010–11	16 696	(14 900–19 110)	10 659	(9 665–11 922)	875	(774–1 006)	26 246	(24 255–28 629)
2011–12	12 841	(11 708–14 093)	8 484	(7 751–9 339)	532	(482–597)	21 539	(20 110–23 188)
2012–13	18 581	(17 067–20 415)	13 148	(12 166–14 271)	891	(824–977)	31 773	(29 885–34 049)
2013–14	25 584	(23 715–27 783)	10 667	(10 071–11 364)	900	(833–979)	37 309	(35 272–39 351)
2014–15	27 798	(25 677–30 173)	17 234	(15 741–18 870)	1 647	(1 519–1 799)	47 961	(44 869–51 509)
2015–16	16 197	(14 872–17 699)	16 311	(14 949–17 854)	1 133	(1 019–1 281)	33 759	(31 610–36 222)
2016–17	17 890	(16 493–19 480)	17 015	(15 482–18 802)	1 330	(1 210–1 476)	35 227	(33 051–37 476)
2017–18	12 207	(11 463–13 085)	17 512	(16 234–18 974)	332	(298–372)	29 914	(28 183–31 831)
2018–19	11 529	(10 712–12 522)	12 943	(11 827–14 118)	206	(182–232)	24 598	(23 041–26 435)
2019–20	6 789	(6 379–7 224)	8 583	(7 902–9 381)	179	(161–200)	14 738	(13 946–15 587)
2020–21	8 565	(8 005–9 225)	9 206	(8 566–9 946)	177	(160–196)	18 142	(17 198–19 180)
2021–22	9 603	(9 021–10 339)	9 369	(8 682–10 172)	160	(147–175)	19 200	(18 093–20 365)

Table 5: Expected log pointwise predictive density (ELPD) model selection with the revised method for areas-as-grid, grid, and grid with a vessel random effect, by species category. Best fitting model selected in bold.

	QMS		Non–QMS fish		Non–QMS Inv.		Total	
	ELPD	ELPD diff	ELPD	ELPD diff	ELPD	ELPD diff	ELPD	ELPD diff
Area	-497068.0	-7250.4	-448371.4	-10182.6	-249139.1	-6484.1	-538662.1	-8854.8
Grid	-493702.4	-3884.9	-445328.9	-7140.0	-247506.7	-4851.7	-535566.9	-5759.6
Vessel	**-489817.5**	**0.0**	**-438188.8**	**0.0**	**-242655.0**	**0.0**	**-529807.2**	**0.0**

Table 6: Revised method estimates of total annual non-target catch (t) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery, by species category and fishing year using the best fitting model in Table 5; 95% confidence intervals in parentheses; –, not estimated (see text).

Fishing year	QMS		Non–QMS fish		Non–QMS Inv.		Total	
2002–03	–	–	–	–	–	–	–	–
2003–04	–	–	–	–	–	–	–	–
2004–05	20 927	(19 187–23 125)	13 142	(11 952–15 778)	860	(767–971)	35 672	(33 090–39 102)
2005–06	21 589	(19 856–23 618)	11 894	(10 967–13 408)	987	(895–1 092)	34 515	(32 328–37 301)
2006–07	21 305	(19 277–23 716)	11 477	(10 657–12 801)	1 163	(1 045–1 312)	33 102	(31 315–34 831)
2007–08	20 693	(19 307–22 252)	14 378	(13 415–15 520)	987	(920–1 069)	34 864	(33 324–36 674)
2008–09	17 807	(16 335–19 476)	12 746	(11 699–13 908)	789	(718–877)	30 534	(28 897–32 394)
2009–10	14 893	(13 846–16 023)	13 006	(11 995–14 485)	931	(869–1 000)	29 292	(27 810–31 013)
2010–11	17 165	(15 876–18 572)	11 065	(10 203–12 032)	897	(828–980)	27 630	(26 314–29 032)
2011–12	15 846	(14 703–17 023)	9 089	(8 534–9 854)	789	(719–867)	25 357	(24 086–26 610)
2012–13	19 864	(19 054–20 862)	12 847	(12 244–13 574)	1 189	(1 143–1 243)	33 181	(32 217–34 301)
2013–14	24 711	(23 554–26 265)	11 449	(10 939–12 182)	1 061	(1 011–1 121)	37 176	(35 892–38 847)
2014–15	22 889	(21 843–24 236)	13 586	(12 918–14 434)	1 543	(1 478–1 627)	37 599	(36 270–39 031)
2015–16	16 817	(15 890–18 102)	13 899	(13 166–14 975)	1 369	(1 294–1 469)	31 618	(30 334–33 125)
2016–17	16 869	(16 018–17 957)	14 142	(13 253–15 226)	1 304	(1 217–1 400)	31 788	(30 452–33 490)
2017–18	15 437	(14 611–16 521)	17 735	(16 873–19 341)	484	(445–536)	33 139	(31 846–35 124)
2018–19	13 752	(12 990–14 851)	12 409	(11 671–13 874)	282	(252–317)	26 235	(25 080–28 081)
2019–20	9 425	(8 983–9 974)	9 084	(8 602–9 828)	289	(267–315)	18 841	(18 170–19 756)
2020–21	11 677	(11 073–12 385)	11 202	(10 585–12 295)	345	(312–382)	24 100	(23 165–25 388)
2021–22	12 562	(11 903–13 323)	11 646	(10 970–12 613)	274	(246–310)	24 128	(23 050–25 301)

Table 7: Summary of results of linear regression analyses for trends in standard method annual non-target catch estimates, by species category, in the HOK, HAK, LIN, SWA, and WWA target trawl fishery between 2002–03 and 2021–22. The *p*-values indicate whether the slopes differed significantly from zero. Those results where *p*-values are less than 0.01 (generally considered highly significant) are shown in bold.

Species category	Slope	*p*
QMS	**-0.034**	**0.010**
Non-QMS fish	-0.018	0.104
Non-QMS invertebrate	**-0.067**	**0.009**
Total	-0.027	0.016

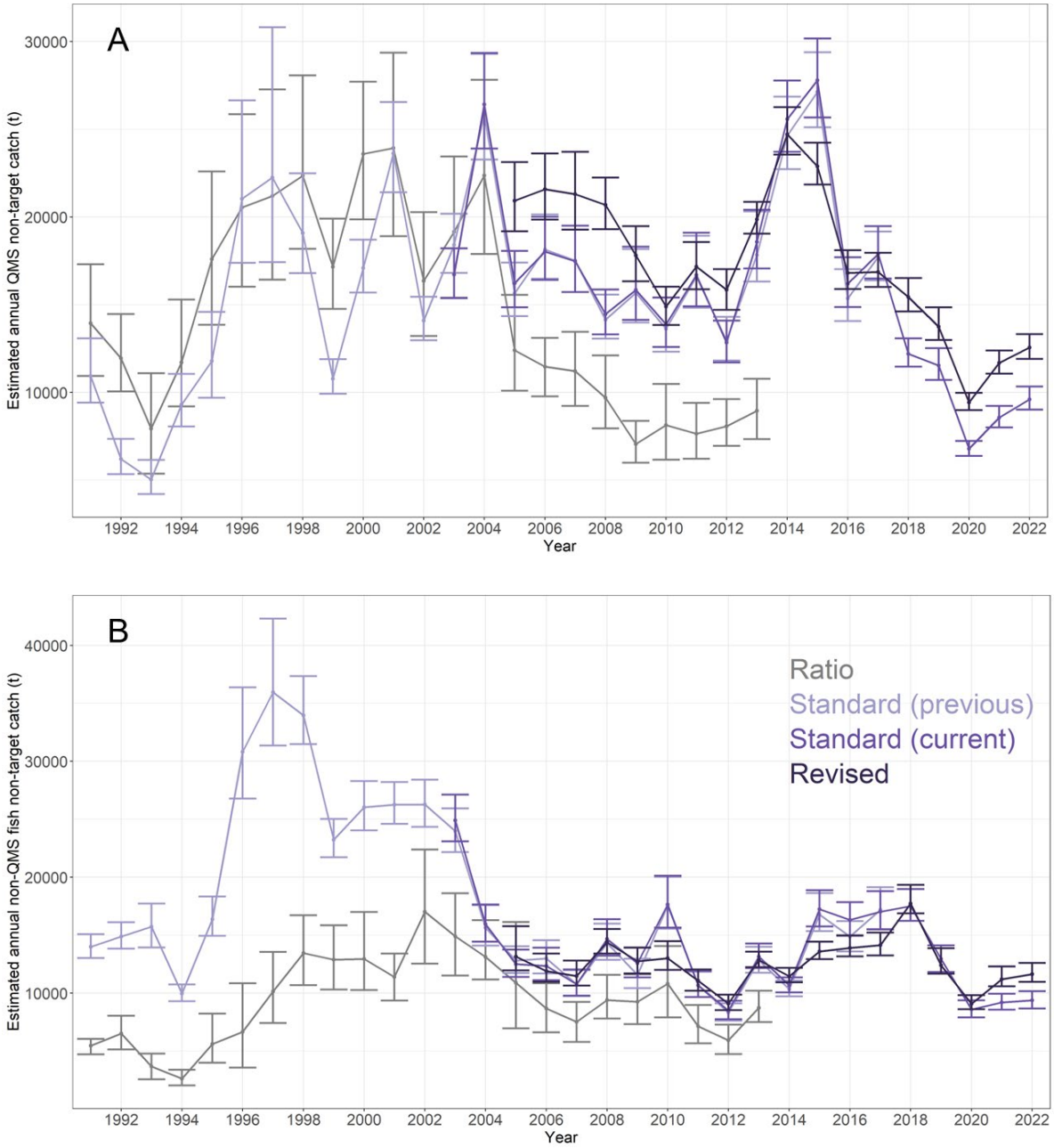
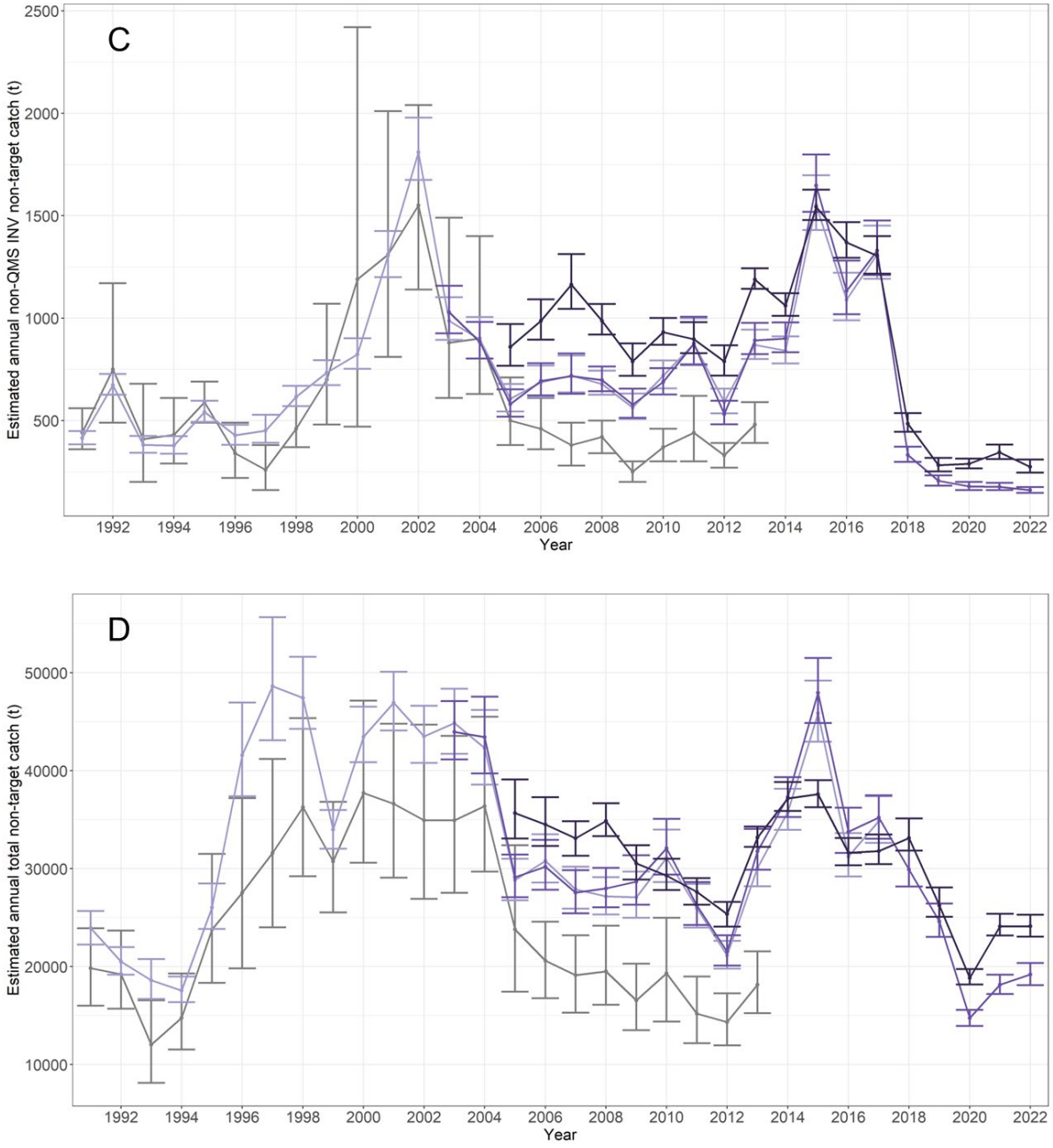


Figure 19: Annual estimates of non-target catch (t) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery since 1990–91, for A) QMS, B) non-QMS fish, C) non-QMS invertebrates, and D) Total non-target species, using the ratio method ('Ratio'; Ballara & O'Driscoll 2015), the previous iteration which used the standard statistical method ('Standard (previous)'; Anderson et al. 2019), the standard statistical method used in this study ('Standard (current)'), and the revised (spatial) method ('Revised') using the best fitting model in Table 5. (Continued next page)



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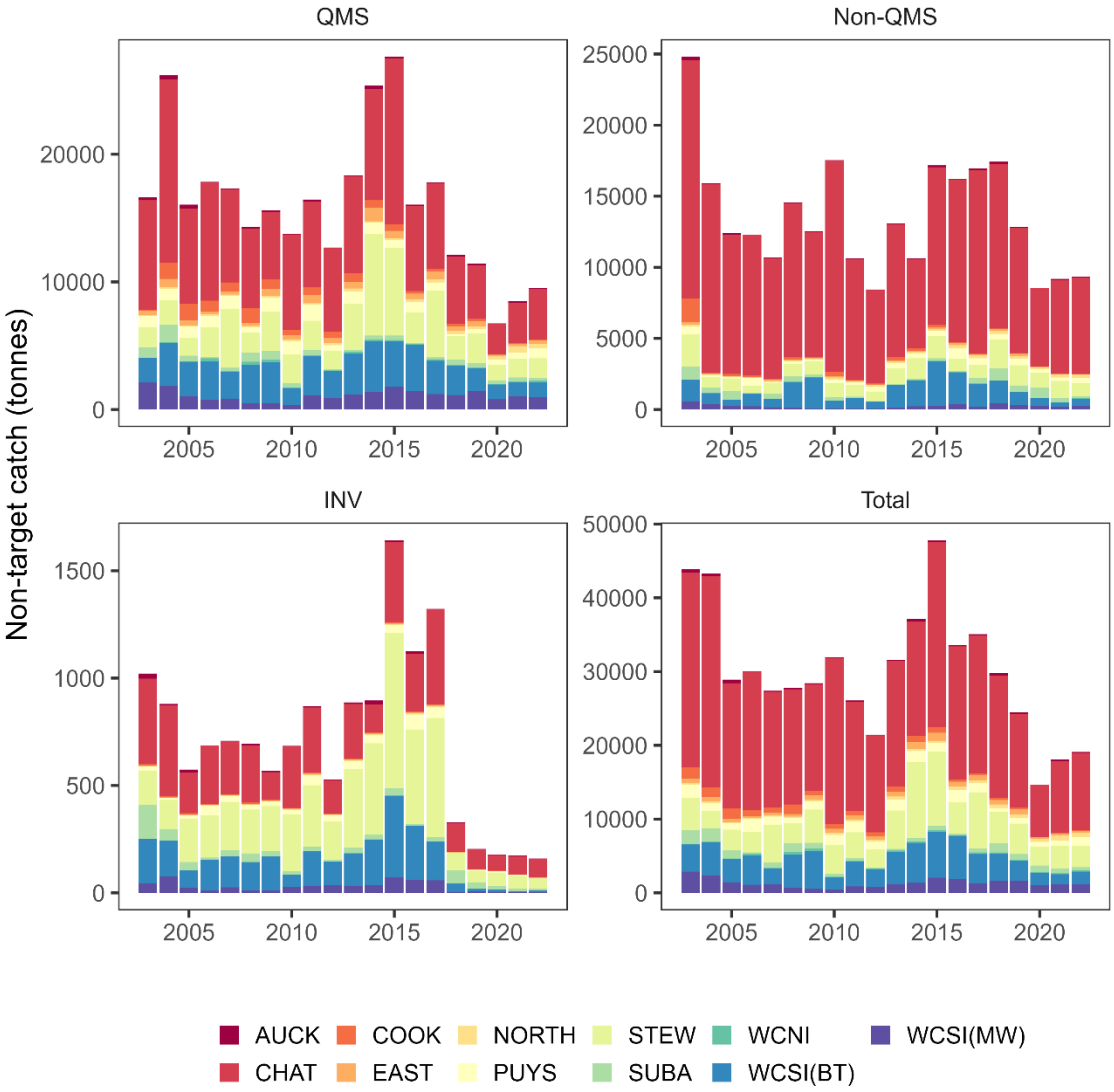


Figure 20: Standard method estimated annual non-target catch of QMS species (top left), non-QMS fish species (top right), non-QMS invertebrate (INV) species (bottom left), and all species combined (bottom right) in each standard area where species were reported in the HOK, HAK, LIN, SWA, and WWA target trawl fishery by fishing years 2002–03 to 2021–22.

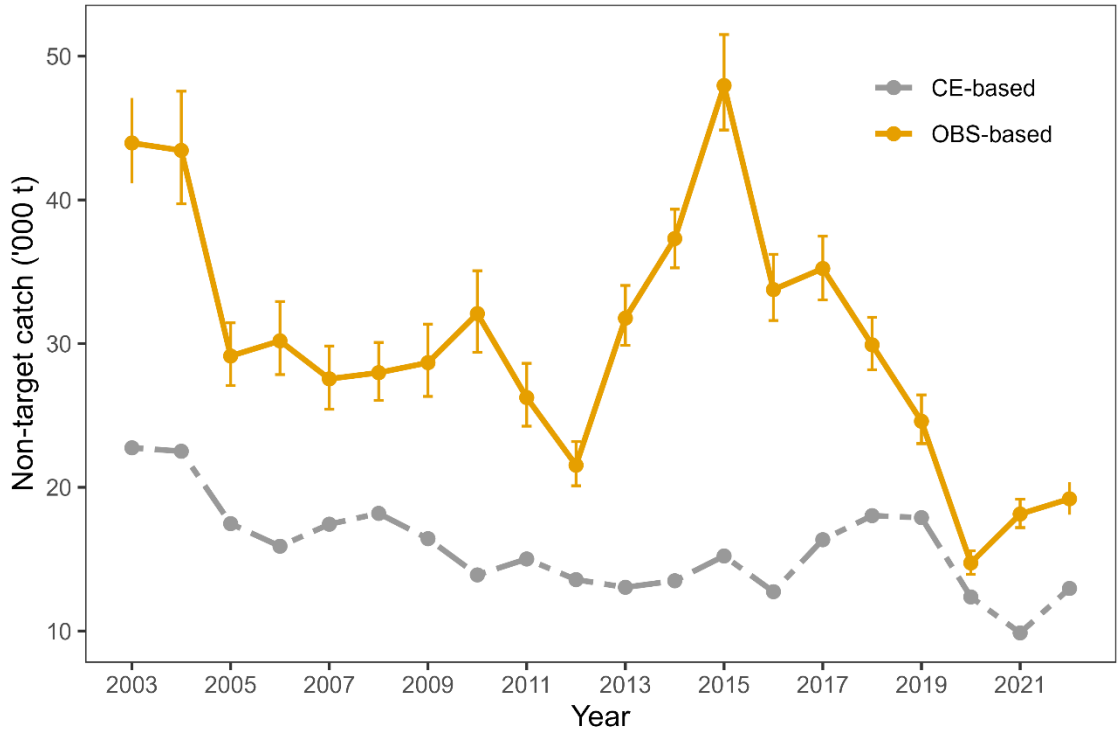


Figure 21: Total annual non-target catch in the HOK, HAK, LIN, SWA, and WWA target trawl fishery from scaled up observer (OBS) catch rates (standard method) and commercial catch effort (CE) records.

Table 8: Total annual non-target catch estimates for the HOK, HAK, LIN, SWA, and WWA target trawl fishery based solely on catch effort records, compared with estimates from the standard method observer-based statistical model. Estimates are derived by summing the difference between the recorded total catch and HOK, HAK, LIN, SWA, and WWA catch for each trawl (TCEPR, TCER, and ERS type forms) or group of trawls (CELR type forms).

Fishing year	Catch effort (t)	Total non-target catch (t)	% of observer-based estimate
2002–03	22 750	43 963	51.7
2003–04	22 512	43 444	51.8
2004–05	17 473	29 139	60.0
2005–06	15 901	30 193	52.7
2006–07	17 433	27 549	63.3
2007–08	18 187	27 978	65.0
2008–09	16 428	28 676	57.3
2009–10	13 906	32 088	43.3
2010–11	15 015	26 246	57.2
2011–12	13 576	21 539	63.0
2012–13	13 043	31 773	41.1
2013–14	13 498	37 309	36.2
2014–15	15 223	47 961	31.7
2015–16	12 737	33 759	37.7
2016–17	16 354	35 227	46.4
2017–18	18 028	29 914	60.3
2018–19	17 890	24 598	72.7
2019–20	12 372	14 738	83.9
2020–21	9 869	18 142	54.4
2021–22	12 965	19 200	67.5

3.5 Estimation of discards

3.5.1 Annual discard levels

Estimated discards in the hoki, hake, ling, silver warehou, and white warehou target trawl fishery for the target species group (HHLSW) and each of the main catch categories (QMS, non-QMS fish, non-QMS invertebrate, and Total) are shown in Figure 21 and Table 9. The ELPD model selection outputs are reported in Table 10 and identify the best fitting model used to produce the revised estimates reported in Table 11.

Target species group (HHLSW)

Discarding of target species has generally been low, with no more than 3000 t estimated annually in most years. Estimated annual discarding of target species increased to 1655–2646 t between 2013–14 and 2016–17. Since the peak in 2016–17, estimated annual discards of target species have been very low, with no more than 100 t reported annually, and as low as 11 t in 2020–21. Confidence intervals were largest in the earlier part of the time series (2003–04 to 2006–07) and again between 2014–15 and 2016–17. The trend in estimated discards of target species was not considered statistically significant (Table 12).

QMS species

The trend in discards of QMS fish species was relatively stable across the time series, with about 1500–2500 t of discards estimated annually across all years up to 2018–19, except 2003–04 (3697 t). The confidence intervals were relatively large across most years. Discarding declined slightly in the most recent years (2019–20 onwards) to an estimated 521–980 t, compared to about 1300–2000 t estimated in years leading up (2013–14 to 2018–19). The trend in estimated discards of QMS fish species was not considered statistically significant (Table 12).

Non-QMS fish species

The trend in discards of non-QMS fish species was variable between 2002–03 and 2019–20, ranging from 2206 (2015–16) to 15 020 t (2002–03). Discarding in most years varied between 2000 and 7000 t annually and showed a gradual declining trend over time. Like the non-target catch of QMS fish species, non-target catch of non-QMS fish species was considerably lower in the most recent years of the time series, with 1099 and 1244 t estimated annually for 2020–21 and 2021–22, respectively. The declining trend in estimated discards of non-QMS fish species was considered statistically significant (Table 12).

Non-QMS invertebrate species

Discarding of non-QMS invertebrate species was much lower than QMS and non-QMS fish species, with no more than 150 t estimated annually since 2009–10 (and a maximum of 465 t in 2002–03). The trend in discarding declined considerably to 2010–11 and has remained relatively stable thereafter. Since 2017–18, discarding has not exceeded 50 t annually. The declining trend in estimated discards of non-QMS invertebrate species was considered statistically significant (Table 12).

Total non-target catch

Total discards showed a declining trend over time. Estimated discards was highest until 2008–09 (about 10 000–25 000 t), followed by relatively consistent estimates of 6000 to 9000 t annually between 2009–10 and 2017–18. Since 2019–20, total discards have remained consistently around 3000 t annually. The declining trend in estimated total discards was considered statistically significant (Table 12).

As for non-target catch, there have been four methods used to estimate discards in this fishery (Ballara & O'Driscoll 2015, Anderson et al. 2019, this study). In overlapping years, the revised method explored here provided higher estimates of discards for all four groups assessed (total, QMS, non-QMS fish, non-QMS invertebrates); however, the general trend of the revised method estimates was similar to the standard statistical methods (both the previous iteration and the current version) (Figure 22). The greatest difference observed between the modelling methods was observed for the years 2012–13 to 2017–18, where the revised method overestimated annual estimates of discards. The modelling methods

provided higher estimates of annual non-target discards for all groups compared with estimates from the ratio method, where years overlapped.

The estimated annual discards in each of the standard areas, for each catch category, are shown in Figure 23 and in more detail (with confidence intervals) in Table A5. Like the non-target catch, most discarding occurred from three main areas, CHAT, STEW, and WCSI (bottom and midwater trawl). A large proportion of target catch discarding also occurred in COOK from 2013–14 to 2016–17 and from 2017–18 onwards this discarding was almost exclusively from STEW and WCSI bottom trawl fisheries. Non-QMS fish discards were mostly recorded from CHAT and non-QMS invertebrate discards from STEW and CHAT in earlier years (to 2010–11). Small amounts of total discards were reported from smaller areas, including COOK, NORTH, SUBA, and virtually no discards were reported from AUCK or EAST. The proportion of discarding from each area has remained relatively consistent over time.

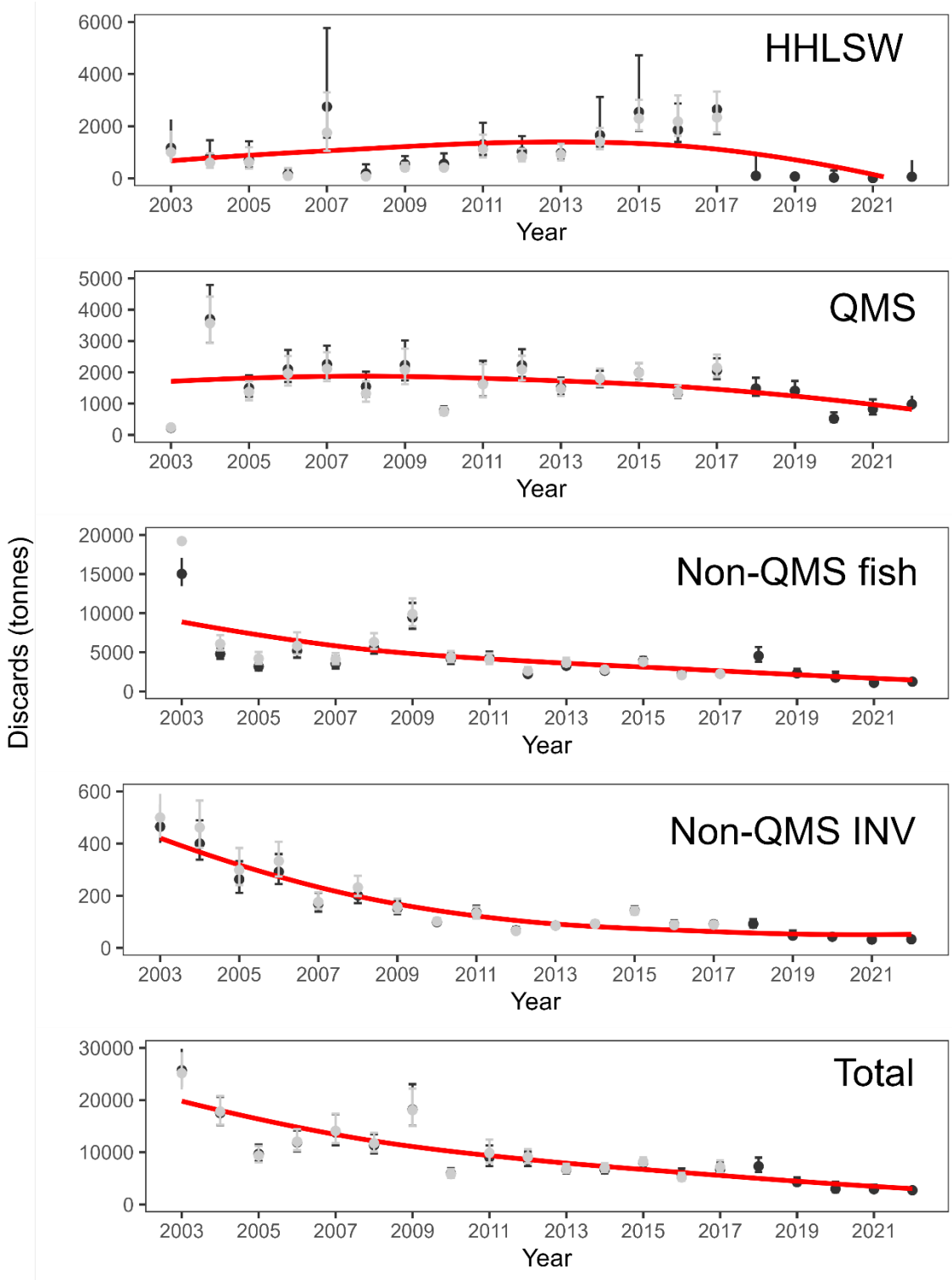


Figure 22: Standard method annual estimates of discards in the HOK, HAK, LIN, SWA, and WWA target fishery, by species category, for 2002–03 to 2021–22 (black dots). Also shown (in grey) are earlier estimates of discards calculated for 2002–03 to 2016–17 (Anderson et al. 2019). Error bars indicate 95% confidence intervals. The red lines show the fit of a locally weighted polynomial regression to annual discards.

Table 9: Standard-method estimates of total annual discards (t) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery, by species category and fishing year; 95% confidence intervals in parentheses.

Fishing year	HHLSW		QMS		Non-QMS fish		Non-QMS Inv.		Total discards	
2002–03	1 167	(729–2 267)	225	(160–334)	15 020	(13 440–17 050)	465	(402–551)	25 705	(22 532–29 824)
2003–04	820	(517–1 464)	3 697	(2 948–4 789)	4 792	(4 150–5 595)	400	(338–489)	17 518	(15 236–20 639)
2004–05	710	(417–1 420)	1 500	(1 226–1 907)	3 187	(2 685–3 825)	263	(211–332)	9 689	(8 333–11 500)
2005–06	161	(79–383)	2 097	(1 689–2 717)	5 207	(4 311–6 581)	292	(245–360)	11 891	(10 157–14 136)
2006–07	2 748	(1 563–5 761)	2 256	(1 822–2 849)	3 553	(2 904–4 495)	169	(139–212)	13 790	(11 362–17 322)
2007–08	191	(91–538)	1545	(1 224–2 019)	5 571	(4 814–6 581)	201	(172–239)	11 337	(9 765–13 481)
2008–09	548	(382–857)	2 231	(1 739–3 021)	9 453	(8 000–11 309)	152	(130–180)	18 193	(15 071–23 040)
2009–10	558	(403–957)	768	(647–914)	4 123	(3 502–4 948)	99	(89–113)	5 940	(5 155–6 963)
2010–11	1 306	(902–2 131)	1 630	(1 229–2 366)	4 314	(3 662–5 081)	136	(116–162)	9 007	(7 359–11 308)
2011–12	1 024	(752–1 617)	2 225	(1 852–2 740)	2 233	(1 925–2 638)	67	(57–80)	8 527	(7 350–10 105)
2012–13	972	(739–1 402)	1 510	(1 282–1 826)	3 281	(2 904–3 755)	86	(78–95)	6 684	(5 937–7 732)
2013–14	1 655	(1 219–3 120)	1 758	(1 522–2 051)	2 642	(2 361–2 980)	92	(83–104)	6 669	(5 913–7 528)
2014–15	2 546	(1 821–4 723)	1 988	(1 753–2 301)	3 924	(3 559–4 393)	144	(130–159)	8 089	(7 356–8 925)
2015–16	1 861	(1 402–2 871)	1 338	(1 184–1 517)	2 206	(1 925–2 605)	90	(79–105)	5 859	(5 110–6 913)
2016–17	2 646	(1 699–6 274)	2 058	(1 781–2 445)	2 260	(1 975–2 611)	91	(81–103)	6 771	(5 886–8 066)
2017–18	99	(17–912)	1 484	(1 253–1 825)	4 539	(3 796–5 686)	92	(79–110)	7 309	(6 230–8 980)
2018–19	72	(33–181)	1 409	(1 198–1 726)	2 316	(1 941–2 875)	47	(37–67)	4 277	(3 655–5 227)
2019–20	29	(5–304)	521	(408–720)	1 773	(1 375–2 506)	43	(35–55)	2 985	(2 339–4 301)
2020–21	11	(2–75)	826	(651–1 135)	1 099	(915–1 345)	32	(26–41)	2 919	(2 393–3 792)
2021–22	63	(13–708)	980	(802–1 253)	1 244	(1 085–1 439)	33	(29–38)	2 717	(2 362–3 224)

Table 10: Expected log pointwise predictive density (ELPD) model selection with the revised method for areas-as-grid, grid, and grid with a vessel random effect, by species category. In this case the areas-as-grid model included the vessel category, to match the assumptions of the standard model. Best fitting model selected in bold.

	QMS		Non–QMS fish		Non–QMS Inv.		Total	
	ELPD	ELPD diff	ELPD	ELPD diff	ELPD	ELPD diff	ELPD	ELPD diff
Area	-250168.2	-35011.1	-256712.0	-35442.4	-110600.2	-14433.8	-349516.9	-46151.2
Grid	-231476.8	-16319.7	-245526.4	-24256.8	-109097.9	-12931.5	-330536.9	-27171.2
Vessel	**-215157.1**	**0.0**	**-221269.5**	**0.0**	**-96166.3**	**0.0**	303365.6	**0.0**

Table 11: Revised method estimates of total annual discards (t) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery, by species category and fishing year using the best fitting model in Table 10; 95% confidence intervals in parentheses; –, not estimated (see text).

Fishing year	QMS		Non–QMS fish		Non–QMS Inv.		Total	
2002–03	–	–	–	–	–	–	–	–
2003–04	–	–	–	–	–	–	–	–
2004–05	1 399	(1 052–2 031)	3 591	(3 066–4 300)	153	(127–189)	7 031	(5 717–9 688)
2005–06	2 287	(1 814–3 056)	4 963	(4 165–6 336)	189	(159–226)	11 768	(9 813–14 914)
2006–07	3 723	(2 808–5 147)	4 969	(4 142–6 000)	178	(148–216)	17 968	(14 631–22 794)
2007–08	2 188	(1 663–3 091)	6 499	(5 591–7 735)	175	(152–207)	10 138	(8 696–12 221)
2008–09	2 627	(1 950–3 857)	7 272	(6 437–8 277)	124	(107–145)	12 772	(10 906–15 276)
2009–10	1 682	(1 363–2 170)	5 229	(4 666–5 918)	104	(94–115)	7 708	(6 913–8 679)
2010–11	2 086	(1 747–2 625)	5 218	(4 621–5 909)	133	(118–151)	10 119	(9 046–11 560)
2011–12	2 715	(2 229–3 451)	4 301	(3 700–5 085)	88	(76–108)	10 556	(8 940–12 979)
2012–13	2 823	(2 443–3 401)	5 672	(5 208–6 259)	115	(108–123)	10 400	(9 527–11 627)
2013–14	3 643	(3 192–4 333)	4 140	(3 831–4 555)	95	(89–103)	11 949	(10 818–13 523)
2014–15	4 295	(3 815–4 953)	6 512	(6 038–7 148)	131	(122–142)	14 974	(13 804–16 657)
2015–16	2 837	(2 419–3 681)	4 102	(3 599–4 819)	86	(79–96)	9 805	(8 713–11 552)
2016–17	3 080	(2 738–3 568)	3 638	(3 335–4 068)	100	(92–111)	11 451	(10 305–13 240)
2017–18	2 761	(2 316–3 465)	7 113	(6 386–8 223)	163	(150–179)	10 866	(9 826–12 459)
2018–19	2 173	(1 886–2 644)	3 518	(3 067–4 219)	81	(71–95)	6 171	(5 472–7 318)
2019–20	1 198	(969–1 581)	2 628	(2 284–3 196)	113	(102–127)	4 317	(3 751–5 454)
2020–21	1 964	(1 623–2 570)	1 907	(1 668–2 311)	92	(84–104)	5 149	(4 356–6 962)
2021–22	2 092	(1 696–2 722)	2 421	(2 111–2 928)	67	(62–74)	4 987	(4 326–6 320)

Table 12: Summary of results of linear regression analyses for trends in annual discards, by species category, for the HOK, HAK, LIN, SWA, and WWA target trawl fishery between 2002–03 and 2021–22. 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*
HHLSW	-0.138	0.023
QMS	-0.015	0.553
Non–QMS fish	**-0.082**	**<0.010**
Non–QMS invertebrate	**-0.121**	**<0.010**
Total	**-0.093**	**<0.010**

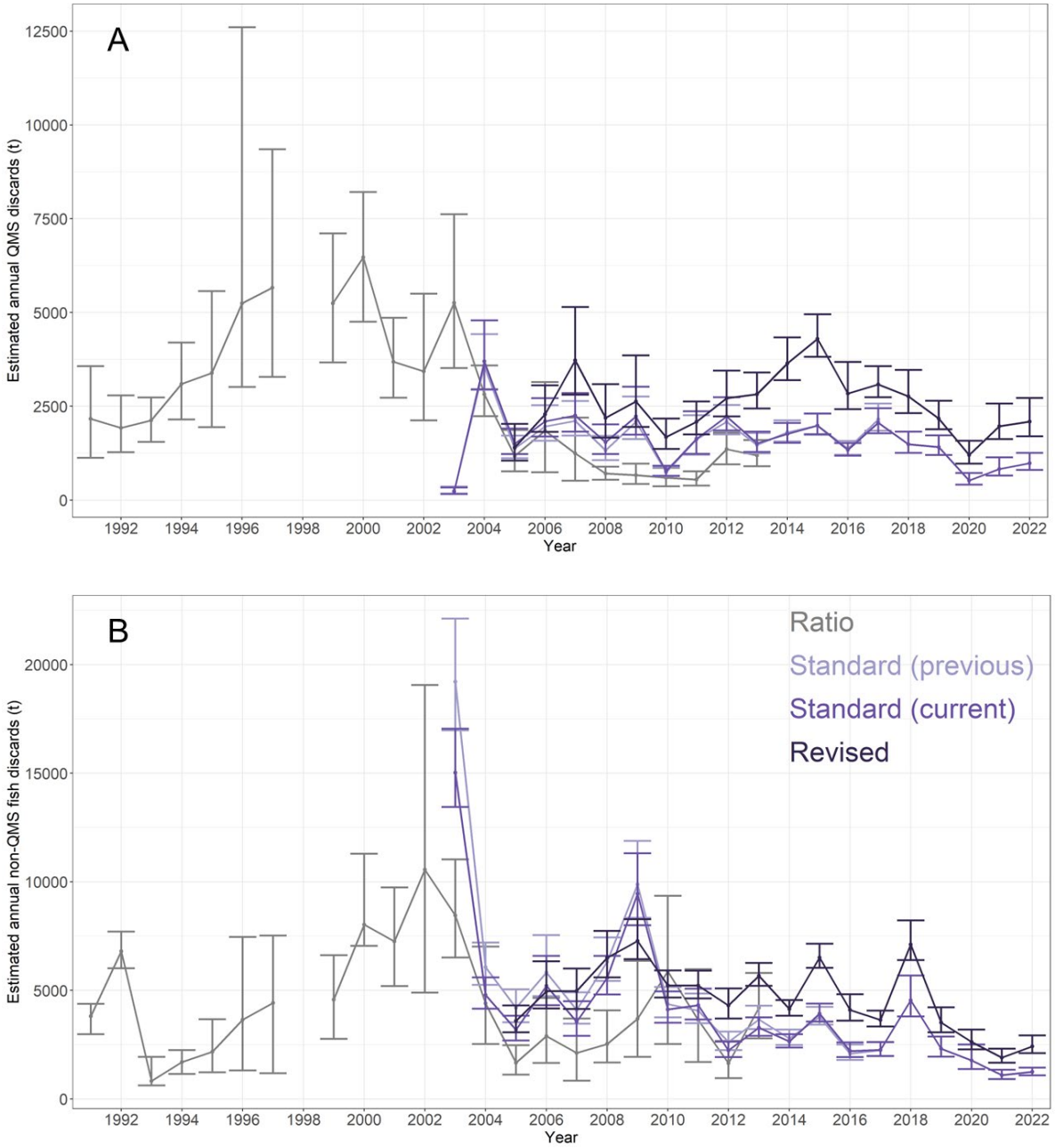
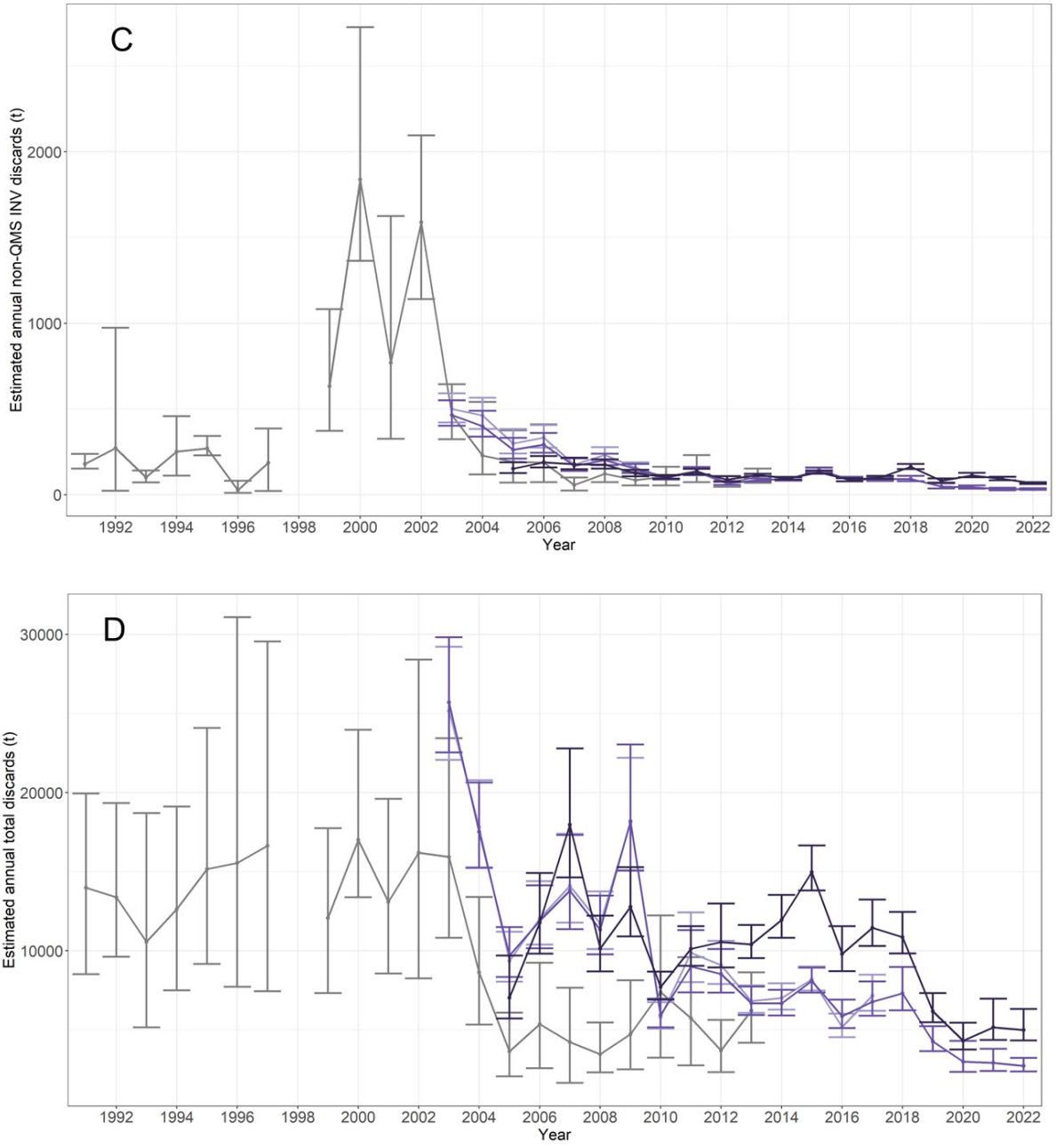


Figure 23: Annual estimates of discards (t) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery since 1990–91, for A) QMS, B) non-QMS fish, C) non-QMS invertebrates, and D) Total non-target species, using the ratio method ('Ratio'; Ballara & O'Driscoll 2015), the previous iteration which used the standard statistical method ('Standard (previous)'; Anderson et al. 2019), the standard statistical method used in this study ('Standard (current)'), and the revised (spatial) method ('Revised') using the best fitting model in Table 10. (Continued next page)



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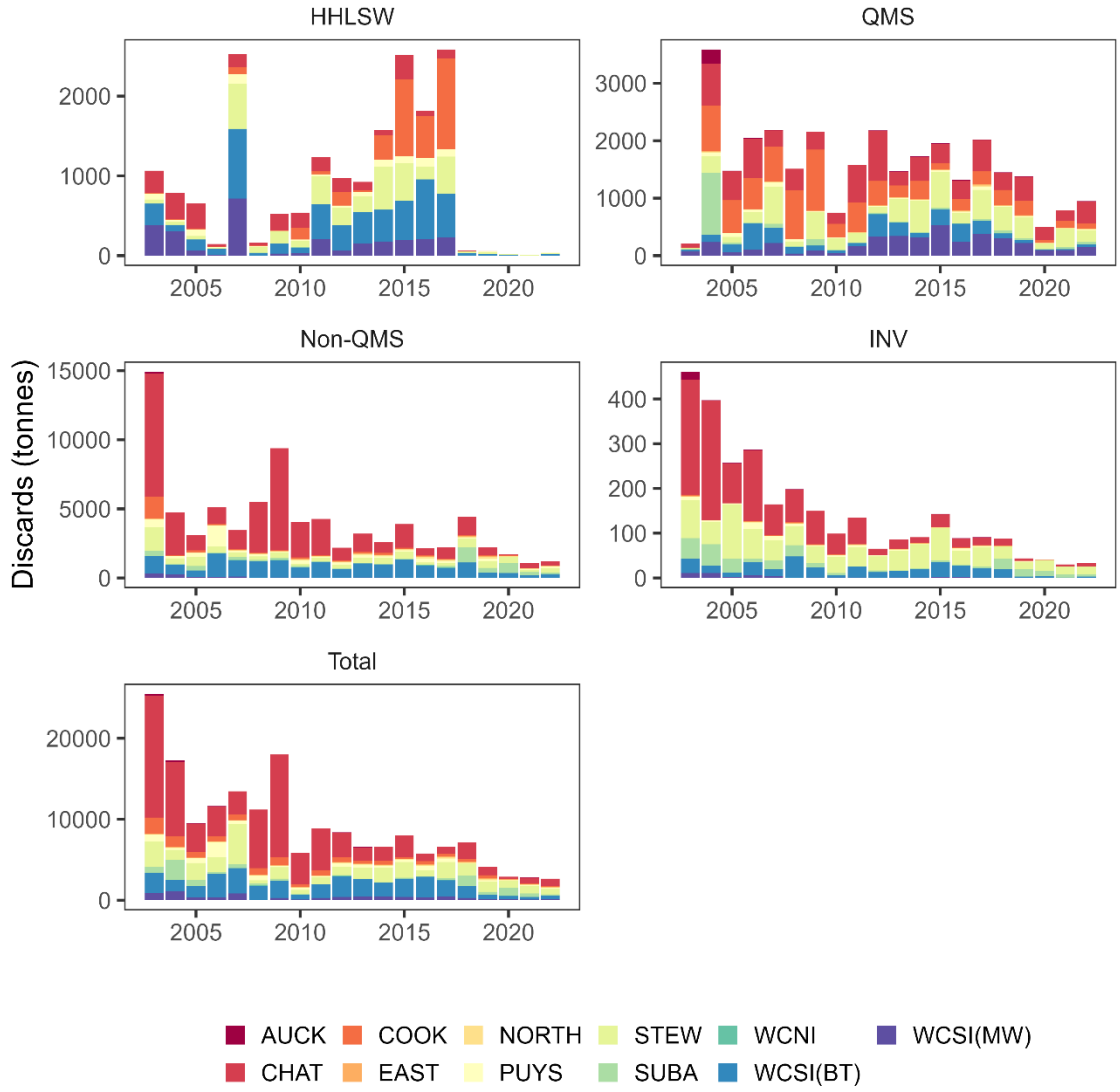

Figure 24: Standard method estimated annual discards of target species (HOK, HAK, LIN, SWA, and WWA, top left), QMS species (top right), non-QMS fish species (middle left), non-QMS invertebrate (INV) species (middle right), and all species combined (bottom left) in each standard area where species were reported in the HOK, HAK, LIN, SWA, and WWA target trawl fishery by fishing years 2002–03 to 2021–22.

3.6 Non-target catch utilisation rates

Annual non-target catch and discard estimates in the HOK, HAK, LIN, SWA, and WWA trawl fishery were divided by the estimated annual target species catch, and annual discards were divided by annual non-target catch in the fishery, to provide measures of the fishery's utilisation rates (Table 13, Figure 24). 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 was relatively consistent across all years, averaging 0.22 across all years and varying between 0.13 in 2019–20 and 0.27 in 2003–04, 2009–10, and 2014–15. The discards fraction showed a general decline over time, from a peak of 0.17 in 2008–09 to 0.03 to

0.07 thereafter, and averaged 0.07 across the 20-year period (2002–03 and 2021–22). Total discards as a fraction of non-target catch was highest between 2002–03 and 2011–12 (mostly between 0.33 and 0.63), but since declined to estimates between 0.14 and 0.24. The average total discards to non-target catch ratio was 0.30.

Table 13: Estimated annual catch of target species (t), standard method estimated total non-target catch and discards (t) in the HOK, HAK, LIN, SWA, and WWA target trawl fishery; non-target catch ratio (kilogram of total non-target catch per kilogram of HOK, HAK, LIN, SWA, and WWA caught), discards ratio (kilogram of total discards per kilogram HOK, HAK, LIN, SWA, and WWA caught); and discards as a fraction of non-target catch.

Fishing year	Target species estimated catch	Total non-target catch	Total discards	Non-target catch fraction	Discard fraction	Discards / non-target catch
2002–03	207 863	43 963	25 705	0.21	0.12	0.59
2003–04	163 008	43 444	17 518	0.27	0.11	0.40
2004–05	131 706	29 139	9 689	0.22	0.07	0.33
2005–06	125 175	30 193	11 891	0.24	0.10	0.39
2006–07	125 394	27 549	13 790	0.22	0.11	0.50
2007–08	108 783	27 978	11 337	0.26	0.10	0.41
2008–09	110 040	28 676	18 193	0.26	0.17	0.63
2009–10	119 165	32 088	5 940	0.27	0.05	0.19
2010–11	130 605	26 246	9 007	0.20	0.07	0.34
2011–12	141 684	21 539	8 527	0.15	0.06	0.40
2012–13	147 417	31 773	6 684	0.22	0.05	0.21
2013–14	161 251	37 309	6 669	0.23	0.04	0.18
2014–15	176 117	47 961	8 089	0.27	0.05	0.17
2015–16	151 343	33 759	5 859	0.22	0.04	0.17
2016–17	155 539	35 227	6 771	0.23	0.04	0.19
2017–18	149 599	29 914	7 309	0.20	0.05	0.24
2018–19	126 497	24 598	4 277	0.19	0.03	0.17
2019–20	113 242	14 738	2 985	0.13	0.03	0.20
2020–21	112 540	18 142	2 919	0.16	0.03	0.16
2021–22	105 056	19 200	2 717	0.18	0.03	0.14
All years	138 101	30 172	9 294	0.22	0.07	0.30

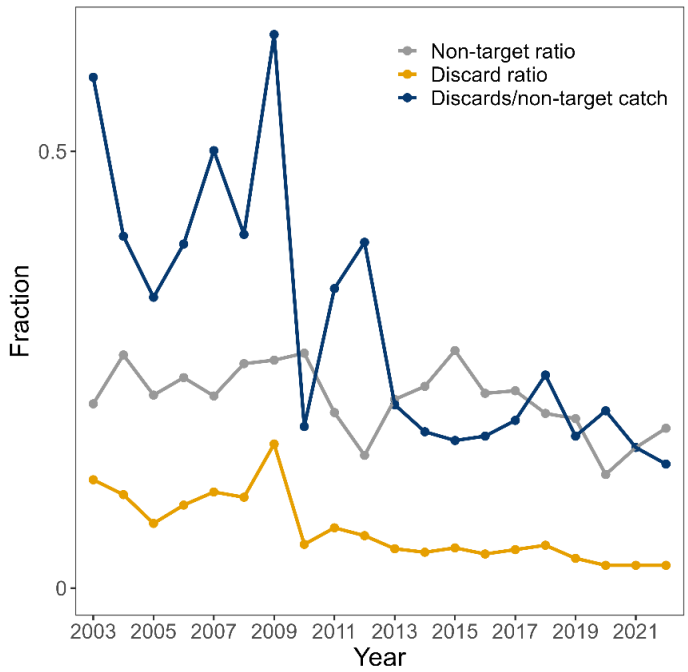

Figure 25: Non-target catch and discard fractions in the HOK, HAK, LIN, SWA, and WWA target trawl fishery. Non-target ratio (grey), total non-target catch divided by total estimated HOK, HAK, LIN, SWA, and WWA catch; discards ratio (yellow), total discards divided by total estimated target catch; discards/non-target catch (blue), total discards divided by total non-target catch.

3.7 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 catch and discard trends, are presented in Tables A6, A8, and Figure 25. Note that estimates of non-target catch and discards were not made for corals due to lack of model convergence associated with very low catches in this group.

Based on these estimates, the non-target species/species categories caught in the greatest amounts over the entire commercial fishery were (in decreasing order) unspecified rattails (RAT), sharks (SHA), javelinfish (JAV), Schedule 6 species, spiny dogfish (SPD), pale ghost shark (GSP), morid cods (MORID), black oreo (BOE), and sea perch (SPE) (Appendix A, Figure 25). Of the non-target catch species/species groups examined, one species had a significant increasing trend over time (gemfish, RSO), and two species groups had significant decreasing trends over time: sharks and slickheads (Table A6).

Annual discards of QMS species and of combined groups mainly comprising non-QMS species (e.g., morid cods) were in most cases only a small fraction of non-target catch, and often close to zero (Figure 25). The exceptions to this were the Schedule 6 group of QMS species and spiny dogfish (SPD), all of which can legally be returned to the sea. Discards of Schedule 6 species showed a significant declining trend over time. There were six additional species and species groups with significant and declining trends: barracouta (BAR), javelinfish (JAV), rattails (RAT), sharks, slickheads, and shovelnose dogfish (SND) (Table A8).

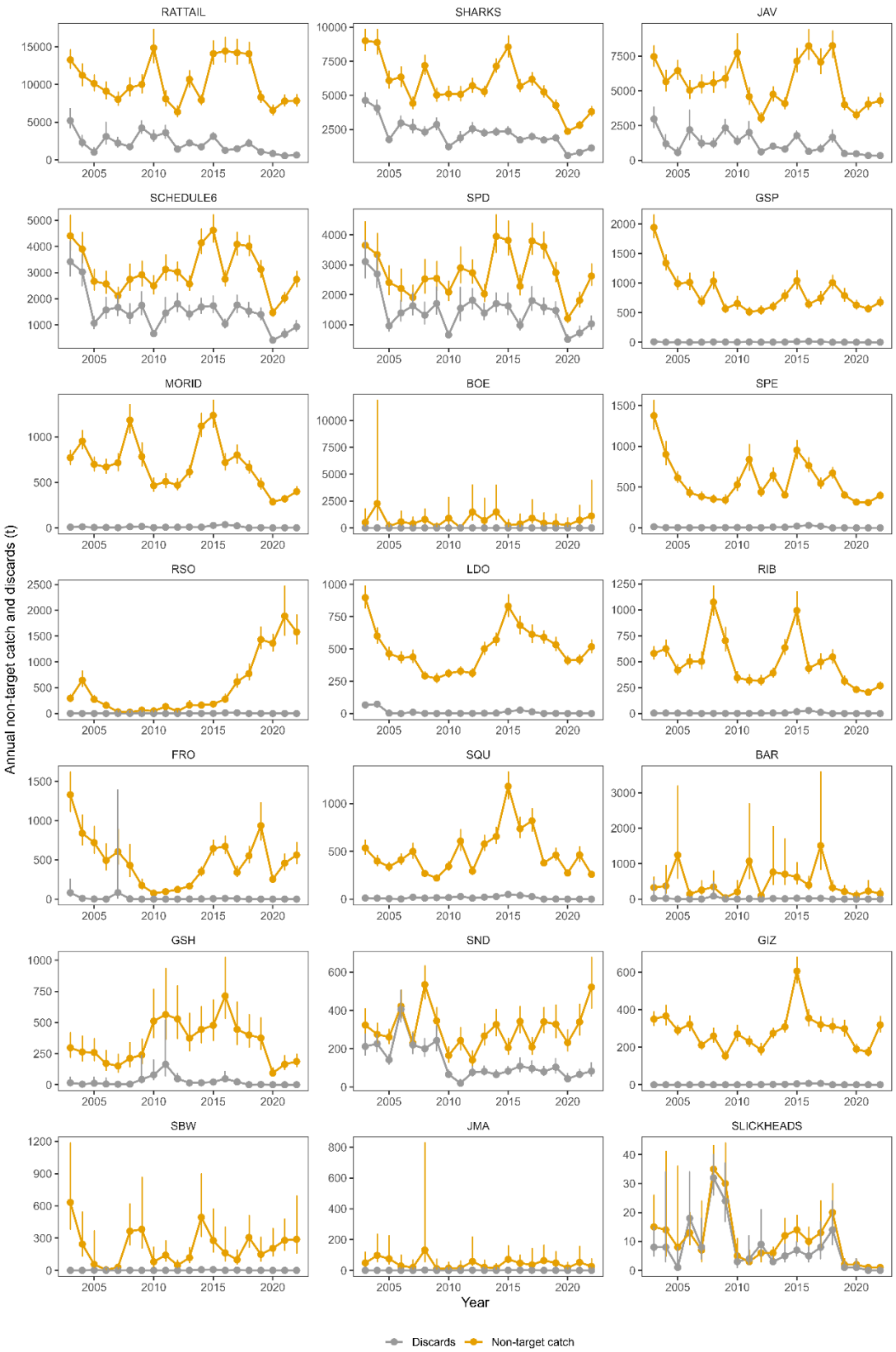

Figure 26: Estimates of annual non-target catch (yellow) and discards (grey) in the target hoki, hake, ling, silver warehou, and white warehou trawl fishery for selected non-target species groups and the main individual non-target catch species, with 95% confidence intervals. Plots are ordered (from 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.

4. SUMMARY AND DISCUSSION

Observer coverage

Annual estimates of non-target catch and discards in this fishery rely heavily 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. 2016), and potentially biased if the providers of such information are not selected randomly, and therefore not easily incorporated into the analysis carried out for this report.

The annual level of observer coverage is relatively high compared with other offshore fisheries (e.g., <10% in the scampi trawl fishery, Anderson et al. 2023). On average, 30.6% of the catch and 23.5% of target tows were observed between 2002–03 and 2021–22. Observer effort throughout the period was relatively well spread across the main fishery locations, times of year, and the fishing fleet. For comparison with other offshore fisheries, observer coverage (of the target catch) since 2003–04 averaged 34% in the orange roughy trawl fishery, 28% in the oreo trawl fishery, 17% in the ling longline fishery, 55% in the jack mackerel trawl fishery, and 46% in the arrow squid trawl fishery (Finucci et al. 2020, Finucci et al. 2022, Anderson & Finucci 2022, Anderson et al. 2023).

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 research programme. Although these standard areas do not exactly 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.

Statistical model-based methods have 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 selected here for the standard method (area, fishing year, gear type) and for discards (vessel category) were unchanged from that used in the previous assessment (Anderson et al. 2019).

Estimation of non-target catch and discards focused on four broad categories of catch in each fishery: Total non-target catch, QMS species, non-QMS fish species, and non-QMS invertebrate species. The repeated estimates of annual total non-target catch and discards using the standard method were generally very similar to earlier estimates for most years (Anderson et al. 2019). Where differences were observed, they are likely to be due to a combination of changes in the estimation model from that used previously (which employed a zero-inflated statistical distribution for the dependent variable rather than the two-part log-normal/binomial structure used here) and the influence the additional years of data had on estimated model coefficients.

The revised model-based method was successfully implemented for the first time in the assessment of this fishery and represents an improvement over the standard method due to its ability to incorporate a finer spatial resolution for parameter estimation and account for spatial autocorrelation in the observer data in the estimation of uncertainty. Model diagnostics indicated that the revised model method generally provided a good fit to the input data while reducing the level of estimated uncertainty around the estimates of annual non-target catch and discards within each species category. The slight drawback that the year-of-entry into the QMS cannot be taken into account in the combined categories in this method becomes less important for future analyses, as few species have been added in recent years and any new additions are likely to comprise species of minor catch or value. The revised model method provided estimates of annual non-target catch for the key species groups that were very similar to

estimates using previous models. Some disparities with the estimates of annual discards were observed and may require further refinement before formally adopting this approach. Therefore estimates from the standard method should be considered the most reliable when quoting from this report.

Composition and level of non-target catch and discards

Since 2002–03, hoki accounted for about 73% of the total estimated catch weight recorded by observers in the fishery, while the other target species accounted for a further 16%: ling (5.9%), hake (5.7%), silver warehou (3.9%), and white warehou (1.1%). About half of the remaining catch comprised javelinfish (2.0%), other (unspecified) rattails (1.6%), and spiny dogfish (1.5%) while the other half comprised mostly a range of other bony fishes and chondrichthyans. Non-target invertebrate catch was dominated by the QMS species arrow squid, with non-QMS invertebrates comprising a wide range of molluscs, sponges, echinoderms, crustaceans, and cnidarians, most of which were less than 0.05% of the observed catch during the period.

Non-target catch across all years was an even mixture of QMS species and non-QMS fish species, although several species moved from the non-QMS fish category to the QMS category during the period and resulted in decreased contributions of the former and increased contributions of the latter category, and therefore trends are difficult to interpret. These species include skates (*Dipturus innominatus* and *Zearaja nasuta*), spiny dogfish, and lookdown dory (*Cyttus traversi*) in 2003 and 2004; and redbait (*Emmelichthys nitidus*) in 2009. Although none of these species accounted for more than 2% of the total observed catch, all were in the top 40 recorded non-target species. The range of total annual non-target catch during the 20-year period analysed was about 15 000–48 000 t, fluctuating over time approximately in keeping with changes in total effort throughout the period. There was a considerable decline in total annual non-target catch (and fishing effort) in recent years, most likely reflective of the COVID pandemic.

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

Discarding of target species (hoki, hake, ling, silver warehou, white warehou) was generally low but highly variable, ranging from 11 t to about 2650 t, with no more than 100 t reported annually since 2016–17. Discards of QMS species and non-QMS fish species followed a similar pattern to that of non-target catch (for the years in common) and have declined over time. Discards of non-QMS species and total discarding declined significantly over the 20-year time period. Total discards ranged from about 3000 t to about 25 000 t per year, and, since 2019–20, total discards have remained consistently around 3000 t annually.

The estimation of non-target catch levels for several additional species groups plus the main individual non-target species enables detection of substantial changes in catches over time—and possibly provides an early indication of a change in abundance. There were few significant trends in non-target species catch levels over time for these taxa. Of the non-target catch species/species groups examined, one species had a significant increasing trend over time (gemfish), and two species groups had significant decreasing trends over time: sharks and slickheads. Gemfish biomass has increased considerably since 2015 (up to 10-fold around the Stewart-Snares shelf and WCSI) and this increase in biomass likely accounts for the increasing trend in non-target catch of this species (Fisheries New Zealand 2023). The reason for the decreasing trends in sharks and slickheads may be reflective of reduced fishing effort, which began about 2015 (see Figure 17). It is not clear if there is an individual species (or several species) driving the trends in the species groups. Computing catch rates for species of interest may provide clarity in the drivers of these trends and may be useful in inferring abundance trends.

Discards relative to target catch

The annual discards ratio (kilogram of discards/kilogram of target species catch) was highest in early years on the time period (between 0.07 and 0.12), peaking in 2008–09 at 0.17, and has declined since to estimates generally between 0.03 and 0.05. The overall average across the 20-year period (2002–03 and 2020–22) was 0.07. This ratio can be compared with recent mean ratios in other New Zealand deepwater trawl fisheries which are similarly monitored: ling (0.3), jack mackerel (0.006), orange roughy (0.075), oreo fishery (0.014), arrow squid (0.088), and scampi (3.0) (Anderson et al. 2013, Finucci et al. 2020, Finucci et al. 2022, Anderson & Finucci 2022, Anderson et al. 2023).

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7. APPENDIX A: Summary data tables

Table A1: Observed FISH non-target catch and discards for the HOK, HAK, LIN, SWA, and WWA target trawl fishery. 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 1 Oct 2002 to 30 Sep 2022. Records are ordered by decreasing percentage of catch (continued on next page).

Species code	Common name	Scientific name	Observed catch (t)	% of catch	% discarded
HOK	Hoki	*Macruronus novaezelandiae*	690 237.8	73.85	0.24
LIN	Ling	*Genypterus blacodes*	55 325.1	5.92	0.07
HAK	Hake	*Merluccius australis*	52 962.8	5.67	0.06
SWA	Silver warehou	*Seriolella punctata*	36 028.2	3.85	0.14
JAV	Javelin fish	*Lepidorhynchus denticulatus*	18 568.9	1.99	32.08
RAT	Rattails	Macrouridae	14 984	1.60	36.33
SPD	Spiny dogfish	*Squalus acanthias*	13 813.6	1.48	54.75
WWA	White warehou	*Seriolella caerulea*	10 754.3	1.15	0.03
FRO	Frostfish	*Lepidopus caudatus*	4 068.5	0.44	0.96
BAR	Barracouta	*Thyrsites atun*	3 903.8	0.42	1.32
GSP	Pale ghost shark	*Hydrolagus bemisi*	3 207.9	0.34	0.21
RSO	Gemfish	*Rexea* spp.	3 111.1	0.33	0.04
SPE	Sea perch	*Helicolenus* spp.	2 365.7	0.25	0.37
RIB	Ribaldo	*Mora moro*	2 346.8	0.25	0.17
LDO	Lookdown dory	*Cyttus traversi*	2 186.7	0.23	0.20
GSH	Ghost shark	*Hydrolagus novaezealandiae*	2 072.7	0.22	5.39
BOE	Black oreo	*Allocyttus niger*	1 967.2	0.21	0.02
SBW	Southern blue whiting	*Micromesistius australis*	1 837.4	0.20	0.03
GIZ	Giant stargazer	*Kathetostoma* spp.	1 467.1	0.16	0.19
SND	Shovelnose spiny dogfish	*Deania* spp.	1 397.2	0.15	28.64
RCO	Red cod	*Pseudophycis bachus*	1 200.0	0.13	0.70
SSI	Silverside	*Argentina elongata*	1186.2	0.13	75.81
SSK	Smooth skate	*Dipturus innominatus*	1 158.5	0.12	0.57
JMA	Jack mackerel	*Trachurus declivis, T. murphyi, T. novaecelandiae*	849.1	0.09	0.11
ETB	Baxter's lantern dogfish	*Etmopterus granulosus*	839.7	0.09	25.44
CSQ	Leafscale gulper shark	*Centrophorus squamosus*	677.6	0.07	50.01
RBT	Redbait	*Emmelichthys nitidus*	586.6	0.06	6.14
SDO	Silver dory	*Cyttus novaezealandiae*	526.8	0.06	66.80
BYS	Alfonsino	*Beryx splendens*	489.1	0.05	0.31
BEN	Scabbardfish	*Benthodesmus* spp.	481.5	0.05	2.59
LCH	Long-nosed chimaera	*Harriotta raleighana*	430.4	0.05	19.90
RBM	Ray's bream	*Brama* spp.	428.4	0.05	0.42
OSD	Other sharks and dogs	Selachii	418.2	0.04	40.82
RSK	Rough skate	*Zearaja nasuta*	402.3	0.04	0.85
CON	Conger eel	*Conger* spp.	397.9	0.04	86.07
SOR	Spiky oreo	*Neocyttus rhomboidalis*	365.3	0.04	0.84
SCH	School shark	*Galeorhinus galeus*	362.4	0.04	2.26
FHD	Deepsea flathead	*Hoplichthys haswelli*	360.1	0.04	62.95
WAR	Common warehou	*Seriolella brama*	350.7	0.04	0.04
BBE	Banded bellowsfish	*Centriscops humerosus*	348.9	0.04	56.68
BSH	Seal shark	*Dalatias licha*	322.4	0.03	40.48
CDL	Cardinalfish	Epigonidae	315.9	0.03	0.41
SCO	Swollenhead conger	*Bassanago bulbiceps*	292.3	0.03	82.25
RUD	Rudderfish	*Centrolophus niger*	291.4	0.03	43.84
RHY	Common roughy	*Paratrachichthys trailli*	270.7	0.03	86.60
CBO	Bollons' rattail	*Coelorinchus bollonsi*	256.6	0.03	27.20
BYX	Alfonsino & long-finned beryx	*Beryx splendens* & *B. decadactylus*	239.0	0.03	1.95
BNS	Bluenose	*Hyperoglyphe antarctica*	232.9	0.02	3.78
SSO	Smooth oreo	*Pseudocyttus maculatus*	205.8	0.02	0.00
SRH	Silver roughy	*Hoplostethus mediterraneus*	199.1	0.02	75.15
ETL	Lucifer dogfish	*Etmopterus lucifer*	195.1	0.02	54.93
DWD	Deepwater dogfish		193.6	0.02	40.83
BSK	Basking shark	*Cetorhinus maximus*	176.2	0.02	22.33
ORH	Orange roughy	*Hoplostethus atlanticus*	174.4	0.02	0.08
CYP	Longnose velvet dogfish	*Centroscymnus crepidater*	163.5	0.02	35.20

Table A1: continued

Species code	Common name	Scientific name	Observed catch (t)	% of catch	% discarded
HAP	Hāpuku	*Polyprion oxygeneios*	162.8	0.02	0.23
NSD	Northern spiny dogfish	*Squalus griffini*	160.8	0.02	62.41
POS	Porbeagle shark	*Lamna nasus*	146.1	0.02	38.48
COL	Oliver's rattail	*Coelorinchus oliverianus*	120.4	0.01	32.73
NMP	Tarakihi	*Nemadactylus macropterus* & *N.* sp. A	118.2	0.01	0.66
CBE	Crested bellowsfish	*Notopogon lilliei*	117.7	0.01	96.74
SSH	Slender smooth-hound	*Gollum attenuatus*	117.3	0.01	69.27
MDO	Mirror dory	*Zenopsis nebulosa*	117.0	0.01	3.91
EPT	Deepsea cardinalfish	*Epigonus telescopus*	110.8	0.01	0.08
TOA	Toadfish	*Neophrynichthys* spp.	106.8	0.01	45.36
PLS	Plunket's shark	*Proscymnodon plunketi*	94.7	0.01	75.25
BEL	Bellowsfish	*Centriscops* spp.	85.0	0.01	70.39
OPE	Orange perch	*Lepidoperca aurantia*	82.9	0.01	23.77
JMD	Greenback jack mackerel	*Trachurus declivis*	82.0	0.01	0.02
SWO	Broadbill swordfish	*Xiphias gladius*	75.5	0.01	0.75
SBK	Spineback	*Notacanthus sexspinis*	74.5	0.01	60.38
DEA	Dealfish	*Trachipterus trachypterus*	67.5	0.01	9.54
CAR	Carpet shark	*Cephaloscyllium isabellum*	58.1	0.01	93.62
YBO	Yellow boarfish	*Pentaceros decacanthus*	58.0	0.01	68.20
STN	Southern bluefin tuna	*Thunnus maccoyii*	52.5	0.01	3.15
WHX	White rattail	*Trachyrincus aphyodes*	51.8	0.01	65.97
PIG	Pigfish	*Congiopodus leucopaecilus*	48.5	0.01	96.73
RSO	Gemfish	*Rexea solandri*	48.0	0.01	2.63
RBY	Rubyfish	*Plagiogeneion rubiginosum*	44.6	<0.01	1.01
WIT	Witch	*Arnoglossus scapha*	44.5	<0.01	84.18
ERA	Electric ray	*Torpedo fairchildi*	44.3	<0.01	81.66
EPL	Bigeye cardinalfish	*Epigonus lenimen*	44.2	<0.01	83.94
TOP	Pale toadfish	*Ambophthalmos angustus*	43.3	<0.01	49.39
JMM	Slender jack mackerel	*Trachurus murphyi*	42.2	<0.01	0.04
CYO	Smooth skin dogfish	*Centroscymnus owstoni*	41.1	<0.01	62.56
SLK	Slickhead	Alepocephalidae	40.7	<0.01	58.55
RDO	Rosy dory	*Cyttopsis roseus*	40.1	<0.01	79.06
HPB	Hāpuku & bass	*Polyprion oxygeneios* & *P. americanus*	37.0	<0.01	0.29
HJO	Slender cods	*Halargyreus* spp.	34.4	<0.01	26.07
PDG	Prickly dogfish	*Oxynotus bruniensis*	33.0	<0.01	62.07
HEX	Sixgill shark	*Hexanchus griseus*	31.6	<0.01	78.15
GUR	Gurnard	*Chelidonichthys kumu*	30.5	<0.01	1.48
BEE	Basketwork eel	*Diastobranchus capensis*	29.5	<0.01	69.89
DWE	Deepwater eel		29.1	<0.01	13.45
CDO	Capro dory	*Capromimus abbreviatus*	28.1	<0.01	39.20
THR	Thresher shark	*Alopias vulpinus*	28.0	<0.01	78.36
HCO	Hairy conger	*Bassanago hirsutus*	27.8	<0.01	54.16
HAG	Hagfish	*Eptatretus cirrhatus*	26.8	<0.01	35.17
ETM	*Etmopterus* spp.	*Etmopterus* spp.	25.5	<0.01	20.72
LAN	Lantern fish	Myctophidae	24.2	<0.01	6.07

Table A2: Observed INVERTEBRATE catch and discards for the HOK, HAK, LIN, SWA, and WWA target trawl fishery. 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 2022. Records are ordered by decreasing percentage of catch (continued on next page).

Species code	Common name	Scientific name	Observed catch (t)	% of catch	% discarded
SQU	Arrow squid	*Nototodarus sloanii* & *N. gouldi*	4 547.6	0.48	1.30
WSQ	Warty squid	*Moroteuthopsis* & *Onykia* spp.	443.7	0.05	34.59
HYA	Floppy tubular sponge	*Hyalascus* sp.	166.7	0.02	2.29
ONG	Sponges	Porifera	156.9	0.02	8.24
SFI	Starfish	Asteroidea & Ophiuroidea	83.6	0.01	61.18
SAL	Salps		81.7	0.01	90.26
GSC	Giant spider crab	*Jacquinotia edwardsii*	59.8	0.01	11.47
OPI	Umbrella octopus	*Opisthoteuthis* spp.	57.9	0.01	97.23
MIQ	Warty squid	*Moroteuthopsis ingens*	51.2	0.01	23.87
SCI	Scampi	*Metanephrops challengeri*	50.7	0.01	0.41
GLS	Glass sponges	Hexactinellida	47.9	0.01	0.00
TSQ	*Todarodes filippovae*	*Todarodes filippovae*	43.0	<0.01	44.15
PHB	Grey fibrous massive sponge	*Phorbas* spp.	26.2	<0.01	0.65
TAM	Tam O shanter urchin	Echinothuriidae & Phormosomatidae	23.7	<0.01	85.96
ACS	Smooth deepsea anemones	Actinostolidae	21.3	<0.01	0.64
VSQ	Violet squid	*Histioteuthis* spp.	20.9	<0.01	67.96
FMA	*Fusitriton magellanicus*	*Fusitriton magellanicus*	18.0	<0.01	32.99
OCT	Octopus	*Pinnoctopus cordiformis*	17.5	<0.01	65.87
HOR	Horse mussel	*Atrina zelandica*	16.4	<0.01	0.00
PYR	*Pyrosoma atlanticum*	*Pyrosoma atlanticum*	16.1	<0.01	91.83
HMT	Deepsea anemone	Hormathiidae	16.0	<0.01	0.79
GSQ	Giant squid	*Architeuthis dux*	15.8	<0.01	49.86
DWO	Deepwater octopus	*Graneledone* spp.	14.9	<0.01	87.61
SQX	Squid		14.3	<0.01	40.37
CRB	Crab		13.3	<0.01	81.96
RSQ	*Ommastrephes bartrami*	*Ommastrephes bartrami*	10.9	<0.01	51.41
ANT	Anemones	Anthozoa	7.2	<0.01	10.18
QSC	Queen scallop	*Zygochlamys delicatula*	6.8	<0.01	57.16
PSI	Geometric star	*Psilaster acuminatus*	6.1	<0.01	67.99
CJA	Sun star	*Crossaster multispinus*	5.5	<0.01	81.41
JFI	Jellyfish		4.4	<0.01	92.13
MRQ	Warty squid	*Onykia robsoni* & *O.* sp. A	4.3	<0.01	23.00
GMC	Garrick's masking crab	*Leptomithrax garricki*	4.3	<0.01	100.02
PRU	*Pseudechinaster rubens*	*Pseudechinaster rubens*	4.1	<0.01	93.50
DMG	*Dipsacaster magnificus*	*Dipsacaster magnificus*	4.1	<0.01	64.42
PKN	Abyssal star	*Plutonaster knoxi*	4.0	<0.01	41.70
GAS	Gastropods	Gastropoda	3.7	<0.01	47.11
PSQ	Large red scaly squid	*Pholidoteuthis* spp.	3.7	<0.01	77.06
BPI	*Benthopecten pikei*	*Benthopecten pikei*	3.6	<0.01	0.00
ZOR	Rat-tail star	*Zoroaster* spp.	3.6	<0.01	48.56
HTH	Sea cucumber	*Holothurian* unidentified	3.5	<0.01	60.42
HTR	Trojan starfish	*Hippasteria phrygiana*	3.3	<0.01	149.98
ASR	Asteroid (starfish)		3.1	<0.01	77.22
PRK	Prawn killer	*Ibacus alticrenatus*	3.1	<0.01	3.00
KIC	King crab	*Lithodes murrayi, Neolithodes brodiei*	3.0	<0.01	2.05
PAO	*Pillsburiaster aoteanus*	*Pillsburiaster aoteanus*	2.9	<0.01	80.14
CPA	Pentagon star	*Ceramaster patagonicus*	2.9	<0.01	16.90
NCB	Smooth red swimming crab	*Nectocarcinus bennetti*	2.3	<0.01	86.16
GRM	Sea urchin	*Gracilechinus multidentatus*	2.2	<0.01	24.85
LNV	Rock star	*Lithosoma novaezelandiae*	2.2	<0.01	28.60
PRA	Prawn		2.0	<0.01	44.76
LLC	Long-legged masking crab	*Leptomithrax longipes*	2.0	<0.01	79.62
LHO	Omega prawn	*Lipkius holthuisi*	2.0	<0.01	13.57
CRM	Airy finger sponge	*Callyspongia* cf *ramosa*	1.9	<0.01	0.10
PMO	*Pseudostichopus mollis*	*Pseudostichopus mollis*	1.9	<0.01	16.19

Table A2: continued

Species code	Common name	Scientific name	Observed catch (t)	% of catch	% discarded
SMO	Cross-fish	*Sclerasterias mollis*	1.8	<0.01	83.14
WHE	Whelks		1.7	<0.01	77.60
LMU	Murray's king crab	*Lithodes murrayi*	1.7	<0.01	1.00
URO	Sea urchin other		1.7	<0.01	91.68
GOR	*Gorgonocephalus* spp.	*Gorgonocephalus* spp.	1.6	<0.01	62.75
SPI	Spider crab		1.5	<0.01	6.10
TDQ	Dana octopus squid	*Taningia* spp.	1.3	<0.01	39.16
SDM	Pagurid	*Sympagurus dimorphus*	1.3	<0.01	49.82
EZE	Yellow octopus	*Enteroctopus zealandicus*	1.2	<0.01	47.10
COF	Flabellum coral	*Flabellum* spp.	1.1	<0.01	3.35
DIR	Pagurid	*Diacanthurus rubricatus*	1.1	<0.01	83.23
KWH	Knobbed whelk	*Austrofucus glans*	1.1	<0.01	20.92
MSL	Starfish	*Mediaster sladeni*	1.1	<0.01	89.19
PLT	*Plutonaster* spp	*Plutonaster* spp.	1.0	<0.01	0.00
SOT	*Solaster torulatus*	*Solaster torulatus*	0.9	<0.01	51.27
GVO	Golden volute	*Provocator mirabilis*	0.9	<0.01	75.72
HDF	Feathery hydroids	Leptothecata (Order) ; Anthoathecata (Order) but excluding family Stylasteridae	0.8	<0.01	0.00
ECT	Echinothuriidae (family)	Echinothuriidae	0.8	<0.01	101.67
PNE	*Proserpinaster neozelanicus*	*Proserpinaster neozelanicus*	0.8	<0.01	79.41
SMK	Spiny masking crab	*Teratomaia richardsoni*	0.8	<0.01	85.01
COU	True coral (unidentified)	Gorgonian octocorals in Order Alcyonacea Scleractinia (Order) Antipatharia (Order) Stylasteridae (Family)	0.8	<0.01	0.39
ASC	Sea squirt	Ascidiacea	0.7	<0.01	0.00
BNO	*Benthoctopus* spp.	*Benthoctopus* spp.	0.7	<0.01	66.62
MOL	Molluscs		0.7	<0.01	21.47
TLD	Furry oval sponge	*Tetilla leptoderma*	0.7	<0.01	0.00
PCH	*Penion chathamensis*	*Penion chathamensis*	0.7	<0.01	40.18
DHO	Sea urchin	*Dermechinus horridus*	0.6	<0.01	42.65
ALH	Three-and-three stars	*Allostichaster* spp.	0.6	<0.01	0.00
PAG	Pagurid	Paguroidea	0.6	<0.01	92.16
NEB	Brodie's king crab	*Neolithodes brodiei*	0.6	<0.01	15.77
BES	*Benthopecten* spp.	*Benthopecten* spp.	0.5	<0.01	80.84
ECH	Echinoderms	Echinodermata	0.5	<0.01	4.20
VOL	Volute	Volutidae	0.5	<0.01	70.62
CBD	Coral rubble - dead		0.5	<0.01	0.00
PLY	Polychelidae	*Polycheles* spp.	0.5	<0.01	89.02
BAM	*Bathyplotes* spp.	*Bathyplotes* spp.	0.5	<0.01	88.56
SPT	Heart urchin	*Spatangus multispinus*	0.5	<0.01	29.99
AER	*Aeneator recens*	*Aeneator recens*	0.5	<0.01	47.58
PZE	Prickly king crab	*Paralomis zealandica*	0.4	<0.01	27.68
PNN	Feathery sea pens	*Pennatula* spp.	0.4	<0.01	0.23
SSP	Scallop spat	*Pecten novaezelandiae*	0.4	<0.01	0.00
CHQ	Cranchiid squid	Cranchiidae	0.4	<0.01	16.71
GPA	Sea urchin	*Goniocidaris parasol*	0.4	<0.01	92.98
DAP	Antlered crab	*Dagnaudus petterdi*	0.4	<0.01	82.15

Table A3: Observed estimated non-target catch by species group for the HOK, HAK, LIN, SWA, and WWA target trawl fishery. Observed estimated catch, percentage of total catch, and overall percentage discarded from observer records between 1 Oct 2002 and 30 Sep 2022.

Group	Observed catch (t)	% of catch	% discarded
Fish			
Target (HOK, HAK, LIN, SWA, WWA)	845 308.30	90.45	0.21
Fish (other)*	34 392.31	3.68	8.87
Rattails (all species combined)	34 048.00	3.64	34.00
Sharks & dogfish	19 425.72	2.08	49.53
Chimaeras	5 722.47	0.61	3.59
Rays	1 722.71	0.18	7.28
Eels	864.58	0.09	77.83
Tunas and Billfish	96.04	0.01	2.25
Invertebrates			
Squid	5 157.92	0.55	7.76
Porifera	402.27	0.04	4.21
Crustacea	155.03	0.02	21.13
Other	98.80	0.01	89.77
Octopuses	92.90	0.01	88.37
Echinoderms	84.19	0.01	60.81
Cnidaria	54.87	0.01	9.32
Asteriidae	53.30	0.01	63.58

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

Table A1: Estimates of annual non–target catch (rounded to the nearest tonne) in the target hoki, hake, ling, silver warehou, and white warehou trawl fishery, by species category and standard area. 95% confidence intervals in parentheses.

(a) QMS species

FY	AUCK		CHAT		COOK		EAST	
2003	231	(148–358)	8 587	(7 638–9 612)	88	(65–120)	341	(170–677)
2004	292	(153–558)	14 389	(12 578–16 556)	1 269	(972–1 666)	619	(213–1 684)
2005	313	(124–762)	7 467	(6 660–8 397)	1 279	(995–1 639)	404	(147–1 123)
2006	53	(20–160)	9 251	(8 171–10 459)	849	(604–1 218)	219	(81–676)
2007	48	(17–157)	7 298	(6 379–8 465)	709	(540–928)	237	(97–563)
2008	134	(86–221)	6 252	(5 651–6 963)	1 126	(903–1 419)	261	(91–776)
2009	137	(75–275)	5 259	(4 513–6 093)	752	(567–1 030)	531	(184–1 648)
2010	43	(15–121)	7 481	(6 593–8 495)	385	(307–491)	344	(131–950)
2011	179	(98–346)	6 702	(5 816–7 783)	606	(425–882)	653	(238–1 806)
2012	46	(20–119)	6 547	(5 814–7 367)	501	(397–656)	415	(169–1 033)
2013	101	(47–246)	7 607	(6 777–8 546)	671	(519–901)	499	(171–1 515)
2014	261	(155–470)	8 746	(7 831–9 900)	589	(464–765)	1 059	(599–1 879)
2015	124	(69–227)	13 006	(11 546–14 864)	522	(427–647)	563	(373–880)
2016	95	(52–200)	6 670	(5 998–7 507)	213	(164–281)	427	(167–1 145)
2017	63	(36–120)	6 686	(5 992–7 495)	220	(165–293)	623	(369–1 071)
2018	141	(90–225)	5 283	(4 780–5 835)	206	(170–255)	341	(173–743)
2019	132	(73–251)	4 207	(3 812–4 622)	201	(163–249)	401	(151–1 035)
2020	30	(16–63)	2 381	(2 185–2 608)	57	(47–69)	98	(53–181)
2021	104	(67–166)	3 149	(2 914–3 435)	101	(75–138)	162	(60–418)
2022	85	(47–162)	3 978	(3 658–4 356)	95	(75–121)	236	(101–574)

FY	NORTH		PUYS		STEW		SUBA	
2003	52	(19–166)	889	(603–1 325)	1 579	(1 336–1 887)	791	(602–1 033)
2004	146	(54–424)	906	(600–1 400)	1 933	(1 526–2 495)	1 355	(1 012–1 830)
2005	87	(30–243)	903	(626–1 305)	1 398	(1 108–1 778)	422	(239–772)
2006	143	(58–409)	872	(571–1 367)	2 328	(1 933–2 819)	109	(39–290)
2007	103	(35–313)	1 031	(647–1 739)	4 560	(3 775–5 530)	306	(144–631)
2008	114	(42–322)	422	(234–757)	1 535	(1 345–1 768)	730	(559–956)
2009	145	(51–406)	1 082	(669–1 892)	3 105	(2 600–3 792)	669	(467–1 037)
2010	162	(68–388)	1 027	(669–1 634)	2 248	(1 954–2 625)	331	(170–653)
2011	133	(53–332)	1 254	(743–2 158)	2 302	(1 918–2 790)	387	(244–635)
2012	142	(52–412)	425	(297–658)	1 454	(1 248–1 704)	108	(62–202)
2013	258	(93–710)	917	(615–1 463)	3 630	(3 162–4 297)	124	(80–202)
2014	94	(55–164)	906	(611–1 417)	7 961	(7 009–9 256)	293	(211–423)
2015	146	(101–219)	613	(414–941)	6 879	(6 020–7 990)	358	(230–571)
2016	236	(138–412)	808	(561–1 180)	2 383	(2 027–2 846)	87	(45–191)
2017	230	(149–378)	663	(438–1 029)	5 207	(4 455–6 125)	157	(103–246)
2018	272	(175–445)	149	(105–217)	1 827	(1 644–2 076)	424	(344–528)
2019	163	(102–265)	363	(265–507)	2 334	(1 998–2 711)	349	(256–493)
2020	292	(222–386)	397	(263–612)	1 243	(1 104–1 408)	238	(187–316)
2021	525	(339–812)	477	(340–677)	1 455	(1 292–1 657)	301	(228–411)
2022	324	(214–486)	815	(620–1 056)	1 512	(1 342–1 722)	242	(181–339)

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	33	(9–135)	1 935	(1 647–2 300)	2 106	(1 825–2 439)
2004	89	(24–365)	3 363	(2 816–4 043)	1 820	(1 603–2 067)
2005	54	(12–243)	2 693	(2 236–3 246)	1 039	(915–1 195)
2006	209	(59–748)	3 054	(2 627–3 601)	746	(642–878)
2007	81	(27–286)	2 091	(1 589–2 828)	843	(697–1 018)
2008	250	(77–845)	2 981	(2 564–3 477)	513	(430–617)
2009	219	(69–746)	3 222	(2 473–4 332)	470	(376–600)
2010	51	(12–204)	1 323	(1 112–1 596)	358	(289–449)
2011	91	(25–386)	3 043	(2 488–3 746)	1 115	(904–1 407)
2012	56	(21–160)	2 092	(1 786–2 506)	911	(769–1 084)
2013	149	(42–534)	3 229	(2 771–3 865)	1 173	(1 007–1 383)
2014	121	(31–476)	4 000	(3 447–4 704)	1 377	(1 211–1 579)
2015	99	(25–411)	3 519	(3 095–4 051)	1 819	(1 632–2 041)
2016	34	(10–148)	3 651	(3 141–4 280)	1 447	(1 281–1 630)
2017	130	(43–424)	2 592	(2 278–2 954)	1 216	(1 072–1 392)
2018	92	(27–319)	2 266	(2 048–2 530)	1 134	(1 021–1 256)
2019	52	(14–208)	1 791	(1 526–2 091)	1 437	(1 298–1 604)
2020	61	(17–204)	1 149	(1 024–1 292)	800	(730–880)
2021	103	(31–380)	1 059	(915–1 227)	1 045	(927–1 176)
2022	136	(56–366)	1 174	(1 022–1 364)	944	(839–1 060)

Table A4: continued

(b) Non–QMS fish species

FY		AUCK		CHAT		COOK		EAST
2003	227	(152–345)	16 781	(15 289–18 648)	1 628	(1 257–2 131)	230	(114–456)
2004	45	(24–83)	13 280	(11 843–14 948)	52	(37–73)	49	(14–160)
2005	144	(55–400)	9 783	(8 837–10 893)	158	(115–215)	20	(7–59)
2006	15	(5–47)	9 885	(8 767–11 362)	99	(53–186)	27	(8–98)
2007	54	(19–161)	8 489	(7 591–9 584)	63	(47–85)	102	(44–245)
2008	63	(37–111)	10 841	(9 583–12 405)	153	(112–212)	42	(13–144)
2009	35	(21–65)	8 779	(7 793–9 926)	80	(54–119)	59	(16–186)
2010	34	(11–116)	14 887	(13 056–17 278)	278	(212–381)	101	(33–320)
2011	63	(36–114)	8 498	(7 558–9 615)	36	(25–54)	72	(24–220)
2012	27	(11–63)	6 545	(5 898–7 285)	97	(75–132)	62	(21–185)
2013	40	(21–83)	9 359	(8 508–10 319)	228	(174–304)	72	(22–246)
2014	98	(64–159)	6 237	(5 755–6 811)	202	(164–250)	63	(38–102)
2015	134	(76–243)	11 096	(9 758–12 528)	154	(125–194)	117	(76–184)
2016	54	(27–116)	11 436	(10 277–12 771)	88	(65–121)	124	(41–371)
2017	97	(54–193)	12 922	(11 541–14 659)	35	(25–51)	87	(50–153)
2018	180	(113–306)	11 561	(10 423–12 930)	41	(32–55)	135	(57–309)
2019	84	(44–175)	8 810	(7 861–9 830)	51	(39–71)	156	(50–519)
2020	23	(10–59)	5 514	(4 945–6 176)	12	(8–17)	51	(24–111)
2021	80	(52–133)	6 602	(6 055–7 207)	10	(7–17)	22	(7–64)
2022	35	(18–72)	6 807	(6 201–7 508)	31	(22–44)	10	(4–29)

FY		NORTH		PUYS		STEW		SUBA
2003	95	(28–308)	590	(424–856)	2 252	(1 964–2 595)	907	(714–1 148)
2004	44	(14–147)	129	(89–185)	767	(629–952)	368	(287–480)
2005	36	(11–129)	92	(59–148)	902	(731–1 101)	595	(340–1 067)
2006	47	(15–145)	537	(352–829)	491	(412–592)	57	(20–165)
2007	56	(16–187)	83	(56–132)	723	(622–862)	376	(192–728)
2008	71	(19–244)	186	(93–377)	896	(766–1 072)	359	(263–503)
2009	57	(18–200)	116	(75–188)	930	(809–1 087)	170	(122–244)
2010	151	(51–453)	240	(151–399)	966	(826–1 147)	261	(133–553)
2011	73	(29–184)	172	(111–277)	807	(691–949)	101	(68–153)
2012	80	(22–263)	370	(258–549)	660	(575–764)	52	(31–88)
2013	136	(43–437)	343	(244–502)	1 107	(981–1 255)	49	(34–71)
2014	116	(74–180)	331	(232–466)	1 429	(1 298–1 587)	106	(83–137)
2015	151	(105–224)	349	(241–528)	1 573	(1 381–1 805)	189	(126–300)
2016	210	(117–388)	736	(523–1072)	870	(739–1 037)	79	(40–165)
2017	205	(126–344)	438	(287–689)	960	(810–1 146)	362	(234–576)
2018	198	(119–333)	389	(263–604)	2 024	(1 785–2 321)	851	(688–1 080)
2019	203	(119–355)	442	(309–646)	1 412	(1 199–1 672)	485	(340–730)
2020	128	(90–181)	255	(154–433)	1 050	(895–1 243)	728	(526–1 042)
2021	213	(134–342)	259	(182–380)	1 193	(1 044–1 363)	275	(206–385)
2022	241	(151–383)	342	(251–463)	933	(812–1 076)	145	(101–202)

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	18	(4–83)	1 514	(1 323–1 748)	570	(502–655)
2004	8	(2–33)	798	(686–933)	353	(315–400)
2005	4	(1–22)	435	(368–521)	258	(230–289)
2006	28	(7–112)	865	(737–1 016)	228	(195–267)
2007	18	(7–59)	574	(437–741)	163	(138–195)
2008	46	(11–172)	1 801	(1 506–2 168)	106	(84–137)
2009	36	(10–137)	2 194	(1 687–2 789)	60	(49–73)
2010	13	(3–62)	518	(425–643)	96	(72–128)
2011	10	(2–49)	722	(606–856)	76	(61–96)
2012	12	(5–33)	453	(387–535)	77	(65–92)
2013	24	(6–84)	1 579	(1 381–1 823)	142	(125–163)
2014	18	(5–66)	1 816	(1 639–2 034)	232	(210–257)
2015	21	(5–98)	3 123	(2 736–3 613)	267	(236–300)
2016	18	(5–87)	2 234	(1 923–2 614)	388	(345–443)
2017	32	(10–113)	1 612	(1 414–1 854)	193	(164–230)
2018	35	(8–145)	1 578	(1 403–1 778)	438	(388–499)
2019	10	(2–53)	891	(748–1 082)	314	(274–362)
2020	17	(4–78)	523	(447–607)	261	(227–296)
2021	8	(2–30)	348	(297–406)	171	(147–199)
2022	20	(7–63)	530	(451–625)	247	(216–288)

Table A4: continued

(c) Non–QMS invertebrate species

FY		AUCK		CHAT		COOK		EAST
2003	23	(13–40)	399	(348–464)	5	(3–9)	4	(1–10)
2004	7	(4–14)	421	(363–488)	7	(4–11)	2	(1–8)
2005	14	(5–37)	189	(168–213)	7	(4–11)	2	(1–6)
2006	2	(1–6)	273	(235–317)	3	(2–6)	1	(0–4)
2007	3	(1–11)	246	(210–292)	4	(3–7)	2	(1–7)
2008	7	(5–12)	266	(238–299)	8	(5–12)	1	(0–5)
2009	7	(4–13)	128	(110–153)	6	(4–11)	2	(1–8)
2010	3	(1–9)	286	(252–327)	4	(3–6)	3	(1–8)
2011	6	(3–12)	303	(256–363)	4	(2–8)	5	(2–14)
2012	3	(1–10)	156	(137–180)	2	(2–4)	2	(1–6)
2013	7	(3–15)	253	(224–284)	5	(3–8)	3	(1–11)
2014	20	(12–33)	130	(116–144)	5	(4–8)	4	(2–6)
2015	11	(6–20)	371	(328–424)	5	(4–7)	3	(2–5)
2016	10	(5–23)	270	(235–311)	4	(3–7)	4	(1–14)
2017	4	(2–9)	441	(386–509)	3	(2–4)	4	(2–7)
2018	5	(3–9)	134	(115–158)	1	(0–2)	1	(1–4)
2019	2	(1–4)	92	(80–108)	1	(0–1)	1	(0–3)
2020	1	(0–2)	74	(65–85)	1	(0–2)	0	(0–1)
2021	3	(2–6)	86	(76–98)	0	(0–1)	0	(0–1)
2022	1	(1–3)	87	(77–98)	1	(0–1)	0	(0–1)

FY		NORTH		PUYS		STEW		SUBA
2003	1	(0–5)	20	(13–32)	158	(131–193)	160	(118–218)
2004	2	(1–6)	8	(5–13)	138	(108–175)	52	(39–69)
2005	1	(0–4)	17	(11–28)	200	(163–246)	39	(22–69)
2006	2	(1–7)	46	(29–74)	196	(162–243)	10	(3–29)
2007	2	(1–6)	28	(17–47)	226	(187–278)	28	(13–58)
2008	2	(1–6)	22	(11–42)	204	(177–236)	40	(30–53)
2009	2	(1–7)	21	(13–36)	210	(178–250)	24	(17–35)
2010	4	(2–11)	19	(12–30)	264	(231–302)	18	(10–33)
2011	4	(2–13)	46	(26–83)	288	(233–362)	18	(11–33)
2012	3	(1–9)	29	(19–47)	178	(150–217)	8	(5–15)
2013	5	(2–17)	37	(25–58)	365	(319–419)	27	(18–41)
2014	4	(2–7)	38	(26–60)	424	(379–481)	23	(17–31)
2015	6	(4–10)	38	(26–58)	722	(628–836)	34	(21–56)
2016	5	(3–10)	70	(49–109)	441	(369–547)	8	(4–20)
2017	6	(4–10)	51	(33–81)	554	(469–666)	19	(12–31)
2018	1	(0–2)	2	(1–4)	81	(69–96)	61	(47–83)
2019	2	(1–4)	4	(2–6)	52	(43–63)	32	(22–48)
2020	2	(1–3)	6	(3–12)	62	(53–75)	16	(12–23)
2021	1	(0–4)	3	(2–5)	62	(53–73)	12	(9–18)
2022	1	(0–1)	3	(2–4)	47	(41–54)	8	(6–12)

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	0	(0–1)	208	(170–255)	43	(34–55)
2004	0	(0–2)	165	(139–197)	78	(65–94)
2005	0	(0–1)	82	(68–99)	23	(20–27)
2006	1	(0–4)	141	(119–170)	13	(10–16)
2007	1	(0–3)	143	(107–197)	26	(20–34)
2008	1	(0–5)	132	(112–157)	11	(9–13)
2009	1	(0–6)	156	(121–207)	13	(10–17)
2010	0	(0–2)	56	(47–67)	28	(21–36)
2011	0	(0–3)	164	(128–213)	31	(22–43)
2012	0	(0–1)	111	(91–135)	35	(28–45)
2013	1	(0–3)	153	(131–181)	31	(26–38)
2014	1	(0–3)	214	(189–248)	34	(29–39)
2015	1	(0–3)	378	(329–436)	74	(65–84)
2016	0	(0–3)	252	(211–304)	60	(51–72)
2017	1	(0–2)	182	(158–214)	58	(49–72)
2018	0	(0–1)	38	(32–45)	5	(4–7)
2019	0	(0–0)	12	(10–16)	6	(5–9)
2020	0	(0–1)	11	(9–14)	5	(4–6)
2021	0	(0–0)	3	(2–4)	4	(3–6)
2022	0	(0–1)	8	(6–9)	4	(3–5)

Table A4: continued

(d) ALL species

FY		AUCK		CHAT		COOK		EAST
2003	473	(326–685)	26 356	(24 061–28 891)	1 529	(1 227–1 935)	660	(363–1 181)
2004	360	(213–610)	28 615	(25 485–31 984)	1 259	(985–1 598)	658	(261–1 610)
2005	484	(229–1085)	17 018	(15 566–18 746)	1 328	(1 097–1 654)	497	(205–1 208)
2006	73	(30–171)	18 755	(16 874–20 861)	819	(608–1 113)	264	(97–656)
2007	109	(45–283)	15 726	(14 270–17 406)	635	(520–779)	399	(203–801)
2008	187	(128–274)	15 658	(14 362–17 199)	1 260	(1 033–1 516)	351	(138–927)
2009	166	(105–287)	14 452	(12 971–16 139)	637	(506–808)	594	(247–1 456)
2010	74	(31–192)	22 542	(20 151–25 228)	645	(537–790)	504	(209–1 167)
2011	206	(129–337)	14 814	(13 392–16 442)	503	(387–658)	658	(276–1 526)
2012	82	(42–168)	13 161	(12 042–14 415)	546	(447–671)	503	(229–1 122)
2013	163	(89–313)	17 006	(15 690–18 477)	757	(614–936)	614	(243–1 557)
2014	372	(250–576)	15 491	(14 258–16 774)	800	(664–968)	1 020	(649–1 611)
2015	286	(177–464)	25 090	(22 602–28 042)	735	(630–865)	1 105	(777–1 619)
2016	176	(103–309)	18 088	(16 497–19 819)	286	(228–359)	652	(283–1 531)
2017	175	(107–280)	18 699	(17 165–20 338)	228	(180–290)	696	(466–1 058)
2018	323	(219–487)	16 615	(15 240–18 103)	257	(213–312)	606	(304–1 147)
2019	221	(130–376)	12 642	(11 569–13 788)	282	(235–341)	715	(306–1 622)
2020	61	(34–115)	7 049	(6 570–7 632)	63	(53–76)	185	(107–316)
2021	182	(122–278)	9 730	(9 110–10 466)	107	(83–139)	211	(91–482)
2022	126	(72–239)	10 451	(9 647–11 292)	135	(109–172)	274	(129–604)

FY		NORTH		PUYS		STEW		SUBA
2003	149	(61–354)	1 785	(1 302–2 453)	4 399	(3 857–5 000)	1 844	(1 476–2 325)
2004	203	(82–520)	1 080	(784–1 552)	2 360	(1 931–2 882)	1 791	(1 406–2 286)
2005	138	(54–357)	901	(665–1 240)	2 824	(2 367–3 363)	1 095	(672–1 831)
2006	205	(83–482)	1 690	(1 209–2 419)	2 792	(2 408–3 263)	176	(77–409)
2007	161	(63–403)	1 106	(746–1 635)	5 169	(4 501–5 932)	673	(379–1 221)
2008	186	(77–456)	710	(427–1 210)	2 782	(2 479–3 131)	1 117	(877–1 429)
2009	198	(79–524)	1 132	(758–1 717)	4 494	(3 960–5 156)	775	(589–1 048)
2010	283	(129–610)	1 364	(948–1 984)	3 918	(3 485–4 450)	414	(240–735)
2011	194	(92–390)	1 497	(1 012–2 217)	3 455	(3 040–3 950)	413	(294–595)
2012	219	(89–535)	1 081	(801–1 488)	2 410	(2 134–2 737)	155	(103–246)
2013	394	(160–990)	1 525	(1 127–2 106)	5 224	(4 694–5 800)	189	(138–265)
2014	230	(150–357)	1 538	(1 100–2 192)	10 242	(9 276–11 324)	505	(392–647)
2015	309	(220–437)	1 176	(860–1 662)	10 057	(8 978–11 314)	618	(422–912)
2016	419	(248–693)	1 731	(1 291–2 352)	4 281	(3 707–4 932)	189	(105–353)
2017	404	(273–604)	1 251	(909–1 764)	7 580	(6 703–8 641)	576	(407–821)
2018	459	(300–715)	553	(400–767)	4 261	(3 880–4 708)	1 255	(1 051–1 504)
2019	420	(273–650)	805	(598–1 093)	4 116	(3 610–4 742)	839	(633–1 118)
2020	409	(315–525)	665	(450–976)	2 556	(2 304–2 869)	904	(719–1 142)
2021	680	(453–1014)	807	(609–1 080)	3 072	(2 777–3 430)	610	(477–784)
2022	532	(367–795)	1 211	(936–1 531)	2 910	(2 622–3 262)	403	(307–541)

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	82	(24–263)	3 693	(3 222–4 235)	2 890	(2 565–3 257)
2004	104	(35–336)	4 485	(3 866–5 202)	2 368	(2 144–2 635)
2005	74	(22–272)	3 119	(2 684–3 642)	1 447	(1 306–1 611)
2006	270	(100–749)	3 947	(3 417–4 469)	1 095	(960–1 244)
2007	100	(40–257)	2 175	(1 784–2 681)	1 127	(984–1 306)
2008	354	(122–984)	4 496	(3 953–5 116)	710	(609–827)
2009	299	(109–833)	5 180	(4 047–6 464)	526	(448–626)
2010	73	(22–245)	1 654	(1 423–1 946)	459	(373–570)
2011	106	(35–340)	3 346	(2 890–3 870)	885	(754–1 038)
2012	71	(33–157)	2 362	(2 091–2 704)	856	(755–969)
2013	185	(64–547)	4 433	(3 919–5 001)	1 131	(1 021–1 259)
2014	167	(59–487)	5 434	(4 854–6 123)	1 367	(1 253–1 511)
2015	155	(51–507)	6 251	(5 584–6 990)	2 045	(1 864–2 252)
2016	73	(24–254)	5 849	(5 137–6 635)	1 869	(1 696–2 064)
2017	204	(81–514)	3 977	(3 611–4 397)	1 285	(1 163–1 431)
2018	175	(56–521)	3 689	(3 361–4 079)	1 595	(1 457–1 748)
2019	80	(23–286)	2 670	(2 300–3 088)	1 673	(1 524–1 849)
2020	98	(34–279)	1 637	(1 482–1 812)	1 057	(973–1 148)
2021	140	(46–406)	1 376	(1 217–1 573)	1 130	(1 019–1 255)
2022	179	(75–433)	1 730	(1 518–1 972)	1 149	(1 039–1 280)

Table A2: Estimates of annual discards (rounded to the nearest tonne) in the hoki, hake, ling, silver warehou, and white warehou target trawl fishery, by species category and standard area. 95% confidence intervals in parentheses.

(a) Hoki, hake, ling, silver warehou, white warehou

FY	AUCK		CHAT		COOK		EAST	
2003	2	(0–44)	281	(104–822)	8	(1–120)	0	(0–0)
2004	0	(0–5)	326	(127–865)	7	(1–42)	0	(0–0)
2005	0	(0–6)	313	(135–781)	14	(2–73)	0	(0–0)
2006	0	(0–2)	35	(11–123)	2	(0–25)	0	(0–0)
2007	1	(0–24)	161	(65–458)	88	(13–728)	0	(0–1)
2008	0	(0–1)	42	(16–123)	2	(0–26)	0	(0–0)
2009	0	(0–0)	207	(112–402)	9	(2–49)	0	(0–0)
2010	0	(0–4)	189	(136–272)	150	(43–538)	0	(0–1)
2011	0	(0–5)	178	(110–320)	33	(8–159)	0	(0–3)
2012	0	(0–3)	179	(110–305)	168	(45–667)	0	(0–3)
2013	0	(0–0)	101	(58–218)	24	(4–164)	0	(0–1)
2014	0	(0–3)	66	(38–136)	307	(52–1 739)	0	(0–9)
2015	1	(0–4)	305	(233–409)	962	(299–3 133)	1	(0–14)
2016	0	(0–6)	63	(40–111)	526	(211–1 396)	0	(0–16)
2017	1	(0–9)	115	(75–192)	1 134	(283–4 767)	1	(0–29)
2018	0	(0–1)	5	(0–130)	0	(0–28)	0	(0–0)
2019	0	(0–0)	3	(0–28)	2	(0–23)	0	(0–0)
2020	0	(0–0)	0	(0–15)	0	(0–13)	0	(0–0)
2021	0	(0–0)	0	(0–2)	0	(0–7)	0	(0–0)
2022	0	(0–0)	0	(0–18)	0	(0–24)	0	(0–0)

FY	NORTH		PUYS		STEW		SUBA	
2003	0	(0–0)	72	(16–442)	49	(17–165)	1	(0–10)
2004	0	(0–0)	29	(9–97)	38	(8–142)	1	(0–6)
2005	0	(0–0)	84	(18–449)	40	(11–155)	2	(0–11)
2006	0	(0–0)	12	(4–43)	9	(3–26)	0	(0–1)
2007	0	(0–0)	121	(44–410)	563	(278–1385)	6	(1–51)
2008	0	(0–0)	19	(3–128)	68	(17–346)	1	(0–11)
2009	0	(0–0)	9	(4–27)	152	(99–262)	1	(0–7)
2010	0	(0–0)	19	(11–34)	78	(59–109)	1	(0–7)
2011	0	(0–0)	28	(10–88)	350	(224–663)	0	(0–5)
2012	0	(0–1)	25	(12–60)	220	(159–330)	2	(0–16)
2013	0	(0–1)	53	(23–165)	197	(132–351)	1	(0–13)
2014	0	(0–2)	90	(40–253)	533	(390–816)	3	(1–13)
2015	0	(0–3)	85	(49–157)	476	(381–615)	1	(0–3)
2016	0	(0–2)	110	(61–237)	158	(116–229)	0	(0–1)
2017	0	(0–2)	92	(48–194)	460	(346–655)	7	(3–21)
2018	0	(0–0)	1	(0–72)	21	(2–300)	0	(0–12)
2019	0	(0–0)	8	(1–45)	27	(7–104)	0	(0–2)
2020	0	(0–0)	0	(0–30)	9	(1–131)	0	(0–3)
2021	0	(0–0)	0	(0–11)	5	(1–35)	0	(0–1)
2022	0	(0–0)	6	(0–134)	15	(2–251)	0	(0–1)

Hoki, hake, ling, silver warehou, white warehou continued.

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	0	(0–0)	270	(141–616)	383	(219–803)
2004	0	(0–0)	82	(47–155)	302	(194–514)
2005	0	(0–0)	140	(79–283)	64	(33–144)
2006	0	(0–0)	74	(29–224)	16	(6–55)
2007	0	(0–0)	867	(346–2 446)	717	(315–1 951)
2008	0	(0–0)	35	(17–88)	1	(0–14)
2009	0	(0–0)	124	(61–265)	25	(12–57)
2010	0	(0–0)	73	(49–116)	31	(15–65)
2011	0	(0–0)	436	(214–1 010)	208	(99–572)
2012	0	(0–1)	316	(205–524)	65	(30–163)
2013	0	(0–1)	391	(265–634)	156	(79–350)
2014	0	(0–2)	397	(290–583)	179	(111–347)
2015	0	(0–3)	492	(402–629)	194	(127–305)
2016	0	(0–1)	748	(567–1 036)	209	(128–369)
2017	0	(0–4)	548	(428–725)	227	(139–381)
2018	0	(0–0)	34	(3–543)	0	(0–5)
2019	0	(0–0)	20	(7–63)	0	(0–5)
2020	0	(0–0)	10	(1–162)	0	(0–2)
2021	0	(0–0)	3	(0–38)	0	(0–1)
2022	0	(0–0)	17	(2–285)	0	(0–9)

Table A5: continued

(b) QMS species

FY		AUCK		CHAT		COOK		EAST
2003	1	(0–5)	72	(41–141)	11	(3–41)	0	(0–2)
2004	249	(70–843)	729	(597–901)	784	(568–1 091)	21	(4–127)
2005	9	(2–44)	500	(380–672)	568	(398–835)	4	(1–22)
2006	8	(2–54)	686	(539–909)	539	(300–983)	5	(1–30)
2007	7	(1–53)	276	(206–389)	612	(430–886)	7	(2–42)
2008	4	(1–16)	369	(270–524)	846	(599–1 269)	3	(1–18)
2009	5	(1–32)	303	(211–453)	1 062	(729–1 710)	8	(1–45)
2010	2	(0–14)	194	(153–257)	231	(178–311)	3	(1–21)
2011	3	(0–31)	650	(438–1093)	515	(312–914)	7	(1–47)
2012	3	(0–24)	876	(655–1212)	424	(305–611)	10	(2–52)
2013	8	(2–43)	234	(180–322)	202	(142–309)	10	(2–61)
2014	8	(2–41)	418	(327–563)	316	(231–438)	12	(5–29)
2015	19	(7–59)	331	(257–433)	115	(89–152)	8	(3–23)
2016	18	(6–54)	312	(248–391)	192	(147–254)	16	(4–71)
2017	13	(3–58)	545	(396–776)	222	(157–325)	24	(12–58)
2018	6	(1–29)	305	(222–445)	265	(188–384)	7	(1–35)
2019	5	(1–24)	413	(311–587)	255	(184–368)	10	(2–53)
2020	0	(0–4)	229	(149–402)	53	(36–84)	1	(0–6)
2021	6	(1–33)	183	(125–290)	116	(68–218)	3	(1–23)
2022	3	(0–16)	385	(282–576)	93	(62–153)	3	(0–14)

FY		NORTH		PUYS		STEW		SUBA
2003	0	(0–1)	2	(0–9)	13	(7–25)	6	(2–20)
2004	8	(2–38)	69	(36–140)	288	(180–482)	1072	(631–1832)
2005	1	(0–8)	68	(39–125)	100	(64–162)	32	(12–83)
2006	6	(1–30)	41	(21–89)	183	(136–264)	10	(2–51)
2007	4	(1–26)	79	(33–204)	646	(467–949)	68	(22–236)
2008	2	(0–14)	39	(14–122)	78	(52–122)	23	(12–50)
2009	3	(1–24)	18	(8–48)	467	(317–757)	109	(39–333)
2010	4	(1–18)	20	(11–38)	194	(149–260)	16	(4–63)
2011	4	(1–21)	9	(4–31)	167	(109–285)	5	(1–27)
2012	7	(1–41)	11	(5–25)	99	(72–145)	19	(4–95)
2013	9	(2–44)	20	(10–49)	389	(293–573)	13	(5–42)
2014	9	(4–23)	11	(6–26)	542	(427–721)	15	(8–35)
2015	8	(4–18)	20	(11–41)	623	(491–839)	31	(14–78)
2016	12	(6–27)	24	(15–42)	179	(138–239)	5	(1–22)
2017	26	(12–57)	48	(26–101)	516	(391–702)	20	(10–47)
2018	1	(0–4)	12	(5–34)	413	(301–623)	52	(32–97)
2019	7	(2–26)	19	(10–42)	367	(263–551)	24	(12–51)
2020	2	(1–6)	4	(2–12)	90	(62–149)	16	(8–37)
2021	8	(2–30)	11	(5–32)	316	(213–555)	34	(18–86)
2022	6	(2–21)	13	(7–28)	207	(145–323)	38	(19–91)

QMS species continued.

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	0	(0–1)	28	(16–49)	81	(52–138)
2004	4	(0–45)	126	(98–168)	237	(196–291)
2005	0	(0–4)	134	(94–201)	60	(45–82)
2006	7	(1–77)	456	(336–670)	103	(76–145)
2007	4	(0–48)	261	(138–519)	219	(155–333)
2008	4	(0–38)	108	(73–170)	37	(25–62)
2009	6	(0–68)	88	(52–164)	85	(55–156)
2010	1	(0–9)	37	(27–54)	47	(31–71)
2011	1	(0–17)	56	(33–107)	162	(96–302)
2012	5	(0–49)	388	(274–574)	335	(249–480)
2013	4	(0–58)	236	(172–355)	341	(260–478)
2014	3	(0–28)	75	(56–106)	318	(259–407)
2015	3	(0–28)	276	(215–366)	528	(439–651)
2016	2	(0–14)	314	(245–412)	242	(206–292)
2017	8	(1–60)	219	(171–291)	382	(306–488)
2018	3	(0–32)	82	(58–128)	306	(235–424)
2019	1	(0–14)	58	(38–97)	219	(176–283)
2020	1	(0–8)	11	(6–20)	98	(73–141)
2021	1	(0–17)	13	(7–27)	100	(70–156)
2022	2	(0–31)	46	(30–83)	152	(111–230)

Table A5: continued

(c) Non–QMS fish species

FY		AUCK		CHAT		COOK		EAST
2003	137	(77–262)	8 896	(7 671–10 486)	1 574	(1 169–2 197)	63	(25–160)
2004	4	(1–12)	3 095	(2 589–3 724)	40	(26–61)	23	(5–101)
2005	21	(6–92)	1 087	(900–1 333)	145	(99–216)	25	(6–96)
2006	6	(1–37)	1 204	(988–1 532)	57	(23–141)	16	(3–76)
2007	4	(1–34)	1 375	(1 097–1 760)	62	(46–88)	22	(8–62)
2008	1	(0–2)	3 716	(3 099–4 545)	53	(39–76)	12	(3–50)
2009	1	(0–9)	7 373	(6 079–9 103)	46	(30–72)	28	(7–104)
2010	3	(1–27)	2 548	(2 085–3 227)	107	(83–140)	55	(19–164)
2011	2	(0–10)	2 647	(2 150–3 266)	14	(9–20)	31	(9–105)
2012	1	(0–7)	921	(746–1 155)	77	(58–104)	29	(9–95)
2013	1	(0–5)	1 315	(1 109–1 616)	125	(95–165)	35	(9–150)
2014	1	(0–4)	804	(664–1 014)	125	(99–164)	38	(22–67)
2015	10	(4–26)	1 709	(1 447–2 069)	95	(80–114)	13	(8–20)
2016	1	(0–3)	538	(438–679)	75	(56–101)	53	(15–190)
2017	8	(2–35)	836	(659–1 078)	29	(21–40)	45	(27–76)
2018	8	(2–38)	1 320	(996–1 950)	42	(31–59)	79	(29–217)
2019	6	(1–32)	583	(450–789)	54	(39–76)	91	(25–383)
2020	0	(0–4)	102	(68–168)	9	(6–14)	11	(4–31)
2021	5	(2–21)	364	(282–491)	7	(5–12)	13	(3–50)
2022	1	(0–6)	335	(270–427)	23	(17–32)	5	(1–14)

FY		NORTH		PUYS		STEW		SUBA
2003	48	(12–196)	541	(304–963)	1 712	(1 406–2 187)	349	(248–518)
2004	20	(4–84)	154	(94–278)	426	(313–606)	41	(26–69)
2005	20	(5–87)	294	(145–581)	669	(484–950)	313	(151–676)
2006	40	(8–161)	1 481	(847–2 690)	461	(346–649)	52	(12–217)
2007	25	(6–105)	111	(58–219)	357	(274–482)	210	(72–601)
2008	20	(5–82)	163	(73–378)	255	(187–351)	86	(55–141)
2009	30	(7–132)	54	(30–102)	407	(320–526)	146	(67–316)
2010	73	(22–237)	224	(131–404)	174	(139–227)	101	(28–381)
2011	44	(18–121)	63	(36–113)	289	(232–372)	10	(3–32)
2012	39	(8–167)	184	(115–323)	251	(202–324)	45	(11–201)
2013	66	(16–274)	198	(121–338)	404	(334–509)	19	(9–43)
2014	75	(44–130)	92	(54–166)	477	(396–591)	15	(8–30)
2015	62	(44–89)	125	(82–208)	487	(414–575)	47	(25–98)
2016	88	(50–164)	299	(189–492)	189	(146–250)	3	(1–11)
2017	71	(46–112)	142	(85–248)	241	(198–305)	112	(63–213)
2018	62	(33–128)	46	(21–117)	627	(472–923)	1 104	(751–1 824)
2019	117	(66–220)	206	(114–425)	458	(336–674)	317	(180–625)
2020	59	(38–98)	33	(13–111)	416	(300–639)	734	(442–1397)
2021	56	(31–105)	46	(25–98)	155	(116–215)	205	(131–352)
2022	51	(30–88)	99	(65–165)	314	(250–408)	117	(78–199)

Non–QMS fish species continued.

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	11	(2–68)	1 269	(1 023–1 583)	334	(277–409)
2004	4	(1–22)	688	(548–891)	259	(206–334)
2005	2	(0–17)	487	(384–633)	52	(40–70)
2006	17	(3–108)	1 704	(1 356–2 210)	63	(46–90)
2007	13	(4–59)	1 194	(792–1 826)	96	(69–141)
2008	13	(3–69)	1 205	(980–1 501)	3	(2–5)
2009	17	(4–90)	1 254	(927–1 688)	27	(19–41)
2010	5	(1–34)	731	(549–983)	21	(13–35)
2011	4	(1–22)	1 161	(908–1 531)	8	(5–12)
2012	4	(1–13)	622	(495–805)	12	(7–20)
2013	13	(3–58)	1 008	(823–1 267)	32	(25–44)
2014	7	(1–42)	951	(790–1 175)	25	(19–33)
2015	7	(1–41)	1 326	(1 139–1 561)	18	(14–23)
2016	9	(2–44)	904	(723–1 157)	13	(10–18)
2017	13	(4–47)	718	(607–869)	14	(11–19)
2018	18	(3–113)	1 098	(839–1 554)	12	(8–20)
2019	4	(1–26)	393	(282–584)	8	(6–11)
2020	5	(1–40)	351	(250–547)	4	(2–8)
2021	3	(1–16)	216	(161–322)	2	(2–4)
2022	8	(2–30)	264	(205–358)	6	(4–9)

Table A5: continued

(d) Non–QMS invertebrate species

FY		AUCK		CHAT		COOK		EAST
2003	18	(9–41)	257	(213–317)	2	(1–6)	2	(0–7)
2004	1	(0–4)	267	(216–339)	0	(0–1)	1	(0–3)
2005	1	(0–4)	89	(73–114)	0	(0–1)	0	(0–2)
2006	1	(0–5)	158	(128–206)	1	(0–5)	1	(0–2)
2007	1	(0–3)	69	(55–87)	1	(1–3)	1	(0–3)
2008	1	(0–2)	72	(59–93)	2	(1–6)	1	(0–2)
2009	0	(0–1)	75	(60–93)	1	(0–3)	1	(0–2)
2010	0	(0–1)	46	(39–55)	1	(0–1)	1	(0–2)
2011	0	(0–1)	60	(47–77)	0	(0–1)	1	(0–3)
2012	0	(0–1)	15	(11–20)	0	(0–1)	0	(0–1)
2013	0	(0–0)	21	(18–24)	1	(0–1)	0	(0–2)
2014	0	(0–0)	12	(10–15)	1	(1–2)	1	(0–1)
2015	1	(0–3)	28	(24–34)	1	(1–1)	0	(0–1)
2016	1	(0–2)	20	(16–26)	1	(0–3)	1	(0–3)
2017	1	(0–2)	17	(14–22)	0	(0–1)	1	(0–1)
2018	0	(0–1)	16	(12–23)	0	(0–1)	1	(0–3)
2019	0	(0–0)	6	(4–10)	0	(0–1)	0	(0–1)
2020	0	(0–1)	2	(1–3)	0	(0–0)	0	(0–0)
2021	0	(0–1)	5	(4–8)	0	(0–0)	0	(0–0)
2022	0	(0–0)	7	(5–9)	0	(0–0)	0	(0–0)

FY		NORTH		PUYS		STEW		SUBA
2003	1	(0–2)	8	(3–19)	84	(66–109)	46	(31–69)
2004	0	(0–2)	3	(2–6)	50	(36–71)	47	(31–72)
2005	0	(0–1)	3	(2–7)	121	(86–174)	31	(16–61)
2006	1	(0–4)	14	(6–30)	67	(51–94)	8	(2–30)
2007	0	(0–2)	9	(5–19)	45	(34–60)	19	(7–49)
2008	1	(0–2)	6	(3–15)	42	(32–56)	25	(17–41)
2009	0	(0–1)	2	(1–4)	37	(29–48)	10	(5–20)
2010	0	(0–1)	4	(3–6)	36	(30–43)	4	(1–10)
2011	1	(0–2)	4	(2–7)	43	(35–56)	1	(0–2)
2012	0	(0–1)	2	(1–3)	31	(25–39)	4	(1–12)
2013	1	(0–2)	2	(1–3)	44	(38–52)	2	(1–3)
2014	0	(0–1)	2	(1–3)	54	(47–64)	1	(1–2)
2015	1	(0–1)	1	(1–2)	72	(62–84)	4	(2–6)
2016	0	(0–1)	5	(3–9)	32	(26–41)	1	(0–2)
2017	1	(0–1)	2	(1–4)	43	(36–52)	4	(3–7)
2018	0	(0–1)	0	(0–1)	28	(22–37)	23	(17–34)
2019	1	(1–3)	1	(1–2)	16	(12–24)	17	(10–34)
2020	1	(0–1)	0	(0–1)	24	(18–33)	11	(7–19)
2021	0	(0–1)	0	(0–1)	17	(13–23)	7	(5–12)
2022	0	(0–1)	1	(0–1)	17	(14–20)	5	(3–7)

Non–QMS invertebrate species continued.

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	0	(0–0)	32	(23–43)	11	(7–16)
2004	0	(0–0)	17	(12–23)	11	(7–16)
2005	0	(0–0)	10	(7–15)	2	(1–4)
2006	0	(0–1)	28	(21–39)	7	(4–12)
2007	0	(0–1)	16	(10–26)	4	(2–7)
2008	0	(0–1)	48	(38–61)	0	(0–1)
2009	0	(0–1)	23	(17–31)	1	(1–2)
2010	0	(0–0)	6	(5–8)	1	(0–1)
2011	0	(0–0)	24	(18–33)	1	(0–1)
2012	0	(0–0)	13	(10–17)	0	(0–1)
2013	0	(0–0)	14	(12–16)	1	(1–1)
2014	0	(0–0)	19	(16–23)	1	(1–2)
2015	0	(0–0)	33	(29–40)	2	(1–3)
2016	0	(0–0)	26	(21–33)	2	(1–3)
2017	0	(0–0)	21	(17–25)	1	(1–1)
2018	0	(0–1)	19	(15–26)	1	(0–3)
2019	0	(0–0)	3	(2–5)	0	(0–1)
2020	0	(0–0)	4	(3–5)	0	(0–2)
2021	0	(0–0)	1	(1–2)	0	(0–1)
2022	0	(0–0)	3	(2–3)	0	(0–1)

Table A5: continued

(e) ALL species

FY		AUCK		CHAT		COOK		EAST
2003	236	(125–499)	15 042	(12 723–18 390)	1 987	(1 462–2 772)	73	(28–199)
2004	184	(67–564)	9 192	(7 618–11 337)	1 296	(952–1 784)	81	(17–404)
2005	53	(14–235)	3 489	(2 884–4 342)	693	(522–946)	38	(8–177)
2006	56	(12–332)	3 636	(2 974–4 603)	669	(388–1 193)	30	(7–141)
2007	19	(3–155)	2 870	(2 232–3 922)	674	(496–963)	35	(11–134)
2008	4	(2–12)	7 217	(5 953–8 981)	858	(655–1 151)	23	(5–104)
2009	3	(1–15)	12 684	(9 967–17 065)	990	(731–1 432)	43	(9–215)
2010	7	(1–48)	3 871	(3 243–4 792)	348	(288–424)	45	(15–141)
2011	1	(0–3)	5 169	(3 860–7 117)	661	(452–1 009)	44	(11–175)
2012	6	(1–33)	3 004	(2 374–3 866)	653	(484–893)	48	(13–178)
2013	9	(3–28)	1 694	(1 391–2 193)	342	(265–444)	44	(10–228)
2014	1	(0–2)	1 687	(1 367–2 215)	512	(408–658)	63	(34–118)
2015	34	(16–89)	2 691	(2 237–3 226)	216	(186–252)	11	(7–17)
2016	15	(6–51)	910	(736–1 203)	368	(280–483)	103	(24–406)
2017	21	(5–118)	864	(655–1 238)	301	(220–414)	113	(62–217)
2018	16	(5–69)	2 011	(1 477–2 964)	371	(280–500)	100	(31–304)
2019	7	(2–25)	1 062	(832–1 470)	383	(297–497)	100	(26–405)
2020	1	(0–9)	222	(150–380)	98	(69–143)	16	(6–54)
2021	23	(8–111)	687	(513–973)	118	(74–194)	25	(6–123)
2022	5	(2–27)	905	(720–1 230)	138	(102–193)	7	(2–24)

FY		NORTH		PUYS		STEW		SUBA
2003	46	(9–225)	817	(442–1 613)	3 175	(2 462–4 220)	691	(465–1 106)
2004	66	(15–307)	254	(151–452)	1 188	(854–1 703)	2 495	(1 531–4 196)
2005	28	(7–133)	622	(376–1 062)	2 112	(1 513–3 063)	676	(332–1 451)
2006	68	(14–319)	1 875	(1 112–3 297)	1 844	(1 417–2 541)	141	(36–598)
2007	52	(11–249)	444	(217–1 015)	4 925	(3 698–7 087)	477	(155–1 613)
2008	34	(8–164)	586	(248–1 471)	400	(304–543)	246	(158–422)
2009	47	(10–214)	144	(69–337)	1 415	(1 047–1 977)	247	(106–625)
2010	61	(19–199)	263	(167–435)	512	(419–640)	119	(33–422)
2011	64	(20–201)	159	(77–381)	856	(618–1 240)	4	(1–17)
2012	81	(16–361)	470	(266–941)	1 033	(789–1 391)	86	(21–364)
2013	89	(21–412)	393	(236–714)	1 339	(1 080–1 757)	21	(10–52)
2014	94	(52–174)	227	(127–469)	1 778	(1 451–2 238)	26	(14–52)
2015	76	(53–110)	272	(173–437)	1 963	(1 672–2348)	107	(55–229)
2016	134	(72–262)	496	(311–884)	823	(640–1 115)	5	(1–23)
2017	161	(91–288)	439	(244–932)	2 023	(1 542–2 827)	208	(106–490)
2018	70	(37–147)	70	(33–178)	1 470	(1 102–2 137)	1 290	(863–2 201)
2019	126	(68–234)	231	(130–499)	1 195	(886–1 754)	391	(226–738)
2020	77	(48–141)	54	(20–181)	916	(627–1 467)	965	(546–2 072)
2021	92	(45–201)	68	(32–194)	962	(678–1 586)	438	(250–908)
2022	68	(39–128)	152	(94–280)	650	(500–909)	184	(113–335)

ALL species.

FY		WCNI		WCSI(BT)		WCSI(MW)
2003	10	(1–68)	2 524	(2 003–3 252)	883	(693–1 136)
2004	12	(2–88)	1 421	(1 118–1 860)	1 077	(886–1 372)
2005	2	(0–16)	1 479	(1 143–1 931)	320	(250–419)
2006	32	(5–174)	2 960	(2 391–3 741)	310	(237–426)
2007	21	(5–103)	3 128	(1 953–5 013)	822	(589–1 270)
2008	24	(5–124)	1 751	(1 410–2 231)	50	(37–79)
2009	28	(5–182)	2 122	(1 482–3 200)	269	(186–444)
2010	4	(1–25)	516	(403–661)	102	(75–148)
2011	5	(1–37)	1 647	(1 156–2 344)	282	(188–464)
2012	7	(2–30)	2 581	(1 961–3 461)	403	(305–585)
2013	16	(4–90)	2 157	(1 754–2 827)	453	(355–634)
2014	10	(2–55)	1 730	(1 402–2 151)	463	(373–609)
2015	10	(2–59)	2 238	(1 925–2 674)	407	(350–497)
2016	17	(3–86)	2 540	(2 003–3 293)	352	(294–454)
2017	31	(8–138)	1 989	(1 573–2 673)	464	(370–650)
2018	22	(3–155)	1 438	(1 072–2 064)	287	(231–370)
2019	5	(1–32)	473	(340–706)	181	(151–221)
2020	7	(1–56)	400	(279–655)	133	(101–187)
2021	7	(1–47)	295	(203–488)	93	(71–131)
2022	10	(3–51)	390	(285–573)	151	(120–198)

Table A3: **Total annual non–target catch estimates (t) (with estimated 95% CIs in parenthesis) for selected categories and main non–target catch species for the target hoki, hake, ling, silver warehou, white warehou trawl fishery. The slope of a regression through the data points and *p*-values are shown (in bold if significant) in the bottom row for each species group/code (see Table A1 for species code definitions).**

FY	Morids		Schedule 6		Rattails (all)		Slickheads		Sharks		BAR		BOE		BYX	
2003	771	(699–851)	4 409	(3 834–5 202)	13 276	(12 122–14 639)	15	(10–26)	9 005	(8 292–9 843)	328	(187–621)	508	(211–1 773)	21	(13–36)
2004	953	(867–1065)	3 903	(3 386–4 530)	11 222	(9 879–12 693)	14	(5–41)	8 885	(8 020–9 814)	371	(178–946)	2 263	(739–11 856)	3	(1–12)
2005	698	(624–779)	2 670	(2 330–3 127)	10 129	(9 139–11 261)	8	(3–36)	6 087	(5 528–6 767)	1 243	(589–3 192)	142	(60–544)	3	(1–20)
2006	669	(600–752)	2 571	(2 208–3 055)	9 112	(8 153–10 298)	13	(9–20)	6 342	(5 667–7 079)	144	(90–254)	568	(286–1 533)	2	(1–8)
2007	716	(629–816)	2 121	(1 848–2 443)	8 027	(7 229–8 992)	7	(3–24)	4 422	(4 005–4 890)	255	(141–525)	387	(206–991)	8	(3–30)
2008	1 183	(1 042–1 353)	2 746	(2 321–3 316)	9 570	(8 481–10 860)	35	(28–43)	7 186	(6 535–7 928)	346	(180–793)	791	(425–1 762)	12	(5–53)
2009	784	(678–931)	2 921	(2 498–3 442)	10 011	(8 898–11 317)	30	(22–44)	5 024	(4 568–5 524)	40	(21–91)	114	(44–443)	24	(9–74)
2010	465	(403–547)	2 495	(2 198–2 875)	14 861	(12 864–17 323)	5	(3–11)	5 110	(4 666–5 638)	205	(111–521)	901	(404–2 809)	16	(7–51)
2011	510	(444–597)	3 125	(2 718–3 676)	8 098	(7 202–9 175)	3	(2–7)	5 078	(4 619–5 637)	1 074	(576–2 688)	11	(4–38)	8	(4–31)
2012	469	(417–542)	3 024	(2 694–3 405)	6 372	(5 763–7 135)	6	(3–11)	5 710	(5 237–6 242)	100	(63–168)	1 476	(728–3 994)	13	(8–31)
2013	615	(557–685)	2 567	(2 331–2 869)	10 696	(9 685–11 812)	6	(4–8)	5 282	(4 921–5 676)	764	(410–2 039)	699	(312–2 760)	15	(10–39)
2014	1118	(1 005–1 255)	4 140	(3 725–4 668)	7 940	(7 317–8 610)	12	(9–18)	7 137	(6 697–7 659)	704	(410–1 691)	1 483	(778–3 984)	26	(19–53)
2015	1 235	(1 107–1 398)	4 620	(4 168–5 209)	14 096	(12 695–15 773)	14	(10–19)	8 546	(7 826–9 365)	620	(429–1 021)	236	(100– 775)	215	(129–408)
2016	719	(637–813)	2 754	(2 492–3 064)	14 442	(13 007–16 250)	10	(7–15)	5 668	(5 270–6 160)	396	(267–649)	366	(153–1 264)	18	(14–26)
2017	801	(710–907)	4 088	(3 680–4 545)	14 212	(12 709–16 003)	13	(8–24)	6 183	(5 765–6 675)	1 510	(838–3 593)	907	(442–2 619)	25	(19–36)
2018	666	(604–736)	4 013	(3 658–4 412)	14 083	(12 794–15 568)	20	(14–30)	5 252	(4 862–5 718)	322	(219–528)	429	(181–1 387)	16	(11–47)
2019	481	(430–543)	3 128	(2 833–3 458)	8 318	(7 623–9 125)	2	(1–4)	4 272	(3 940–4 654)	213	(140–378)	396	(177–1 264)	19	(13–45)
2020	286	(255–323)	1 471	(1 335–1 625)	6 574	(5 970–7 282)	2	(1–4)	2 359	(2 163–2 595)	104	(57–231)	239	(107– 919)	2	(2–3)
2021	319	(289–355)	2 031	(1 846–2 234)	7 814	(7 151–8 600)	1	(0–2)	2 808	(2 591–3 065)	230	(132–523)	727	(366–2 092)	7	(5–15)
2022	400	(362–450)	2 743	(2 475–3 053)	7 844	(7 138–8 652)	1	(1–2)	3 808	(3 495–4 193)	153	(97–306)	1109	(468–4 446)	32	(15–85)
Slope (*p*-value)	–0.035	(0.023)	–0.009	(0.414)	–0.009	(0.44)	**–0.103**	**(0.006)**	**–0.038**	**(0.002)**	–0.012	(0.738)	0.012	(0.793)	0.056	(0.194)

Table A6: continued

FY	FRO	GIZ	GSH	GSP	JAV	JMA	LDO	RIB
2003	1 329 (1 118–1 622)	350 (315–390)	297 (219–420)	1 940 (1 768–2 152)	7 465 (6 789–8 247)	48 (30–118)	897 (818–986)	580 (525–645)
2004	840 (690–1 068)	367 (320–422)	263 (190–388)	1 339 (1 226–1 476)	5 662 (4 991–6 448)	97 (58–233)	600 (545–662)	625 (555–705)
2005	719 (580–927)	290 (266–317)	259 (193–370)	991 (891–1 114)	6 456 (5 825–7 203)	75 (42–225)	463 (419–511)	418 (376–469)
2006	493 (375–701)	322 (288–366)	171 (118–273)	1 012 (893–1 166)	5 043 (4 462–5 740)	29 (16–98)	431 (392–476)	502 (442–570)
2007	605 (444–890)	211 (189–233)	151 (102–246)	687 (614–780)	5 448 (4 835–6 149)	19 (10–68)	438 (393–492)	502 (432–594)
2008	430 (290–695)	260 (228–301)	212 (144–338)	1 035 (909–1 181)	5 581 (4 911–6 382)	132 (58–827)	291 (267–320)	1 074 (949–1 228)
2009	175 (128–251)	153 (131–180)	240 (169–367)	565 (498–643)	5 908 (5 231–6 759)	11 (4–73)	271 (240–309)	703 (603–830)
2010	75 (60–95)	271 (235–316)	511 (380–764)	657 (566–776)	7 743 (6 648–9 087)	14 (7–51)	311 (283–340)	345 (298–401)
2011	95 (76–121)	230 (205–259)	564 (368–935)	514 (453–592)	4 585 (4 045–5 237)	14 (6–60)	328 (297–361)	320 (276–376)
2012	122 (103–146)	186 (160–219)	528 (372–794)	539 (477–612)	3 018 (2 710–3 400)	58 (33–215)	312 (285–345)	316 (275–366)
2013	166 (147–188)	275 (252–301)	374 (275–572)	604 (543–678)	4 756 (4 297–5 293)	20 (13–67)	502 (458–550)	391 (350–438)
2014	350 (300–411)	309 (282–342)	444 (337–629)	786 (699–883)	4 086 (3 717–4 484)	15 (10–43)	572 (528–621)	635 (571–711)
2015	645 (562–748)	606 (544–679)	477 (357–681)	1 042 (904–1 209)	7 133 (6 379–8 044)	72 (52–161)	832 (753–918)	993 (858–1 171)
2016	672 (579–800)	355 (314–400)	713 (533–1023)	644 (571–727)	8 236 (7 261–9 430)	47 (34–99)	682 (619–753)	435 (388–494)
2017	340 (288–415)	320 (285–361)	445 (323–664)	746 (652–858)	7 070 (6 253–8 008)	36 (22–140)	613 (551–685)	497 (432–575)
2018	552 (463–671)	311 (276–353)	399 (304–564)	1 007 (901–1 131)	8 253 (7 398–9 333)	64 (44–164)	590 (544–639)	546 (486–618)
2019	937 (753–1 224)	299 (260–342)	376 (285–537)	790 (697–909)	4 009 (3 644–4 477)	48 (30–120)	533 (487–588)	312 (274–361)
2020	253 (217–303)	190 (168–217)	94 (71–134)	628 (558–711)	3 272 (2 959–3 650)	16 (10–53)	410 (378–446)	231 (203–263)
2021	458 (375–575)	174 (154–199)	164 (125–234)	565 (514–627)	4 041 (3 683–4 522)	52 (30–155)	417 (384–453)	205 (183–230)
2022	562 (456–720)	319 (282–364)	187 (148–243)	677 (609–765)	4 295 (3 867–4 830)	26 (16–76)	517 (470–570)	267 (236–302)
Slope (*p*-value)	–0.010 (0.765)	–0.003 (0.794)	0.001 (0.950)	–0.029 (0.02)3	–0.016 (0.190)	–0.015 (0.614)	0.006 (0.668)	–0.038 (0.023)

Table A6: continued

FY	RSO	SBW	SND	SPD	SPE	SQU
2003	294 (240–367)	632 (382–1 185)	324 (262–407)	3 652 (3 102–4 437)	1376 (1 212–1 561)	535 (469–618)
2004	645 (526–823)	244 (132–541)	275 (232–333)	3 343 (2 839–4 043)	902 (777–1 056)	399 (352–458)
2005	273 (223–352)	56 (17–371)	261 (227–301)	2 409 (2 011–2 961)	614 (555–687)	339 (300–384)
2006	158 (125–217)	5 (2–14)	422 (361–505)	2 210 (1 787–2 859)	432 (377–498)	411 (365–470)
2007	32 (24–48)	29 (16–59)	229 (189–288)	1 911 (1 622–2 321)	385 (339–444)	500 (429–583)
2008	26 (17–43)	364 (238–618)	535 (462–632)	2 529 (2 064–3 176)	353 (313–402)	269 (242–301)
2009	63 (42–99)	382 (207–867)	346 (291–416)	2 546 (2 135–3 109)	341 (290–406)	220 (190–254)
2010	49 (37–71)	80 (33–215)	165 (131–209)	2 087 (1 817–2 450)	530 (458–616)	343 (306–392)
2011	133 (103–180)	142 (85–274)	243 (194–311)	2 901 (2 403–3 590)	839 (709–1 021)	607 (512–729)
2012	43 (31–63)	47 (28–95)	141 (109–188)	2 734 (2 388–3 156)	440 (389–498)	293 (260–338)
2013	164 (126–245)	118 (72–211)	267 (221–328)	2 027 (1 777–2 339)	646 (570–736)	578 (511–668)
2014	162 (132–204)	494 (313–897)	327 (269–403)	3 951 (3 416–4 668)	403 (369–444)	656 (583–751)
2015	183 (153–227)	277 (171–568)	206 (171–253)	3 819 (3 327–4 463)	953 (852–1 071)	1 181 (1 052–1 333)
2016	278 (224–377)	162 (88–405)	343 (285–421)	2 285 (1 996–2 668)	765 (689–861)	737 (645–856)
2017	615 (516–759)	99 (61–188)	209 (172–258)	3 798 (3 362–4 382)	545 (489–609)	820 (715–949)
2018	773 (654–956)	306 (213–510)	341 (285–415)	3 613 (3 222–4 102)	673 (606–743)	379 (348–413)
2019	1 433 (1 260–1 674)	148 (86–306)	328 (259–428)	2 738 (2 440–3 079)	402 (367–445)	461 (410–530)
2020	1 361 (1 211–1 537)	205 (133–390)	232 (188–298)	1 208 (1 061–1 394)	315 (283–354)	273 (242–309)
2021	1 887 (1 522–2 468)	280 (187–477)	340 (273–432)	1 811 (1 603–2 074)	311 (286–339)	463 (398–546)
2022	1 580 (1 355–1 909)	289 (163–693)	522 (411–677)	2 625 (2 309–3 031)	397 (361–439)	259 (230–292)
Slope (*p*-value)	**0.139**	**(0.004)** 0.053	(0.241) 0.005	(0.739) –0.008	(0.508) –0.027	(0.098) 0.007 (0.682)

Table A4: **Total annual non–target catch estimates (t) (with estimated 95% CIs in parenthesis) for selected categories and main non–target catch species, by area for the target hoki, hake, ling, silver warehou, white warehou trawl fishery. Species are ordered by decreasing total catch. See Table A1 for species code definitions.**

Morid cods

FY	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI(BT)	WCSI(MW)
2003	20 (11–34)	395 (345–452)	9 (6–13)	10 (5–21)	1 (0–5)	24 (16–40)	122 (103–147)	52 (37–73)	0 (0–1)	123 (106–144)	9 (7–11)
2004	6 (3–10)	501 (440–575)	12 (9–17)	4 (1–15)	2 (1–7)	20 (13–33)	131 (100–170)	45 (34–59)	0 (0–1)	210 (180–246)	18 (15–21)
2005	8 (3–26)	225 (198–257)	23 (16–32)	4 (1–14)	2 (1–6)	36 (22–59)	149 (119–186)	35 (19–65)	0 (0–1)	196 (164–238)	12 (10–15)
2006	1 (0–4)	191 (166–221)	11 (6–20)	2 (1–7)	3 (1–10)	51 (32–83)	111 (90–138)	8 (3–22)	0 (0–2)	273 (235–321)	12 (9–15)
2007	2 (0–6)	258 (224–297)	18 (14–26)	2 (1–7)	2 (1–7)	20 (13–35)	169 (141–202)	14 (7–30)	0 (0–1)	215 (162–287)	9 (7–11)
2008	5 (2–10)	326 (281–380)	18 (13–27)	3 (1–11)	2 (1–8)	37 (19–76)	134 (111–165)	14 (9–21)	1 (0–3)	635 (521–768)	2 (1–3)
2009	3 (1–6)	214 (183–250)	8 (6–12)	3 (1–9)	1 (0–5)	4 (2–7)	81 (68–95)	10 (7–15)	0 (0–2)	456 (360–586)	2 (1–3)
2010	1 (0–4)	201 (165–250)	14 (9–22)	4 (1–13)	5 (2–15)	15 (8–29)	112 (89–143)	14 (6–36)	0 (0–1)	91 (69–123)	3 (1–6)
2011	1 (1–4)	206 (172–251)	4 (2–6)	4 (1–12)	2 (1–5)	20 (11–36)	72 (56–93)	5 (3–10)	0 (0–1)	190 (151–245)	3 (2–6)
2012	2 (0–6)	184 (157–223)	10 (7–15)	3 (1–12)	3 (1–10)	33 (20–57)	115 (92–143)	7 (3–15)	0 (0–1)	106 (84–135)	3 (2–4)
2013	3 (1–7)	227 (196–265)	17 (12–25)	4 (1–14)	4 (1–14)	28 (18–47)	123 (104–148)	10 (6–17)	0 (0–1)	189 (158–231)	5 (4–7)
2014	4 (2–9)	229 (198–269)	27 (19–39)	4 (2–9)	3 (1–6)	44 (27–72)	235 (198–278)	22 (15–36)	0 (0–2)	538 (452–650)	6 (5–7)
2015	5 (2–13)	346 (293–414)	23 (18–32)	5 (2–11)	3 (2–5)	38 (25–63)	194 (163–235)	13 (7–26)	0 (0–2)	591 (503–722)	9 (7–12)
2016	3 (1–6)	230 (198–268)	7 (5–11)	4 (1–12)	3 (2–6)	115 (75–176)	110 (90–135)	6 (3–16)	0 (0–1)	228 (191–277)	8 (6–10)
2017	2 (1–6)	268 (224–322)	4 (3–8)	6 (3–12)	9 (5–17)	60 (37–103)	127 (101–160)	7 (4–13)	0 (0–1)	304 (257–362)	7 (5–10)
2018	7 (3–14)	207 (176–243)	6 (4–9)	5 (2–12)	4 (2–8)	19 (11–32)	164 (138–196)	63 (47–87)	0 (0–2)	182 (157–213)	5 (4–7)
2019	2 (1–6)	161 (139–186)	4 (2–5)	4 (1–11)	3 (2–6)	32 (21–50)	157 (129–193)	47 (31–75)	0 (0–1)	64 (52–78)	4 (3–5)
2020	1 (0–5)	98 (83–116)	2 (1–3)	1 (0–3)	2 (1–3)	22 (13–38)	59 (48–73)	23 (16–37)	0 (0–1)	72 (60–89)	3 (2–4)
2021	2 (1–4)	121 (106–140)	2 (1–3)	1 (0–4)	4 (2–8)	15 (10–23)	104 (87–126)	15 (10–25)	0 (0–1)	49 (40–61)	3 (3–5)
2022	2 (1–4)	158 (137–184)	2 (1–3)	1 (0–3)	9 (5–15)	65 (46–94)	98 (83–119)	13 (8–21)	0 (0–1)	49 (40–60)	2 (1–2)

Table A7: continued

Schedule 6 species

FY	AUCK	CHAT	COOK	EAST	NORTH	PUYS
2003	97 (55–173)	1 313 (1 122–1 552)	1 652 (1 204–2 323)	16 (6–45)	9 (3–29)	103 (60–189)
2004	80 (40–168)	1 479 (1 246–1 769)	1 139 (832–1 580)	15 (5–47)	12 (4–37)	35 (21–62)
2005	46 (18–128)	965 (839–1 126)	1 006 (749–1 356)	8 (3–26)	6 (2–20)	134 (84–218)
2006	10 (3–38)	904 (764–1 085)	760 (513–1 144)	5 (1–20)	12 (4–37)	51 (30–91)
2007	7 (2–23)	746 (628–903)	478 (355–657)	7 (3–24)	7 (2–23)	82 (45–156)
2008	17 (9–36)	817 (682–978)	1 133 (844–1 609)	6 (2–22)	9 (3–29)	41 (19–88)
2009	31 (14–69)	1 067 (882–1 314)	804 (577–1 153)	14 (4–49)	12 (4–38)	35 (19–67)
2010	9 (3–34)	1 117 (930–1 356)	322 (245–449)	13 (4–44)	21 (8–58)	52 (31–96)
2011	31 (16–78)	1 170 (991–1 438)	586 (398–923)	24 (7–77)	19 (7–54)	34 (19–67)
2012	9 (3–27)	1 154 (983–1 362)	408 (306–553)	13 (4–43)	16 (6–50)	27 (17–49)
2013	20 (9–56)	893 (771–1 046)	184 (135–256)	15 (4–48)	22 (7–65)	36 (23–63)
2014	53 (27–110)	1 481 (1 260–1 760)	451 (317–631)	26 (13–53)	18 (9–39)	45 (26–86)
2015	45 (23–100)	1 845 (1 575–2 204)	131 (103–176)	17 (8–39)	13 (8–23)	67 (41–117)
2016	29 (14–66)	1 312 (1 140–1 515)	190 (143–265)	16 (5–48)	25 (13–52)	42 (28–69)
2017	28 (14–63)	2 185 (1 891–2 550)	212 (157–295)	30 (16–58)	41 (24–72)	54 (34–90)
2018	46 (26–91)	1 885 (1 638–2 178)	223 (172–292)	24 (10–61)	28 (15–54)	38 (24–65)
2019	30 (15–64)	1 478 (1 298–1 686)	203 (158–260)	20 (7–57)	35 (18–66)	98 (63–164)
2020	6 (2–17)	744 (650–857)	55 (42–74)	4 (1–10)	23 (15–35)	44 (25–78)
2021	25 (14–51)	1 038 (918–1 188)	85 (59–125)	4 (1–13)	21 (11–41)	79 (49–132)
2022	20 (9–51)	1 707 (1 490–1 969)	80 (60–112)	5 (1–15)	21 (12–37)	66 (46–99)

Schedule 6 species continued

FY	STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	318	(253–403)	243	(170–360)	5	(1–28)	408	(324–523)	201	(160–256)
2004	229	(176–315)	283	(199–422)	6	(2–32)	401	(322–510)	180	(150–219)
2005	131	(97–179)	46	(22–93)	3	(1–14)	208	(166–267)	89	(74–111)
2006	227	(177–295)	11	(4–35)	14	(4–54)	459	(370–583)	87	(69–113)
2007	404	(325–512)	34	(15–76)	5	(1–19)	211	(149–302)	110	(84–147)
2008	167	(132–218)	56	(36–91)	18	(5–70)	374	(286–493)	74	(55–104)
2009	465	(369–586)	62	(38–107)	21	(6–82)	276	(187–410)	94	(69–135)
2010	417	(348–524)	49	(22–120)	5	(1–27)	371	(289–492)	83	(57–124)
2011	353	(273–473)	48	(27–89)	7	(2–35)	580	(447–764)	219	(165–303)
2012	212	(174–269)	14	(7–31)	9	(3–31)	756	(611–938)	379	(307–476)
2013	515	(431–636)	44	(24–83)	12	(3–48)	547	(451–682)	253	(210–310)
2014	1 176	(977–1 447)	79	(50–133)	11	(3–44)	460	(372–583)	305	(254–376)
2015	1 518	(1 259–1 865)	48	(26–92)	7	(2–39)	486	(401–605)	409	(350–488)
2016	312	(253–392)	11	(5–27)	4	(1–21)	523	(431–645)	269	(231–319)
2017	663	(547–824)	35	(21–63)	15	(5–58)	454	(385–540)	346	(293–417)
2018	814	(691–977)	104	(77–147)	13	(3–56)	545	(467–640)	274	(235–320)
2019	724	(594–896)	45	(29–73)	4	(1–21)	229	(187–285)	231	(199–270)
2020	266	(219–328)	38	(26–61)	6	(1–22)	153	(126–189)	121	(103–144)
2021	481	(402–582)	35	(23–55)	5	(1–22)	121	(98–153)	119	(99–147)
2022	391	(324–487)	44	(28–74)	10	(3–37)	218	(175–280)	161	(134–196)

Table A7: continued

Rattails (all species combined)

FY		AUCK		CHAT		COOK		EAST		NORTH		PUYS
2003	89	(59–135)	11 164	(10 088–12 472)	36	(21–64)	61	(28–132)	5	(1–21)	50	(29–90)
2004	20	(10–39)	1 0307	(8 977–11 746)	21	(14–34)	10	(2–35)	3	(1–14)	11	(7–18)
2005	106	(38–341)	8 391	(7 545–9 367)	29	(17–48)	14	(4–63)	5	(1–18)	56	(32–101)
2006	16	(5–59)	7 905	(6 970–9 032)	38	(13–113)	8	(2–32)	9	(2–36)	199	(128–317)
2007	24	(7–75)	6 935	(6 199–7 825)	34	(25–49)	13	(5–33)	6	(1–21)	31	(19–50)
2008	35	(20–70)	7 732	(6 711–8 955)	79	(54–117)	11	(3–51)	7	(2–30)	61	(28–136)
2009	28	(16–55)	8 138	(7 117–9 343)	49	(31–82)	15	(4–61)	6	(2–23)	12	(7–20)
2010	23	(7–89)	13 554	(11 604–15 949)	112	(78–169)	30	(8–126)	13	(4–43)	26	(15–48)
2011	49	(26–95)	6 981	(6 103–8 018)	12	(7–20)	17	(5–62)	13	(4–40)	29	(18–50)
2012	18	(8–50)	5 442	(4 873–6 173)	71	(49–103)	17	(6–52)	9	(2–31)	51	(34–78)
2013	33	(15–77)	8 445	(7 545–9 532)	132	(94–190)	22	(6–102)	17	(4–71)	72	(48–118)
2014	70	(43–122)	5 250	(4 707–5 853)	118	(90–158)	19	(11–37)	25	(14–42)	131	(88–201)
2015	121	(62–237)	9 970	(8 684–11 468)	106	(81–148)	32	(19–57)	24	(15–39)	229	(148–367)
2016	52	(24–129)	11 484	(10 132–13 152)	57	(39–90)	49	(13–177)	37	(18–76)	427	(274–684)
2017	75	(38–160)	12 147	(10 701–13 887)	10	(6–18)	21	(11–40)	25	(14–45)	241	(151–394)
2018	175	(104–305)	1 0633	(9 457–12 012)	23	(16–33)	29	(11–75)	19	(11–36)	103	(68–170)
2019	62	(32–127)	6 377	(5 743–7 118)	11	(8–16)	52	(16–184)	33	(19–56)	140	(98–207)
2020	15	(6–37)	4 937	(4 432–5 591)	6	(4–9)	3	(1–8)	9	(6–13)	118	(69–201)
2021	54	(31–97)	6 340	(5 721–7 057)	6	(4–11)	8	(2–33)	9	(5–19)	140	(92–217)
2022	29	(14–65)	6 509	(5 839–7 308)	21	(14–35)	5	(2–16)	12	(7–20)	183	(130–262)

Rattails (all species combined) continued

FY	STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	984	(846–1 153)	364	(284–471)	2	(0–12)	399	(339–469)	96	(81–114)
2004	313	(245–404)	185	(141–245)	1	(0–7)	250	(210–295)	93	(80–108)
2005	672	(546–831)	501	(269–946)	1	(0–8)	186	(154–225)	111	(97–129)
2006	291	(243–359)	38	(12–133)	8	(2–39)	478	(399–571)	74	(62–92)
2007	463	(397–548)	182	(91–369)	4	(1–15)	251	(188–332)	56	(45–71)
2008	524	(436–642)	214	(147–318)	10	(2–50)	832	(674–1 031)	24	(18–35)
2009	541	(457–645)	129	(91–198)	8	(2–44)	1 041	(800–1 388)	16	(12–22)
2010	570	(473–695)	200	(86–481)	2	(0–16)	252	(199–325)	30	(21–44)
2011	422	(353–513)	72	(45–114)	3	(0–14)	449	(373–553)	39	(28–53)
2012	372	(316–442)	32	(18–59)	2	(1–7)	304	(258–365)	35	(29–44)
2013	763	(659–895)	28	(19–45)	7	(1–33)	1 041	(881–1 251)	85	(72–102)
2014	1 075	(956–1 224)	72	(54–103)	5	(1–30)	1 077	(938–1 245)	71	(62–81)
2015	1 145	(993–1 343)	131	(78–218)	7	(1–41)	2 176	(1 840–2 578)	111	(95–131)
2016	432	(351–550)	45	(20–108)	7	(1–44)	1 631	(1 359–1 999)	168	(143–201)
2017	480	(398–588)	185	(118–312)	10	(3–44)	902	(778–1 067)	84	(68–104)
2018	1 426	(1 237–1 660)	632	(493–834)	10	(2–51)	805	(710–917)	194	(166–229)
2019	885	(750–1 043)	277	(197–402)	2	(0–15)	329	(274–399)	113	(98–132)
2020	670	(576–794)	422	(301–625)	4	(1–23)	254	(215–303)	107	(91–127)
2021	824	(704–964)	177	(125–261)	3	(0–17)	158	(132–192)	72	(59–88)
2022	668	(571–798)	87	(59–135)	4	(1–16)	165	(137–200)	133	(111–162)

Table A7: continued

Slickheads

FY	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI(BT)	WCSI(MW)
2003	0 (0–0)	8 (4–14)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	7 (4–13)	0 (0–1)
2004	0 (0–0)	5 (1–22)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	7 (3–24)	0 (0–1)
2005	0 (0–0)	2 (0–10)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	5 (2–26)	0 (0–1)
2006	0 (0–0)	4 (2–8)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	8 (6–13)	0 (0–0)
2007	0 (0–0)	3 (1–13)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	4 (2–13)	0 (0–0)
2008	0 (0–0)	7 (5–11)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–1)	26 (21–33)	0 (0–1)
2009	0 (0–0)	11 (6–18)	0 (0–2)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–1)	18 (12–27)	0 (0–1)
2010	0 (0–0)	2 (1–5)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	3 (2–6)	0 (0–0)
2011	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	3 (1–6)	0 (0–0)
2012	0 (0–0)	1 (0–2)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	5 (3–10)	0 (0–0)
2013	0 (0–0)	1 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	5 (3–7)	0 (0–0)
2014	0 (0–0)	2 (1–5)	0 (0–1)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	9 (7–13)	0 (0–1)
2015	0 (0–0)	3 (1–7)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	10 (8–13)	0 (0–1)
2016	0 (0–0)	1 (0–3)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	9 (6–13)	0 (0–0)
2017	0 (0–0)	2 (0–11)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	10 (7–15)	0 (0–1)
2018	0 (0–0)	1 (1–4)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	18 (12–27)	0 (0–0)
2019	0 (0–0)	1 (0–2)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	2 (1–3)	0 (0–0)
2020	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	2 (1–3)	0 (0–0)
2021	0 (0–0)	0 (0–1)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	1 (0–2)	0 (0–0)
2022	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)	1 (0–1)	0 (0–0)

Table A7: continued

Sharks

FY	AUCK	CHAT	COOK	EAST	NORTH	PUYS
2003	225 (150–329)	4 555 (4 089–5 070)	1502 (1 187–1 959)	62 (32–123)	14 (5–36)	231 (162–336)
2004	183 (106–324)	4 784 (4 218–5 403)	1240 (965–1 620)	39 (15–111)	19 (8–48)	143 (97–214)
2005	144 (63–332)	3 354 (3 014–3 755)	1157 (899–1 513)	22 (8–63)	10 (4–28)	282 (189–420)
2006	26 (10–76)	3 732 (3 306–4 236)	891 (639–1 291)	14 (5–41)	20 (8–53)	404 (271–614)
2007	21 (8–59)	2 330 (2 054–2 645)	496 (384–648)	18 (8–41)	12 (5–31)	167 (106–272)
2008	54 (33–90)	3 871 (3 453–4 357)	1394 (1 094–1 800)	22 (8–60)	18 (7–45)	187 (99–347)
2009	69 (41–122)	2 271 (2 016–2 589)	725 (568–942)	31 (12–82)	17 (6–41)	132 (87–209)
2010	27 (10–69)	2 878 (2 547–3 271)	333 (270–420)	32 (12–83)	41 (17–95)	220 (146–341)
2011	87 (50–168)	2 512 (2 213–2 853)	536 (395–750)	54 (21–138)	27 (12–62)	167 (108–265)
2012	41 (17–99)	3 042 (2 718–3 418)	472 (367–609)	41 (17–103)	31 (12–77)	263 (179–393)
2013	63 (33–137)	2 500 (2 259–2 775)	232 (183–300)	34 (13–93)	32 (13–77)	266 (186–397)
2014	122 (75–209)	3 284 (2 962–3 648)	535 (429–668)	52 (31–87)	16 (9–26)	200 (137–303)
2015	98 (58–185)	4 813 (4 232–5 486)	183 (151–231)	25 (14–47)	28 (19–44)	134 (91–202)
2016	54 (29–104)	3 122 (2 828–3 482)	222 (172–291)	38 (15–95)	45 (27–77)	218 (156–313)
2017	53 (31–92)	3 576 (3 235–3 976)	225 (174–292)	49 (31–79)	50 (33–77)	126 (88–185)
2018	57 (34–98)	2 683 (2 391–3 034)	236 (186–308)	35 (16–78)	20 (12–36)	220 (145–348)
2019	37 (20–74)	2 168 (1 957–2 428)	269 (217–346)	31 (13–79)	33 (19–54)	233 (164–341)
2020	9 (4–24)	1 359 (1 206–1 545)	68 (52–93)	6 (3–16)	23 (16–33)	104 (63–180)
2021	32 (19–58)	1 579 (1 421–1 771)	89 (64–131)	7 (3–21)	19 (11–34)	135 (90–201)
2022	20 (10–46)	2 527 (2 266–2 869)	98 (74–139)	6 (2–17)	24 (14–40)	111 (80–156)

Sharks continued

FY	STEW	SUBA	WCNI	WCSI(BT)	WCSI(MW)
2003	1 213 (1 050–1 420)	452 (358–573)	9 (2–32)	535 (460–632)	157 (135–185)
2004	577 (463–732)	975 (745–1 289)	12 (3–46)	711 (601–833)	146 (127–170)
2005	447 (360–553)	206 (119–345)	4 (1–18)	349 (290–419)	75 (65–88)
2006	477 (400–574)	37 (16–95)	28 (9–93)	593 (504–697)	66 (55–80)
2007	708 (599–836)	113 (60–219)	13 (5–39)	413 (319–535)	101 (83–124)
2008	601 (515–707)	201 (147–282)	38 (13–115)	678 (572–810)	73 (58–92)
2009	890 (776–1 040)	160 (119–223)	34 (12–93)	605 (476–776)	55 (44–68)
2010	872 (753–1 011)	140 (75–278)	10 (3–38)	465 (390–554)	58 (43–80)
2011	686 (576–821)	140 (96–218)	12 (4–44)	681 (569–818)	140 (113–177)
2012	449 (383–534)	59 (34–105)	18 (7–50)	937 (788–1 127)	318 (265–380)
2013	991 (878–1 130)	43 (29–64)	20 (6–62)	895 (778–1 036)	172 (149–199)
2014	1 800 (1 602–2 039)	87 (64–115)	15 (5–50)	816 (714–935)	192 (171–218)
2015	1 883 (1 646–2 171)	150 (97–240)	12 (4–48)	902 (789–1 055)	287 (254–328)
2016	710 (605–836)	35 (19–68)	8 (2–28)	997 (858–1 162)	191 (169–217)
2017	1 074 (937–1 240)	87 (60–130)	18 (7–53)	662 (589–741)	248 (218–282)
2018	1 034 (900–1 198)	103 (82–136)	15 (4–55)	606 (538–695)	214 (188–245)
2019	915 (784–1 082)	69 (50–100)	5 (1–21)	303 (253–360)	189 (166–214)
2020	430 (364–516)	57 (40–85)	7 (2–27)	203 (172–243)	76 (66–90)
2021	639 (551–751)	48 (34–70)	6 (2–22)	151 (125–184)	89 (74–108)
2022	488 (410–584)	45 (31–68)	11 (4–35)	342 (287–415)	119 (100–140)

Table A7: continued

BAR (Barracouta)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	0	(0–3)	96	(43–235)	6	(2–19)	2	(0–24)	0	(0–3)	1	(0–8)	100	(39–270)	1	(0–8)	1	(0–32)	11	(3–43)	84	(47–180)
2004	0	(0–4)	109	(32–418)	7	(2–28)	3	(0–35)	0	(0–5)	2	(0–13)	108	(26–468)	1	(0–8)	2	(0–47)	17	(6–66)	78	(48–154)
2005	0	(0–15)	268	(63–1186)	53	(19–215)	10	(1–121)	0	(0–15)	9	(1–65)	282	(60–1 359)	1	(0–21)	2	(0–88)	55	(16–261)	383	(206–899)
2006	0	(0–0)	27	(11–69)	4	(1–18)	1	(0–8)	0	(0–3)	1	(0–7)	42	(18–99)	0	(0–1)	4	(0–52)	15	(7–36)	36	(24–59)
2007	0	(0–0)	33	(11–97)	4	(2–10)	1	(0–12)	0	(0–3)	1	(0–5)	162	(72–388)	0	(0–2)	2	(0–44)	14	(5–40)	21	(13–43)
2008	0	(0–2)	143	(62–407)	4	(2–16)	2	(0–17)	0	(0–4)	1	(0–11)	102	(35–369)	0	(0–3)	8	(0–126)	39	(14–129)	9	(5–26)
2009	0	(0–0)	15	(6–47)	2	(1–5)	0	(0–4)	0	(0–1)	0	(0–1)	10	(5–25)	0	(0–0)	2	(0–21)	3	(1–14)	3	(1–7)
2010	0	(0–0)	92	(43–310)	10	(4–38)	2	(0–23)	0	(0–8)	1	(0–7)	45	(20–136)	0	(0–1)	1	(0–41)	15	(4–84)	14	(4–55)
2011	0	(0–5)	517	(223–1 740)	19	(4–100)	12	(1–167)	1	(0–24)	4	(1–35)	178	(77–596)	0	(0–8)	4	(0–192)	51	(16–250)	153	(67–459)
2012	0	(0–0)	66	(36–125)	2	(1–5)	1	(0–7)	0	(0–2)	1	(0–2)	14	(8–26)	0	(0–0)	2	(0–25)	3	(1–9)	7	(4–12)
2013	0	(0–1)	378	(149–1 423)	17	(6–83)	4	(0–55)	1	(0–15)	1	(0–17)	219	(106–653)	0	(0–5)	5	(0–172)	9	(3–47)	42	(16–130)
2014	0	(0–2)	411	(186–1 274)	10	(3–35)	15	(2–111)	0	(0–6)	2	(0–18)	165	(93–395)	0	(0–5)	3	(0–94)	11	(4–45)	34	(18–76)
2015	0	(0–4)	125	(69–298)	28	(13–73)	6	(1–47)	1	(0–11)	3	(1–14)	304	(183–621)	0	(0–4)	4	(0–86)	21	(8–68)	83	(53–156)
2016	0	(0–1)	147	(76–310)	7	(2–34)	3	(0–33)	0	(0–5)	1	(0–5)	156	(90–318)	0	(0–1)	1	(0–22)	19	(8–51)	40	(26–65)
2017	0	(0–3)	994	(448–2 850)	13	(3–65)	5	(1–42)	1	(0–16)	2	(0–18)	270	(136–759)	0	(0–5)	5	(0–142)	32	(12–114)	99	(46–263)
2018	0	(0–2)	104	(56–235)	7	(2–25)	4	(1–28)	1	(0–9)	1	(0–7)	75	(42–156)	0	(0–3)	4	(0–70)	19	(7–58)	82	(52–154)
2019	0	(0–1)	82	(38–197)	6	(2–23)	2	(0–22)	1	(0–9)	1	(0–6)	66	(38–136)	0	(0–1)	1	(0–27)	6	(2–18)	33	(21–57)
2020	0	(0–0)	29	(9–108)	1	(0–8)	0	(0–7)	0	(0–3)	1	(0–5)	42	(19–124)	0	(0–1)	1	(0–25)	2	(1–13)	14	(7–34)
2021	0	(0–1)	78	(29–255)	2	(0–13)	1	(0–11)	0	(0–10)	1	(0–8)	93	(44–265)	0	(0–2)	1	(0–33)	3	(1–18)	29	(14–81)
2022	0	(0–0)	34	(14–104)	2	(1–9)	0	(0–6)	0	(0–4)	1	(0–8)	37	(19–88)	0	(0–1)	2	(0–51)	3	(1–16)	54	(30–123)

Table A7: continued

BOE (Black oreo)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	0	(0–3)	477	(195–1 746)	0	(0–10)	0	(0–4)	0	(0–0)	0	(0–7)	17	(5–96)	0	(0–6)	0	(0–0)	0	(0–5)	0	(0–3)
2004	0	(0–8)	2 107	(683–11 508)	0	(0–47)	0	(0–25)	0	(0–2)	0	(0–19)	70	(11–678)	1	(0–30)	0	(0–0)	1	(0–20)	0	(0–15)
2005	0	(0–1)	131	(54–517)	0	(0–4)	0	(0–1)	0	(0–0)	0	(0–4)	5	(1–40)	0	(0–1)	0	(0–0)	0	(0–2)	0	(0–1)
2006	0	(0–1)	538	(267–1 452)	0	(0–13)	0	(0–4)	0	(0–1)	0	(0–3)	20	(5–111)	0	(0–1)	0	(0–1)	1	(0–6)	0	(0–3)
2007	0	(0–1)	292	(149–721)	0	(0–16)	0	(0–3)	0	(0–0)	0	(0–3)	74	(19–418)	0	(0–2)	0	(0–0)	0	(0–6)	0	(0–3)
2008	0	(0–3)	738	(396–1 705)	0	(0–17)	0	(0–5)	0	(0–1)	0	(0–3)	35	(11–144)	0	(0–4)	0	(0–1)	1	(0–8)	0	(0–2)
2009	0	(0–0)	107	(40–422)	0	(0–4)	0	(0–1)	0	(0–0)	0	(0–1)	4	(1–30)	0	(0–1)	0	(0–0)	0	(0–2)	0	(0–0)
2010	0	(0–1)	857	(376–2 712)	0	(0–19)	0	(0–3)	0	(0–2)	0	(0–3)	29	(10–160)	0	(0–2)	0	(0–0)	0	(0–9)	0	(0–4)
2011	0	(0–0)	10	(4–35)	0	(0–1)	0	(0–0)	0	(0–0)	0	(0–0)	1	(0–5)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)
2012	0	(0–2)	1 399	(669–3 931)	0	(0–33)	0	(0–14)	0	(0–2)	0	(0–14)	52	(15–297)	0	(0–3)	0	(0–1)	1	(0–20)	0	(0–8)
2013	0	(0–1)	650	(284–2 661)	0	(0–19)	0	(0–4)	0	(0–1)	0	(0–4)	25	(6–169)	0	(0–3)	0	(0–0)	0	(0–7)	0	(0–5)
2014	0	(0–3)	1 427	(738–3 868)	0	(0–26)	0	(0–10)	0	(0–2)	0	(0–4)	34	(12–121)	0	(0–4)	0	(0–1)	1	(0–9)	0	(0–12)
2015	0	(0–2)	185	(74–668)	0	(0–12)	0	(0–4)	0	(0–1)	0	(0–3)	37	(11–168)	0	(0–1)	0	(0–0)	0	(0–6)	0	(0–5)
2016	0	(0–1)	351	(146–1 228)	0	(0–10)	0	(0–6)	0	(0–1)	0	(0–4)	7	(2–51)	0	(0–1)	0	(0–0)	0	(0–5)	0	(0–4)
2017	0	(0–1)	883	(423–2 576)	0	(0–13)	0	(0–8)	0	(0–1)	0	(0–3)	14	(3–90)	0	(0–1)	0	(0–0)	0	(0–4)	0	(0–4)
2018	0	(0–2)	393	(160–1 348)	0	(0–13)	0	(0–9)	0	(0–1)	0	(0–2)	20	(7–104)	0	(0–6)	0	(0–0)	0	(0–6)	0	(0–5)
2019	0	(0–1)	348	(151–1 120)	0	(0–13)	0	(0–4)	0	(0–3)	0	(0–7)	31	(9–170)	0	(0–3)	0	(0–0)	0	(0–5)	0	(0–5)
2020	0	(0–0)	208	(89–875)	0	(0–6)	0	(0–4)	0	(0–2)	0	(0–3)	20	(5–120)	0	(0–2)	0	(0–0)	0	(0–6)	0	(0–4)
2021	0	(0–2)	670	(333–1 971)	0	(0–8)	0	(0–2)	0	(0–4)	0	(0–5)	35	(11–185)	0	(0–3)	0	(0–0)	0	(0–9)	0	(0–5)
2022	0	(0–1)	1 051	(441–4 345)	0	(0–7)	0	(0–3)	0	(0–2)	0	(0–7)	30	(8–237)	0	(0–3)	0	(0–1)	0	(0–7)	0	(0–5)

Table A7: continued

BYX (Alfonsino)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	0	(0–0)	4	(2–8)	1	(0–8)	7	(3–19)	0	(0–1)	0	(0–1)	0	(0–1)	0	(0–0)	0	(0–0)	2	(1–4)	5	(3–7)
2004	0	(0–0)	0	(0–1)	0	(0–2)	1	(0–10)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(0–1)
2005	0	(0–0)	1	(0–3)	0	(0–2)	1	(0–10)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–3)	1	(0–5)
2006	0	(0–0)	0	(0–1)	0	(0–1)	0	(0–4)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(0–4)	0	(0–1)
2007	0	(0–0)	1	(0–3)	0	(0–4)	2	(0–18)	0	(0–0)	0	(0–0)	0	(0–1)	0	(0–0)	0	(0–0)	2	(0–8)	2	(1–5)
2008	0	(0–0)	2	(1–9)	1	(0–6)	3	(0–33)	0	(0–1)	0	(0–0)	0	(0–1)	0	(0–0)	0	(0–0)	2	(1–6)	3	(1–11)
2009	0	(0–0)	16	(5–57)	0	(0–1)	3	(0–24)	0	(0–1)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(0–2)	1	(0–3)
2010	0	(0–0)	5	(2–14)	0	(0–1)	3	(0–32)	0	(0–1)	0	(0–0)	0	(0–1)	0	(0–0)	0	(0–0)	1	(0–5)	4	(1–13)
2011	0	(0–0)	1	(0–3)	0	(0–1)	3	(0–24)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(0–2)	3	(1–8)
2012	0	(0–0)	3	(2–7)	1	(0–3)	4	(1–20)	0	(0–1)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(0–2)	3	(2–6)
2013	0	(0–0)	3	(2–6)	1	(0–1)	4	(1–27)	0	(0–1)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	3	(2–4)	3	(2–4)
2014	0	(0–0)	5	(3–9)	3	(1–6)	6	(1–31)	0	(0–2)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	5	(3–7)	7	(5–9)
2015	0	(0–1)	23	(16–35)	6	(4–11)	154	(71–346)	1	(0–3)	0	(0–1)	0	(0–1)	0	(0–0)	0	(0–1)	6	(4–9)	21	(16–29)
2016	0	(0–0)	6	(4–9)	1	(0–3)	2	(0–10)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	3	(2–4)	5	(4–7)
2017	0	(0–0)	6	(4–9)	4	(1–12)	2	(1–4)	0	(0–1)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	3	(2–4)	9	(7–12)
2018	0	(0–0)	5	(3–6)	1	(0–1)	5	(1–36)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	3	(2–4)	2	(2–3)
2019	0	(0–0)	3	(2–4)	2	(1–4)	5	(1–30)	0	(0–3)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	2	(1–2)	6	(5–8)
2020	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)	0	(0–1)	1	(1–1)
2021	0	(0–0)	3	(2–4)	0	(0–1)	1	(0–9)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(1–2)	2	(1–2)
2022	0	(0–0)	2	(2–3)	1	(1–2)	27	(9–79)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(1–1)	1	(1–1)

Table A7: continued

FRO (Frostfish)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	0	(0–1)	31	(15–65)	8	(5–14)	4	(1–15)	5	(1–14)	6	(2–19)	5	(2–12)	0	(0–1)	1	(0–8)	36	(26–50)	1 224	(1 027–1 510)
2004	0	(0–0)	7	(3–14)	11	(5–24)	4	(1–13)	5	(1–17)	2	(0–9)	3	(1–8)	0	(0–0)	1	(0–6)	27	(18–45)	775	(631–990)
2005	0	(0–0)	7	(3–17)	15	(8–31)	3	(1–12)	3	(1–12)	4	(1–17)	3	(1–10)	0	(0–0)	0	(0–4)	29	(19–50)	647	(519–850)
2006	0	(0–0)	2	(1–7)	5	(2–14)	1	(0–5)	4	(1–14)	0	(0–3)	2	(0–6)	0	(0–0)	1	(0–9)	22	(14–40)	450	(340–648)
2007	0	(0–0)	4	(1–10)	6	(3–13)	1	(0–4)	3	(1–14)	0	(0–1)	2	(1–8)	0	(0–0)	1	(0–6)	14	(8–28)	569	(414–845)
2008	0	(0–0)	4	(1–13)	6	(3–15)	1	(0–7)	4	(1–20)	0	(0–2)	2	(1–6)	0	(0–0)	3	(0–21)	22	(12–48)	378	(247–632)
2009	0	(0–0)	1	(0–3)	3	(1–6)	0	(0–2)	2	(1–7)	0	(0–1)	1	(0–2)	0	(0–0)	1	(0–6)	4	(2–10)	161	(116–233)
2010	0	(0–0)	1	(1–2)	4	(3–7)	0	(0–1)	2	(1–6)	0	(0–1)	1	(0–1)	0	(0–0)	0	(0–1)	4	(2–6)	62	(48–80)
2011	0	(0–0)	1	(0–1)	2	(1–4)	1	(0–3)	2	(1–5)	0	(0–1)	1	(0–1)	0	(0–0)	0	(0–1)	5	(4–8)	83	(65–107)
2012	0	(0–0)	1	(1–2)	3	(2–5)	0	(0–1)	2	(1–6)	0	(0–1)	1	(0–2)	0	(0–0)	0	(0–2)	8	(6–11)	105	(88–128)
2013	0	(0–0)	1	(1–2)	8	(6–11)	0	(0–1)	2	(1–6)	0	(0–1)	1	(0–1)	0	(0–0)	1	(0–2)	5	(4–6)	147	(129–168)
2014	0	(0–0)	1	(1–2)	5	(3–7)	1	(0–2)	3	(1–7)	0	(0–1)	1	(0–1)	0	(0–0)	0	(0–2)	5	(4–8)	333	(285–394)
2015	0	(0–0)	6	(3–10)	16	(12–22)	1	(0–2)	2	(1–4)	1	(0–3)	2	(1–3)	0	(0–0)	1	(0–3)	13	(9–18)	603	(523–703)
2016	0	(0–0)	4	(2–9)	5	(3–8)	2	(1–7)	5	(3–12)	1	(0–2)	1	(0–2)	0	(0–0)	0	(0–2)	14	(11–20)	637	(546–762)
2017	0	(0–0)	4	(2–8)	2	(1–5)	3	(1–7)	4	(2–8)	0	(0–1)	1	(0–2)	0	(0–0)	1	(0–4)	9	(7–12)	314	(264–386)
2018	0	(0–0)	3	(2–6)	6	(4–10)	2	(1–7)	6	(3–14)	0	(0–2)	2	(1–3)	0	(0–0)	1	(0–5)	22	(17–31)	505	(420–622)
2019	0	(0–0)	3	(2–8)	8	(5–14)	1	(0–6)	8	(4–19)	1	(0–6)	1	(0–3)	0	(0–0)	0	(0–4)	21	(13–37)	890	(711–1 165)
2020	0	(0–0)	2	(1–3)	2	(1–3)	1	(0–3)	6	(4–10)	0	(0–1)	1	(0–2)	0	(0–0)	0	(0–3)	8	(6–12)	231	(197–279)
2021	0	(0–0)	3	(2–7)	2	(1–4)	0	(0–2)	10	(5–23)	0	(0–1)	1	(1–2)	0	(0–0)	1	(0–4)	11	(8–17)	427	(347–538)
2022	0	(0–0)	3	(1–7)	3	(2–6)	1	(0–5)	11	(6–24)	1	(0–3)	1	(1–3)	0	(0–0)	1	(0–7)	12	(8–19)	524	(422–680)

Table A7: continued

GIZ (Giant stargazer)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	3	(1–5)	215	(190–244)	1	(0–2)	3	(1–7)	0	(0–1)	16	(10–28)	39	(33–47)	6	(4–10)	1	(0–5)	62	(51–74)	2	(1–3)
2004	1	(0–3)	187	(162–219)	1	(0–2)	1	(0–4)	0	(0–1)	7	(4–12)	75	(51–112)	2	(1–3)	1	(0–5)	86	(72–103)	2	(1–3)
2005	1	(1–3)	168	(153–186)	1	(0–2)	1	(0–3)	0	(0–1)	7	(5–12)	39	(32–47)	1	(0–2)	0	(0–2)	69	(58–81)	1	(1–2)
2006	0	(0–1)	144	(126–168)	1	(0–3)	1	(0–3)	1	(0–2)	40	(26–60)	47	(38–59)	0	(0–1)	5	(1–18)	78	(65–96)	2	(1–4)
2007	0	(0–1)	133	(119–151)	0	(0–1)	1	(0–2)	0	(0–1)	10	(7–14)	41	(35–49)	0	(0–1)	4	(2–8)	19	(15–25)	0	(0–1)
2008	1	(0–1)	139	(120–161)	1	(0–3)	1	(0–2)	0	(0–1)	12	(6–23)	32	(26–40)	2	(1–3)	5	(1–16)	65	(50–86)	0	(0–1)
2009	0	(0–1)	99	(83–120)	0	(0–1)	1	(0–2)	0	(0–1)	3	(2–6)	26	(21–32)	1	(0–1)	2	(1–6)	19	(13–28)	0	(0–1)
2010	0	(0–1)	199	(167–237)	0	(0–2)	1	(0–3)	1	(0–2)	7	(4–12)	31	(25–37)	0	(0–1)	1	(0–4)	29	(22–37)	1	(0–3)
2011	0	(0–1)	131	(115–151)	0	(0–1)	1	(0–3)	0	(0–1)	8	(5–14)	45	(37–54)	1	(0–1)	1	(0–5)	40	(31–49)	1	(1–3)
2012	0	(0–1)	114	(94–138)	0	(0–1)	1	(0–3)	0	(0–1)	12	(7–21)	26	(21–34)	0	(0–1)	1	(1–5)	29	(22–39)	1	(0–2)
2013	1	(0–1)	134	(119–149)	1	(0–3)	2	(1–5)	1	(0–3)	10	(7–14)	74	(65–85)	2	(1–3)	4	(1–12)	45	(38–52)	2	(1–3)
2014	1	(0–2)	123	(109–141)	1	(0–2)	3	(1–7)	1	(0–2)	22	(15–33)	109	(94–126)	3	(2–6)	2	(1–8)	39	(33–47)	2	(1–3)
2015	2	(1–4)	308	(268–362)	1	(0–3)	3	(1–8)	1	(1–2)	42	(29–66)	177	(149–208)	2	(1–3)	3	(1–11)	59	(50–70)	5	(3–8)
2016	1	(0–2)	163	(142–188)	1	(0–2)	2	(1–6)	1	(0–2)	65	(45–95)	49	(40–59)	0	(0–1)	1	(0–5)	65	(54–78)	5	(3–8)
2017	1	(0–2)	154	(131–180)	0	(0–1)	2	(1–4)	1	(0–2)	43	(28–67)	64	(54–78)	0	(0–1)	2	(0–5)	47	(40–55)	3	(2–5)
2018	1	(0–2)	152	(129–182)	0	(0–1)	2	(1–5)	1	(0–3)	24	(14–41)	78	(64–95)	1	(0–1)	3	(1–11)	44	(37–53)	2	(1–3)
2019	0	(0–1)	133	(113–159)	0	(0–1)	2	(1–5)	1	(1–3)	39	(24–66)	67	(54–86)	0	(0–1)	1	(0–4)	48	(38–63)	2	(1–3)
2020	0	(0–1)	86	(75–102)	0	(0–1)	0	(0–1)	1	(0–1)	22	(13–38)	43	(35–54)	0	(0–1)	2	(0–6)	33	(26–42)	1	(1–2)
2021	1	(0–2)	70	(62–80)	0	(0–1)	0	(0–1)	1	(0–2)	38	(25–56)	38	(31–46)	0	(0–1)	1	(0–5)	23	(18–29)	1	(0–2)
2022	0	(0–1)	119	(104–136)	0	(0–1)	0	(0–1)	1	(0–1)	99	(72–136)	47	(39–56)	0	(0–1)	3	(1–9)	47	(39–58)	1	(0–1)

Table A7: continued

GSH (Dark ghost shark)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	63	(31–136)	87	(60–134)	14	(5–36)	3	(1–12)	2	(0–8)	18	(8–42)	53	(33–88)	16	(8–37)	1	(0–5)	27	(18–44)	1	(0–2)
2004	26	(10–77)	77	(51–118)	20	(8–53)	5	(1–19)	3	(1–10)	12	(5–28)	54	(27–112)	9	(4–21)	1	(0–7)	42	(29–67)	1	(0–3)
2005	38	(13–116)	131	(97–179)	15	(7–33)	3	(1–11)	1	(0–6)	13	(6–31)	24	(13–42)	3	(1–10)	0	(0–2)	22	(15–35)	0	(0–1)
2006	4	(1–33)	47	(29–79)	18	(7–50)	1	(0–8)	3	(1–13)	19	(8–52)	31	(17–59)	1	(0–5)	2	(0–16)	32	(19–59)	0	(0–2)
2007	4	(1–31)	39	(24–67)	14	(6–35)	2	(0–11)	2	(0–8)	8	(4–21)	59	(33–115)	2	(0–8)	1	(0–8)	10	(5–24)	0	(0–1)
2008	11	(3–44)	115	(71–201)	21	(9–56)	2	(0–10)	2	(0–10)	8	(3–27)	24	(13–50)	4	(1–14)	2	(0–16)	9	(5–19)	0	(0–1)
2009	15	(5–60)	128	(83–212)	19	(6–62)	4	(1–19)	2	(1–10)	12	(6–30)	28	(17–49)	4	(1–12)	3	(0–21)	9	(4–20)	0	(0–1)
2010	6	(1–37)	360	(248–572)	21	(10–53)	7	(2–29)	8	(2–30)	24	(12–65)	31	(20–56)	2	(0–8)	1	(0–9)	34	(20–64)	1	(0–3)
2011	30	(7–161)	296	(182–561)	26	(8–102)	12	(3–62)	7	(2–33)	16	(6–65)	74	(41–169)	5	(1–26)	2	(0–21)	52	(28–115)	1	(0–7)
2012	9	(2–50)	415	(277–659)	9	(4–23)	5	(1–24)	5	(1–22)	6	(3–15)	33	(21–61)	3	(1–13)	2	(0–16)	26	(16–45)	1	(0–3)
2013	27	(6–146)	182	(126–288)	25	(11–62)	7	(1–32)	9	(2–36)	12	(6–36)	57	(37–101)	5	(2–21)	2	(0–23)	22	(14–40)	1	(0–4)
2014	31	(10–115)	223	(152–354)	22	(10–51)	14	(5–41)	5	(2–17)	11	(5–27)	98	(68–154)	6	(2–20)	1	(0–11)	13	(8–22)	1	(0–3)
2015	33	(12–118)	291	(199–445)	12	(6–29)	5	(1–24)	4	(2–11)	10	(4–26)	82	(55–139)	2	(1–9)	1	(0–10)	17	(11–32)	2	(1–5)
2016	21	(7–87)	504	(353–789)	13	(7–34)	8	(2–41)	7	(3–22)	16	(8–36)	39	(25–70)	2	(0–12)	1	(0–10)	79	(52–138)	2	(1–6)
2017	10	(3–39)	303	(200–507)	10	(4–29)	7	(2–23)	7	(3–20)	10	(5–28)	51	(33–95)	1	(0–3)	1	(0–9)	29	(19–47)	1	(0–3)
2018	33	(11–132)	196	(138–306)	14	(7–34)	7	(2–29)	7	(2–22)	15	(7–43)	70	(46–122)	2	(1–6)	2	(0–16)	31	(21–49)	1	(0–4)
2019	27	(8–118)	159	(111–240)	10	(4–24)	6	(2–26)	9	(4–25)	29	(14–68)	81	(53–139)	2	(1–6)	1	(0–6)	32	(21–57)	1	(0–3)
2020	1	(0–9)	35	(23–58)	3	(1–9)	1	(0–5)	6	(3–13)	7	(3–19)	23	(14–41)	1	(0–4)	1	(0–5)	12	(7–20)	0	(0–1)
2021	20	(7–69)	69	(49–104)	3	(1–10)	1	(0–8)	7	(3–20)	22	(11–49)	25	(16–42)	2	(1–5)	1	(0–7)	5	(3–10)	0	(0–1)
2022	7	(2–30)	94	(69–136)	5	(2–13)	1	(0–6)	5	(2–13)	18	(11–34)	34	(23–53)	1	(0–3)	1	(0–9)	12	(8–20)	1	(0–2)

Table A7: continued

GSP (Pale ghost shark)

FY	AUCK	CHAT	COOK	EAST	NORTH	PUYS	STEW	SUBA	WCNI	WCSI(BT)	WCSI(MW)
2003	45 (28–73)	1 479 (1 330–1 655)	2 (1–5)	4 (1–10)	0 (0–2)	5 (3–11)	188 (159–223)	190 (148–241)	0 (0–1)	22 (16–30)	1 (0–1)
2004	19 (12–31)	886 (805–993)	1 (1–3)	2 (0–6)	0 (0–2)	3 (1–5)	183 (143–235)	229 (189–277)	0 (0–1)	12 (9–17)	0 (0–1)
2005	19 (8–44)	802 (719–897)	1 (0–3)	1 (0–3)	0 (0–1)	2 (1–3)	82 (64–108)	73 (45–115)	0 (0–0)	8 (5–14)	0 (0–0)
2006	4 (2–12)	880 (771–1 021)	2 (1–4)	1 (0–4)	0 (0–3)	6 (3–12)	77 (58–103)	18 (8–42)	0 (0–2)	19 (15–25)	0 (0–1)
2007	4 (2–10)	505 (450–574)	1 (0–2)	1 (0–3)	0 (0–1)	1 (1–3)	109 (88–135)	44 (26–79)	0 (0–1)	17 (12–25)	0 (0–0)
2008	15 (9–29)	717 (616–829)	3 (1–9)	1 (0–6)	0 (0–3)	4 (2–8)	197 (155–250)	78 (55–113)	0 (0–3)	14 (11–19)	0 (0–1)
2009	9 (5–17)	382 (330–449)	1 (1–3)	1 (0–5)	0 (0–2)	1 (1–3)	98 (81–122)	58 (42–81)	0 (0–2)	9 (7–13)	0 (0–0)
2010	4 (1–15)	512 (434–618)	1 (0–2)	1 (0–6)	0 (0–3)	2 (1–4)	85 (68–109)	39 (19–79)	0 (0–1)	7 (5–11)	0 (0–1)
2011	21 (11–43)	351 (306–406)	1 (0–3)	2 (1–9)	0 (0–2)	2 (1–4)	54 (42–71)	57 (37–91)	0 (0–1)	19 (13–26)	0 (0–1)
2012	7 (3–19)	426 (373–488)	1 (0–1)	1 (0–6)	0 (0–2)	2 (1–3)	57 (45–72)	25 (15–46)	0 (0–1)	16 (12–23)	0 (0–1)
2013	6 (3–15)	442 (391–504)	1 (0–3)	1 (0–6)	0 (0–2)	2 (1–4)	112 (93–136)	27 (17–45)	0 (0–1)	9 (7–11)	0 (0–1)
2014	26 (15–49)	475 (414–546)	3 (1–6)	5 (1–19)	1 (0–4)	4 (2–7)	211 (175–258)	33 (23–50)	0 (0–2)	22 (18–28)	1 (0–2)
2015	19 (10–40)	782 (661–934)	1 (1–3)	3 (1–11)	1 (0–5)	3 (2–6)	127 (102–159)	62 (37–112)	0 (0–2)	34 (28–43)	1 (0–2)
2016	9 (4–19)	510 (447–582)	1 (0–3)	2 (1–9)	0 (0–3)	4 (2–6)	60 (47–77)	18 (9–37)	0 (0–1)	36 (29–45)	1 (0–1)
2017	3 (2–7)	651 (562–757)	0 (0–1)	1 (0–6)	0 (0–2)	2 (1–4)	53 (41–70)	19 (12–32)	0 (0–1)	13 (11–16)	0 (0–1)
2018	26 (15–51)	600 (523–694)	1 (0–2)	3 (1–11)	1 (0–3)	2 (1–4)	217 (179–265)	123 (94–162)	0 (0–2)	27 (22–33)	1 (0–1)
2019	14 (6–34)	566 (493–657)	1 (0–2)	2 (1–11)	1 (0–6)	3 (2–7)	93 (72–120)	92 (62–140)	0 (0–1)	12 (8–16)	0 (0–1)
2020	4 (2–13)	452 (394–524)	0 (0–1)	1 (0–4)	1 (0–5)	4 (2–8)	97 (78–125)	51 (35–77)	0 (0–1)	13 (10–17)	0 (0–1)
2021	12 (6–23)	402 (360–450)	0 (0–1)	1 (0–3)	1 (0–4)	4 (2–7)	94 (77–115)	40 (28–59)	0 (0–1)	9 (7–12)	0 (0–1)
2022	5 (2–11)	566 (502–649)	0 (0–1)	0 (0–2)	1 (0–3)	4 (2–7)	67 (55–84)	24 (16–36)	0 (0–1)	8 (6–10)	0 (0–1)

Table A7: continued

JMA (Jack mackerels)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	0	(0–1)	7	(4–16)	6	(3–13)	2	(0–15)	0	(0–2)	0	(0–1)	1	(0–7)	0	(0–1)	2	(0–73)	3	(1–8)	19	(12–33)
2004	0	(0–1)	14	(4–56)	9	(4–22)	5	(1–36)	0	(0–4)	0	(0–2)	2	(0–10)	0	(0–2)	3	(0–127)	4	(1–14)	46	(29–84)
2005	0	(0–1)	17	(6–64)	13	(6–32)	4	(1–31)	0	(0–3)	1	(0–5)	2	(0–12)	0	(0–2)	1	(0–118)	3	(1–14)	21	(12–44)
2006	0	(0–0)	3	(1–7)	3	(1–14)	1	(0–5)	0	(0–2)	0	(0–1)	1	(0–4)	0	(0–0)	6	(0–75)	2	(1–5)	9	(7–13)
2007	0	(0–0)	5	(1–17)	3	(2–8)	0	(0–3)	0	(0–1)	0	(0–0)	0	(0–2)	0	(0–0)	1	(0–48)	0	(0–1)	5	(3–10)
2008	0	(0–1)	35	(15–105)	7	(3–20)	3	(0–32)	1	(0–7)	0	(0–3)	4	(1–26)	0	(0–2)	30	(0–680)	19	(6–82)	7	(3–20)
2009	0	(0–0)	2	(1–6)	1	(0–5)	0	(0–4)	0	(0–1)	0	(0–0)	0	(0–3)	0	(0–0)	2	(0–64)	1	(0–3)	2	(1–5)
2010	0	(0–0)	1	(1–2)	3	(2–6)	0	(0–3)	0	(0–2)	0	(0–0)	1	(0–4)	0	(0–0)	0	(0–30)	1	(0–5)	4	(1–17)
2011	0	(0–0)	2	(1–9)	2	(0–9)	1	(0–10)	0	(0–2)	0	(0–1)	0	(0–2)	0	(0–0)	0	(0–36)	1	(0–5)	4	(2–16)
2012	0	(0–0)	18	(9–43)	12	(6–25)	2	(0–11)	0	(0–4)	0	(0–1)	1	(0–3)	0	(0–0)	6	(0–160)	1	(0–5)	10	(5–21)
2013	0	(0–0)	3	(2–5)	8	(5–13)	1	(0–3)	0	(0–1)	0	(0–0)	0	(0–1)	0	(0–0)	3	(0–50)	0	(0–1)	3	(2–5)
2014	0	(0–0)	2	(1–3)	2	(2–4)	2	(1–6)	0	(0–1)	0	(0–0)	0	(0–1)	0	(0–0)	1	(0–29)	1	(0–2)	4	(3–7)
2015	0	(0–0)	10	(6–18)	20	(13–31)	2	(0–7)	1	(0–3)	0	(0–1)	2	(1–5)	0	(0–0)	4	(0–93)	3	(1–9)	25	(18–39)
2016	0	(0–0)	10	(6–17)	8	(4–14)	3	(0–17)	0	(0–2)	0	(0–1)	1	(0–3)	0	(0–0)	1	(0–50)	2	(1–5)	17	(13–24)
2017	0	(0–0)	8	(4–15)	3	(1–7)	3	(1–10)	0	(0–2)	0	(0–1)	1	(0–2)	0	(0–0)	6	(0–110)	1	(0–2)	10	(7–16)
2018	0	(0–0)	6	(3–12)	6	(3–12)	3	(1–21)	0	(0–2)	0	(0–1)	2	(1–6)	0	(0–0)	5	(0–94)	2	(1–6)	33	(24–50)
2019	0	(0–0)	10	(5–27)	7	(4–16)	2	(0–17)	1	(0–9)	0	(0–1)	1	(0–5)	0	(0–0)	1	(0–66)	2	(1–8)	15	(10–26)
2020	0	(0–0)	3	(1–10)	2	(1–4)	1	(0–5)	1	(0–2)	0	(0–0)	1	(0–2)	0	(0–0)	1	(0–37)	0	(0–1)	6	(4–9)
2021	0	(0–0)	29	(15–60)	3	(1–6)	1	(0–5)	1	(0–5)	0	(0–0)	1	(0–3)	0	(0–0)	4	(0–102)	1	(0–4)	5	(3–9)
2022	0	(0–0)	7	(3–16)	2	(1–4)	1	(0–4)	0	(0–2)	0	(0–0)	0	(0–1)	0	(0–0)	4	(0–55)	0	(0–1)	9	(6–14)

Table A7: continued

JAV (Javelinfish)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS
2003	70	(43–114)	6 196	(5 558–6 967)	19	(6–72)	33	(15–73)	2	(1–10)	29	(17–52)
2004	10	(5–21)	5 097	(4 450–5 850)	12	(3–49)	5	(1–20)	2	(0–8)	8	(5–15)
2005	86	(29–268)	5 115	(4 588–5 758)	24	(8–64)	9	(2–44)	3	(1–15)	33	(18–63)
2006	11	(3–47)	4 315	(3 770–4 974)	20	(5–90)	4	(1–23)	5	(1–20)	109	(65–178)
2007	16	(5–61)	4 757	(4 176–5 417)	12	(5–30)	6	(1–22)	3	(1–12)	13	(8–22)
2008	24	(13–47)	4 548	(3 969–5 316)	47	(21–106)	5	(1–24)	3	(1–16)	39	(16–93)
2009	25	(13–51)	4 814	(4 190–5 590)	39	(13–122)	8	(2–38)	3	(1–14)	7	(4–12)
2010	15	(4–57)	6 995	(5 981–8 306)	27	(16–49)	12	(3–49)	6	(2–21)	13	(7–24)
2011	30	(15–65)	4 003	(3 481–4 627)	17	(5–53)	10	(2–47)	7	(2–25)	9	(5–16)
2012	10	(4–28)	2 515	(2 231–2 871)	16	(9–28)	7	(2–26)	4	(1–16)	24	(16–38)
2013	19	(8–49)	3 652	(3 229–4 139)	31	(19–51)	8	(2–38)	6	(1–29)	38	(25–64)
2014	45	(26–87)	2 628	(2 331–2 964)	24	(15–38)	14	(6–36)	13	(7–24)	60	(38–100)
2015	70	(37–151)	5 044	(4 359–5 894)	22	(15–36)	11	(6–23)	6	(4–11)	91	(59–149)
2016	29	(14–74)	6 400	(5 546–7 467)	24	(12–54)	18	(4–79)	14	(7–32)	293	(183–493)
2017	56	(28–119)	6 216	(5 435–7 148)	5	(2–18)	5	(2–12)	7	(3–14)	96	(60–164)
2018	124	(68–242)	6 224	(5 405–7 201)	5	(2–13)	10	(3–28)	7	(4–15)	47	(29–79)
2019	48	(25–107)	2 986	(2 666–3 397)	5	(2–9)	24	(7–91)	17	(9–32)	53	(35–84)
2020	10	(4–27)	2 334	(2 074–2 659)	2	(1–7)	3	(1–10)	4	(2–6)	37	(21–67)
2021	36	(20–71)	3 176	(2 852–3 598)	3	(1–7)	3	(1–17)	6	(2–17)	31	(20–50)
2022	16	(8–41)	3 648	(3 236–4 176)	3	(2–7)	2	(0–7)	4	(2–7)	31	(22–44)

Javelinfish continued

FY	STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	631	(536–747)	211	(162–273)	0	(0–2)	185	(158–219)	62	(51–75)
2004	208	(160–274)	111	(82–152)	0	(0–1)	125	(104–153)	81	(69–96)
2005	533	(430–679)	407	(224–729)	0	(0–2)	101	(83–123)	100	(87–115)
2006	189	(154–237)	25	(8–89)	1	(0–8)	264	(221–320)	74	(61–92)
2007	301	(254–367)	122	(57–249)	0	(0–3)	149	(107–209)	49	(39–64)
2008	397	(329–489)	121	(82–183)	1	(0–7)	348	(278–438)	15	(11–21)
2009	359	(298–439)	78	(53–123)	1	(0–7)	535	(398–725)	13	(10–18)
2010	337	(281–416)	143	(64–357)	0	(0–3)	135	(105–176)	25	(17–39)
2011	204	(169–254)	42	(27–73)	0	(0–2)	219	(177–278)	28	(20–39)
2012	214	(180–259)	18	(11–34)	1	(0–3)	174	(144–208)	25	(20–31)
2013	365	(310–435)	7	(4–12)	0	(0–2)	556	(465–670)	57	(47–71)
2014	557	(480–654)	22	(16–34)	1	(0–4)	647	(547–772)	59	(50–70)
2015	479	(406–573)	62	(38–107)	1	(0–5)	1 251	(1 061–1 487)	75	(65–89)
2016	331	(263–425)	38	(15–102)	0	(0–5)	926	(759–1 160)	127	(108–157)
2017	190	(157–235)	103	(64–178)	0	(0–2)	320	(274–379)	55	(45–70)
2018	828	(711–995)	409	(308–567)	1	(0–7)	405	(350–475)	168	(143–202)
2019	452	(381–546)	159	(110–240)	0	(0–2)	147	(120–182)	98	(83–118)
2020	381	(315–469)	262	(184–381)	0	(0–4)	118	(98–143)	103	(88–125)
2021	523	(443–631)	117	(79–190)	0	(0–2)	73	(59–92)	58	(47–74)
2022	326	(276–397)	84	(55–136)	0	(0–3)	67	(55–84)	100	(82–124)

Table A7: continued

LDO (Lookdown dory)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	5	(3–9)	683	(612–764)	2	(1–3)	3	(2–8)	2	(1–4)	11	(7–18)	23	(19–30)	12	(8–17)	1	(0–3)	131	(113–154)	22	(18–28)
2004	2	(1–4)	435	(388–492)	2	(1–4)	3	(1–8)	2	(1–5)	8	(5–11)	17	(13–22)	7	(5–10)	1	(0–3)	102	(88–118)	19	(16–22)
2005	1	(0–3)	334	(299–373)	1	(1–3)	2	(1–5)	1	(0–3)	10	(6–17)	22	(15–31)	3	(2–6)	0	(0–2)	81	(67–100)	5	(4–7)
2006	0	(0–1)	231	(205–261)	1	(0–2)	1	(0–3)	2	(1–5)	18	(12–28)	16	(12–20)	0	(0–1)	2	(0–7)	148	(128–170)	9	(7–12)
2007	0	(0–1)	300	(266–341)	1	(0–1)	2	(1–4)	1	(0–4)	9	(6–14)	28	(22–35)	1	(1–3)	1	(0–3)	86	(66–111)	6	(5–9)
2008	1	(0–1)	174	(155–194)	2	(1–3)	1	(1–3)	1	(1–4)	7	(4–13)	12	(10–14)	3	(2–4)	2	(1–7)	82	(71–95)	4	(3–6)
2009	1	(0–1)	150	(130–174)	1	(1–3)	2	(1–6)	2	(1–4)	8	(5–12)	14	(12–18)	2	(1–3)	2	(1–8)	82	(64–105)	5	(4–7)
2010	0	(0–1)	218	(194–243)	1	(1–2)	2	(1–5)	4	(2–8)	10	(7–14)	16	(14–19)	1	(0–1)	1	(0–3)	48	(41–57)	9	(7–12)
2011	0	(0–1)	171	(153–191)	1	(0–1)	3	(1–8)	2	(1–5)	8	(5–12)	14	(12–18)	1	(0–1)	1	(0–3)	113	(96–133)	13	(9–18)
2012	0	(0–1)	218	(195–246)	0	(0–1)	2	(1–5)	2	(1–5)	7	(5–10)	11	(9–14)	0	(0–1)	1	(0–4)	61	(52–73)	7	(6–10)
2013	0	(0–1)	289	(259–326)	1	(1–3)	4	(1–9)	5	(2–11)	8	(5–12)	22	(19–27)	1	(1–3)	2	(1–7)	136	(118–161)	29	(24–36)
2014	1	(1–2)	289	(259–321)	2	(1–4)	8	(4–18)	5	(3–9)	13	(9–20)	27	(23–32)	2	(1–3)	1	(0–6)	204	(178–234)	18	(15–21)
2015	1	(1–3)	521	(455–592)	1	(1–2)	4	(2–8)	4	(3–8)	10	(7–15)	26	(21–32)	1	(1–2)	1	(0–5)	233	(205–270)	26	(22–32)
2016	1	(0–2)	437	(388–491)	1	(1–2)	4	(2–10)	5	(2–10)	14	(10–21)	15	(12–18)	0	(0–1)	1	(0–3)	178	(152–209)	25	(21–30)
2017	0	(0–1)	428	(372–489)	1	(0–1)	4	(2–9)	5	(2–10)	9	(6–14)	16	(13–21)	1	(0–1)	1	(0–5)	125	(109–146)	21	(17–27)
2018	1	(0–2)	344	(308–384)	1	(0–1)	4	(2–9)	5	(2–10)	7	(5–10)	26	(22–31)	2	(1–3)	2	(0–6)	184	(164–206)	13	(11–15)
2019	1	(0–1)	317	(282–356)	1	(0–2)	5	(2–11)	7	(3–13)	18	(12–27)	36	(29–44)	1	(1–2)	1	(0–3)	127	(108–149)	19	(17–23)
2020	0	(0–1)	238	(215–266)	0	(0–1)	1	(1–3)	4	(3–7)	21	(13–32)	26	(22–32)	1	(1–2)	1	(0–5)	102	(90–119)	11	(9–13)
2021	1	(1–2)	263	(239–291)	0	(0–1)	2	(1–5)	5	(2–9)	18	(13–26)	22	(18–26)	1	(1–2)	1	(0–3)	91	(77–107)	11	(9–14)
2022	1	(0–1)	343	(305–385)	1	(0–1)	1	(0–4)	6	(3–14)	30	(22–42)	32	(26–39)	1	(1–3)	2	(0–7)	85	(71–102)	13	(11–17)

Table A7: continued

RIB (Ribaldo)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	11	(6–20)	275	(241–314)	4	(1–11)	6	(3–12)	0	(0–0)	16	(8–31)	75	(63–90)	45	(32–63)	0	(0–1)	142	(119–171)	2	(1–3)
2004	4	(2–7)	319	(275–369)	7	(2–20)	3	(1–12)	0	(0–1)	11	(6–21)	85	(65–112)	43	(32–57)	0	(0–1)	139	(116–167)	11	(7–15)
2005	4	(1–12)	172	(154–195)	4	(2–11)	2	(0–7)	0	(0–0)	6	(4–11)	88	(71–109)	25	(14–44)	0	(0–1)	112	(91–137)	2	(1–3)
2006	1	(0–2)	169	(144–198)	5	(2–14)	1	(0–5)	0	(0–1)	18	(11–30)	61	(48–78)	6	(2–18)	0	(0–3)	235	(196–280)	2	(1–3)
2007	1	(0–3)	190	(166–218)	3	(1–7)	1	(0–4)	0	(0–1)	9	(6–16)	66	(54–80)	10	(5–18)	0	(0–2)	218	(164–296)	2	(1–3)
2008	3	(2–7)	270	(236–312)	8	(3–19)	2	(1–8)	0	(0–1)	16	(7–34)	98	(80–118)	17	(12–25)	1	(0–5)	655	(543–789)	0	(0–1)
2009	2	(1–4)	202	(174–237)	4	(2–8)	2	(1–8)	0	(0–1)	3	(2–5)	60	(50–72)	9	(6–13)	0	(0–3)	417	(332–534)	1	(0–1)
2010	1	(0–3)	123	(103–150)	5	(3–10)	2	(1–8)	0	(0–1)	3	(2–7)	59	(47–75)	12	(6–27)	0	(0–1)	134	(103–176)	1	(0–2)
2011	1	(0–2)	106	(90–126)	2	(1–4)	2	(0–6)	0	(0–0)	4	(2–7)	27	(21–34)	4	(2–7)	0	(0–1)	173	(138–219)	1	(0–1)
2012	1	(0–2)	94	(82–109)	1	(1–3)	1	(0–6)	0	(0–1)	4	(3–7)	49	(39–60)	5	(3–9)	0	(0–2)	159	(126–200)	1	(0–2)
2013	1	(0–4)	151	(130–176)	4	(2–8)	2	(1–7)	0	(0–1)	5	(3–9)	58	(48–71)	9	(5–15)	0	(0–1)	156	(130–187)	1	(1–2)
2014	3	(1–6)	137	(120–157)	7	(4–13)	5	(2–15)	0	(0–1)	13	(8–19)	72	(60–85)	17	(12–24)	0	(0–2)	377	(324–439)	1	(1–2)
2015	4	(1–11)	312	(253–386)	7	(4–14)	3	(1–9)	0	(0–1)	9	(5–17)	103	(79–135)	13	(7–27)	0	(0–2)	535	(440–673)	2	(1–3)
2016	2	(1–5)	149	(129–172)	2	(1–5)	2	(1–5)	0	(0–1)	21	(15–32)	41	(34–53)	4	(2–8)	0	(0–1)	212	(176–253)	1	(1–2)
2017	1	(1–4)	185	(151–226)	2	(1–5)	3	(1–8)	0	(0–1)	5	(3–10)	42	(32–56)	7	(4–13)	0	(0–1)	248	(202–305)	2	(1–3)
2018	5	(2–11)	189	(157–230)	2	(1–5)	5	(1–17)	0	(0–2)	9	(5–18)	109	(89–137)	59	(43–85)	0	(0–2)	161	(137–194)	2	(1–3)
2019	1	(0–3)	136	(114–163)	1	(0–3)	2	(1–6)	0	(0–2)	9	(6–16)	72	(56–93)	38	(25–62)	0	(0–1)	47	(37–60)	1	(1–2)
2020	1	(0–3)	83	(71–99)	1	(0–2)	1	(0–3)	0	(0–1)	9	(5–19)	40	(31–52)	19	(12–30)	0	(0–1)	73	(59–90)	1	(1–3)
2021	1	(0–3)	86	(75–99)	1	(0–3)	1	(0–2)	0	(0–1)	7	(4–12)	45	(37–55)	12	(8–18)	0	(0–1)	50	(40–63)	0	(0–1)
2022	1	(0–3)	149	(129–176)	1	(0–2)	0	(0–2)	0	(0–1)	5	(3–8)	64	(51–80)	9	(5–15)	0	(0–1)	35	(28–44)	0	(0–1)

Table A7: continued

RSO (Gemfish)

FY		AUCK		CHAT		COOK		EAST		NORTH		PUYS
2003	0	(0–0)	8	(4–15)	4	(1–10)	23	(10–51)	15	(4–50)	8	(3–20)
2004	0	(0–0)	7	(3–16)	9	(3–27)	39	(11–138)	29	(8–103)	14	(7–29)
2005	0	(0–0)	2	(1–5)	3	(1–9)	13	(3–46)	9	(3–34)	5	(2–14)
2006	0	(0–0)	1	(0–2)	1	(0–5)	5	(1–20)	13	(4–45)	5	(2–13)
2007	0	(0–0)	1	(0–1)	1	(0–1)	3	(1–7)	5	(1–17)	2	(1–3)
2008	0	(0–0)	0	(0–1)	1	(0–2)	3	(1–10)	5	(1–16)	1	(1–5)
2009	0	(0–0)	1	(0–2)	1	(0–4)	7	(2–27)	7	(2–26)	2	(1–4)
2010	0	(0–0)	1	(1–2)	2	(1–3)	6	(2–19)	9	(3–23)	4	(2–8)
2011	0	(0–0)	1	(1–3)	1	(1–4)	12	(4–38)	9	(4–28)	4	(2–9)
2012	0	(0–0)	0	(0–1)	1	(0–1)	4	(1–12)	8	(2–24)	1	(1–3)
2013	0	(0–0)	1	(1–2)	4	(2–6)	15	(4–51)	29	(9–98)	4	(2–8)
2014	0	(0–0)	1	(0–2)	2	(1–5)	18	(8–40)	11	(5–22)	4	(2–9)
2015	0	(0–0)	2	(1–4)	4	(3–8)	16	(8–34)	13	(8–23)	5	(3–12)
2016	0	(0–0)	3	(2–6)	3	(1–7)	28	(9–97)	63	(32–123)	9	(5–16)
2017	0	(0–0)	21	(13–39)	4	(2–10)	98	(50–191)	33	(18–64)	9	(5–17)
2018	0	(0–0)	14	(10–21)	7	(4–10)	69	(29–169)	162	(89–301)	18	(10–31)
2019	0	(0–0)	24	(18–33)	10	(7–15)	75	(24–232)	78	(46–134)	55	(36–85)
2020	0	(0–0)	11	(8–15)	9	(6–12)	45	(21–95)	229	(162–321)	58	(35–100)
2021	0	(0–1)	22	(14–33)	15	(9–26)	56	(17–182)	579	(314–1 105)	124	(75–216)
2022	0	(0–1)	30	(22–42)	13	(9–21)	38	(11–139)	274	(161–490)	237	(156–378)

Gemfish continued

FY	STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)
2003	9	(5–17)	0	(0–1)	1	(0–6)	141	(110–181)	78	(64–97)
2004	17	(6–49)	0	(0–1)	3	(0–13)	362	(289–457)	144	(121–173)
2005	4	(2–10)	0	(0–0)	0	(0–3)	203	(160–260)	27	(22–33)
2006	3	(2–7)	0	(0–0)	2	(0–11)	107	(83–140)	15	(12–20)
2007	1	(1–2)	0	(0–0)	2	(1–7)	13	(9–19)	4	(3–5)
2008	1	(0–2)	0	(0–0)	1	(0–5)	11	(7–16)	2	(1–3)
2009	2	(1–4)	0	(0–0)	1	(0–5)	26	(15–44)	11	(8–16)
2010	2	(1–4)	0	(0–0)	0	(0–2)	17	(12–22)	6	(4–9)
2011	3	(2–5)	0	(0–0)	1	(0–5)	62	(46–85)	34	(25–48)
2012	1	(0–2)	0	(0–0)	0	(0–2)	16	(11–22)	10	(7–14)
2013	4	(2–5)	0	(0–0)	2	(1–11)	51	(40–66)	48	(38–61)
2014	4	(2–6)	0	(0–0)	1	(0–8)	58	(43–81)	61	(47–82)
2015	7	(5–12)	0	(0–0)	1	(0–8)	80	(60–108)	51	(41–65)
2016	7	(4–11)	0	(0–0)	1	(0–5)	99	(78–128)	59	(49–73)
2017	17	(12–26)	0	(0–0)	5	(1–24)	243	(196–309)	174	(140–223)
2018	32	(24–44)	0	(0–1)	6	(1–31)	314	(269–372)	136	(116–160)
2019	110	(86–147)	0	(0–1)	3	(1–15)	637	(524–781)	420	(367–486)
2020	50	(39–63)	0	(0–1)	8	(2–35)	551	(467–650)	390	(342–447)
2021	95	(70–133)	0	(0–1)	8	(2–54)	483	(384–631)	463	(377–589)
2022	160	(122–211)	0	(0–1)	17	(4–69)	461	(370–588)	315	(264–389)

Table A7: continued

SBW (Southern blue whiting)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	60	(19–183)	4	(2–12)	0	(0–0)	0	(0–1)	0	(0–0)	0	(0–0)	9	(4–24)	549	(330–1052)	0	(0–0)	0	(0–0)	0	(0–0)
2004	49	(16–182)	7	(3–23)	0	(0–0)	0	(0–1)	0	(0–0)	0	(0–0)	5	(2–19)	172	(91–410)	0	(0–0)	0	(0–0)	0	(0–0)
2005	6	(1–73)	0	(0–4)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(0–6)	46	(13–329)	0	(0–0)	0	(0–0)	0	(0–0)
2006	0	(0–1)	0	(0–1)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	1	(0–2)	3	(1–11)	0	(0–0)	0	(0–0)	0	(0–0)
2007	2	(0–6)	1	(0–2)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	3	(2–6)	23	(11–52)	0	(0–0)	0	(0–0)	0	(0–0)
2008	43	(19–125)	3	(1–8)	0	(0–1)	0	(0–1)	0	(0–0)	0	(0–0)	11	(5–24)	297	(185–534)	0	(0–2)	0	(0–0)	0	(0–0)
2009	23	(8–107)	8	(3–24)	0	(0–1)	0	(0–2)	0	(0–0)	0	(0–1)	16	(7–45)	320	(168–800)	0	(0–2)	0	(0–0)	0	(0–0)
2010	3	(1–14)	1	(1–4)	0	(0–0)	0	(0–0)	0	(0–0)	0	(0–0)	2	(1–4)	72	(28–201)	0	(0–0)	0	(0–0)	0	(0–0)
2011	26	(11–75)	7	(3–17)	0	(0–0)	0	(0–1)	0	(0–0)	0	(0–0)	3	(2–6)	100	(53–222)	0	(0–0)	0	(0–0)	0	(0–0)
2012	7	(2–26)	3	(2–7)	0	(0–0)	0	(0–1)	0	(0–0)	0	(0–0)	3	(2–6)	32	(16–75)	0	(0–0)	0	(0–0)	0	(0–0)
2013	4	(1–12)	3	(2–6)	0	(0–0)	0	(0–1)	0	(0–0)	0	(0–0)	4	(3–6)	105	(60–199)	0	(0–0)	0	(0–0)	0	(0–0)
2014	70	(31–203)	6	(4–12)	0	(0–1)	0	(0–7)	0	(0–1)	0	(0–1)	28	(19–45)	376	(219–761)	0	(0–1)	0	(0–1)	0	(0–0)
2015	51	(19–163)	22	(14–38)	0	(0–2)	0	(0–5)	0	(0–2)	0	(0–1)	30	(20–50)	160	(81–434)	0	(0–2)	0	(0–1)	0	(0–0)
2016	46	(15–212)	29	(16–60)	0	(0–1)	0	(0–4)	0	(0–2)	0	(0–1)	24	(12–60)	48	(15–206)	0	(0–1)	0	(0–1)	0	(0–1)
2017	13	(5–42)	14	(8–25)	0	(0–0)	0	(0–2)	0	(0–0)	0	(0–0)	6	(4–12)	60	(32–143)	0	(0–1)	0	(0–0)	0	(0–0)
2018	85	(36–253)	14	(9–24)	0	(0–1)	0	(0–7)	0	(0–2)	0	(0–1)	44	(29–74)	152	(99–275)	0	(0–2)	0	(0–1)	0	(0–0)
2019	27	(9–118)	11	(6–22)	0	(0–1)	0	(0–3)	0	(0–2)	0	(0–1)	13	(7–27)	86	(44–203)	0	(0–0)	0	(0–0)	0	(0–0)
2020	8	(2–41)	12	(7–24)	0	(0–1)	0	(0–1)	0	(0–3)	0	(0–1)	40	(22–79)	137	(77–317)	0	(0–2)	0	(0–0)	0	(0–0)
2021	42	(19–113)	11	(7–19)	0	(0–0)	0	(0–2)	0	(0–2)	0	(0–1)	23	(15–39)	196	(119–372)	0	(0–1)	0	(0–0)	0	(0–0)
2022	25	(7–108)	11	(6–26)	0	(0–1)	0	(0–1)	0	(0–2)	0	(0–1)	17	(10–39)	225	(114–601)	0	(0–1)	0	(0–0)	0	(0–0)

Table A7: continued

SND (Shovelnose dogfish)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	1	(0–3)	266	(212–339)	4	(2–9)	6	(2–19)	0	(0–1)	14	(6–30)	3	(2–5)	1	(0–1)	0	(0–2)	24	(17–36)	2	(1–4)
2004	1	(0–2)	206	(172–251)	6	(2–12)	4	(1–16)	0	(0–1)	12	(6–23)	4	(2–9)	1	(0–2)	0	(0–2)	34	(24–50)	4	(2–7)
2005	1	(0–2)	219	(190–254)	11	(6–20)	3	(1–10)	0	(0–1)	10	(5–19)	6	(3–12)	0	(0–1)	0	(0–1)	9	(6–12)	2	(1–2)
2006	0	(0–1)	243	(208–288)	11	(4–27)	4	(1–14)	0	(0–2)	76	(47–127)	12	(8–18)	0	(0–1)	2	(0–11)	64	(50–83)	3	(2–6)
2007	0	(0–1)	176	(142–225)	6	(3–12)	2	(0–6)	0	(0–1)	8	(4–18)	5	(3–8)	0	(0–1)	0	(0–3)	27	(18–42)	1	(1–3)
2008	0	(0–2)	386	(327–456)	24	(13–45)	5	(1–16)	0	(0–2)	31	(14–70)	9	(6–13)	1	(0–3)	2	(0–12)	69	(51–95)	1	(1–3)
2009	0	(0–1)	282	(235–342)	6	(3–13)	4	(1–15)	0	(0–1)	7	(3–17)	4	(3–7)	0	(0–1)	1	(0–6)	36	(26–51)	1	(0–2)
2010	0	(0–0)	131	(101–169)	8	(4–14)	3	(1–11)	0	(0–2)	6	(2–16)	3	(2–5)	0	(0–1)	0	(0–2)	10	(7–16)	1	(0–3)
2011	0	(0–1)	163	(127–212)	5	(2–13)	5	(1–20)	0	(0–1)	8	(3–20)	3	(2–6)	0	(0–1)	0	(0–3)	52	(36–75)	1	(0–3)
2012	0	(0–1)	113	(85–152)	2	(1–6)	2	(0–7)	0	(0–1)	6	(3–13)	2	(1–4)	0	(0–0)	0	(0–3)	13	(9–19)	1	(0–2)
2013	0	(0–2)	181	(145–230)	6	(3–15)	5	(1–21)	0	(0–3)	15	(7–32)	7	(4–11)	0	(0–2)	1	(0–6)	44	(32–61)	2	(1–5)
2014	1	(0–3)	227	(183–288)	12	(6–23)	11	(3–33)	0	(0–3)	15	(7–31)	8	(5–12)	0	(0–1)	1	(0–5)	44	(34–61)	3	(2–7)
2015	1	(0–3)	123	(97–161)	8	(5–14)	5	(1–18)	0	(0–2)	11	(5–23)	7	(5–12)	0	(0–1)	0	(0–4)	43	(34–57)	3	(2–5)
2016	0	(0–2)	235	(189–298)	7	(3–17)	6	(1–23)	0	(0–2)	16	(9–31)	6	(4–10)	0	(0–1)	0	(0–3)	64	(47–89)	4	(2–7)
2017	0	(0–2)	145	(116–187)	4	(1–9)	5	(1–17)	0	(0–2)	9	(4–18)	6	(3–9)	0	(0–1)	0	(0–3)	34	(27–45)	3	(1–6)
2018	0	(0–2)	241	(196–300)	4	(2–9)	8	(2–28)	0	(0–2)	24	(13–52)	9	(6–14)	1	(0–2)	1	(0–6)	45	(35–59)	2	(1–4)
2019	0	(0–2)	238	(185–320)	6	(3–14)	7	(2–30)	1	(0–5)	21	(10–53)	11	(6–21)	0	(0–1)	0	(0–3)	33	(22–50)	3	(1–5)
2020	0	(0–1)	180	(144–236)	2	(1–7)	1	(0–8)	0	(0–3)	14	(6–36)	6	(4–13)	0	(0–2)	0	(0–4)	21	(14–31)	2	(1–4)
2021	0	(0–3)	251	(199–326)	4	(1–14)	3	(0–15)	1	(0–5)	34	(15–81)	11	(6–21)	0	(0–2)	0	(0–6)	26	(17–42)	1	(1–4)
2022	0	(0–2)	460	(357–607)	3	(1–9)	1	(0–8)	0	(0–3)	13	(7–29)	5	(3–11)	0	(0–1)	1	(0–7)	32	(21–55)	1	(1–3)

Table A7: continued

SPD (Spiny dogfish)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS	
2003	91	(51–175)	1 022	(855–1 232)	1 641	(1213–2 281)	2	(0–10)	0	(0–2)	61	(34–111)
2004	77	(35–176)	1 261	(1 027–1 571)	1 185	(880–1 671)	2	(1–11)	0	(0–3)	25	(14–51)
2005	43	(14–126)	805	(678–954)	1 133	(806–1 605)	1	(0–6)	0	(0–1)	103	(62–180)
2006	12	(3–50)	717	(588–886)	890	(558–1 454)	1	(0–5)	0	(0–3)	31	(16–65)
2007	7	(2–32)	639	(520–810)	561	(398–813)	1	(0–6)	0	(0–2)	51	(26–104)
2008	13	(6–27)	730	(589–923)	1 284	(919–1 852)	1	(0–6)	0	(0–3)	26	(11–66)
2009	27	(13–69)	985	(791–1 257)	856	(597–1 253)	2	(0–9)	0	(0–3)	18	(9–41)
2010	11	(3–43)	905	(741–1 120)	357	(264–493)	2	(0–11)	1	(0–6)	25	(14–52)
2011	30	(13–86)	1 192	(957–1 544)	697	(454–1 121)	5	(1–23)	1	(0–7)	21	(10–47)
2012	9	(3–31)	1 169	(978–1 400)	441	(326–625)	3	(1–12)	1	(0–6)	14	(8–28)
2013	19	(7–69)	789	(651–997)	215	(148–321)	2	(0–13)	1	(0–7)	22	(12–47)
2014	47	(22–118)	1 610	(1 313–2 046)	575	(395–888)	6	(2–19)	1	(0–8)	18	(9–42)
2015	46	(21–114)	1 508	(1 206–1 913)	147	(110–219)	3	(1–13)	1	(0–7)	42	(23–88)
2016	34	(14–96)	1 358	(1 128–1 671)	216	(153–314)	2	(0–11)	1	(0–5)	20	(11–38)
2017	25	(12–62)	2 323	(1 967–2 830)	224	(159–330)	4	(1–12)	1	(0–6)	29	(16–54)
2018	43	(22–91)	1 826	(1 553–2 175)	235	(175–314)	5	(1–21)	1	(0–5)	22	(12–45)
2019	25	(12–65)	1 511	(1 295–1 778)	219	(167–297)	4	(1–18)	2	(0–13)	38	(23–69)
2020	4	(2–15)	723	(610–874)	54	(40–77)	0	(0–2)	1	(0–3)	15	(8–30)
2021	25	(13–60)	1 034	(886–1 236)	87	(56–136)	1	(0–5)	1	(0–6)	39	(22–73)
2022	20	(8–57)	1 820	(1 533–2 181)	88	(61–135)	1	(0–5)	1	(0–5)	23	(14–38)

Spiny dogfish continued

FY	STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	281	(221–362)	180	(122–270)	0	(0–7)	205	(156–277)	138	(108–177)
2004	197	(140–280)	276	(185–424)	1	(0–9)	149	(112–209)	132	(108–166)
2005	111	(79–161)	34	(16–71)	0	(0–3)	99	(74–137)	62	(50–77)
2006	211	(163–288)	9	(3–33)	2	(0–17)	246	(181–346)	64	(48–88)
2007	383	(299–509)	27	(11–70)	1	(0–11)	119	(75–197)	95	(71–132)
2008	132	(101–180)	44	(28–79)	2	(0–18)	221	(154–333)	54	(38–83)
2009	434	(334–584)	55	(33–101)	3	(0–23)	80	(45–140)	52	(36–78)
2010	369	(299–476)	52	(22–134)	1	(0–9)	266	(194–377)	69	(42–110)
2011	296	(219–423)	56	(28–121)	1	(0–15)	348	(243–524)	204	(139–305)
2012	171	(135–224)	10	(5–25)	2	(0–18)	525	(403–699)	361	(280–473)
2013	392	(318–515)	36	(19–77)	2	(0–16)	301	(221–424)	213	(170–282)
2014	1 071	(863–1 423)	80	(47–156)	2	(0–19)	208	(152–302)	274	(220–359)
2015	1 315	(1 047–1 735)	36	(18–80)	1	(0–16)	340	(251–473)	334	(274–422)
2016	209	(160–281)	10	(4–29)	0	(0–6)	188	(141–261)	225	(185–278)
2017	501	(394–662)	22	(12–43)	2	(0–14)	258	(205–335)	382	(314–473)
2018	812	(670–1 000)	67	(48–103)	2	(0–19)	309	(250–389)	266	(221–321)
2019	531	(424–679)	37	(24–61)	1	(0–8)	123	(90–174)	224	(189–269)
2020	198	(157–262)	28	(18–47)	1	(0–6)	59	(43–85)	114	(95–142)
2021	406	(326–530)	33	(20–60)	1	(0–8)	52	(36–78)	112	(90–143)
2022	339	(268–439)	40	(24–73)	1	(0–13)	130	(95–188)	145	(118–185)

Table A7: continued

SPE (Sea perch)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	0	(0–1)	1 216	(1 066–1 389)	4	(2–13)	36	(18–73)	8	(3–21)	16	(8–31)	11	(6–18)	0	(0–1)	1	(0–3)	73	(61–87)	3	(2–4)
2004	0	(0–0)	800	(687–952)	3	(1–10)	13	(4–39)	7	(3–20)	6	(4–11)	4	(2–9)	0	(0–1)	1	(0–3)	57	(47–70)	5	(3–7)
2005	0	(0–0)	543	(487–611)	2	(1–5)	6	(2–16)	3	(1–8)	5	(2–8)	2	(1–5)	0	(0–0)	0	(0–1)	50	(42–60)	1	(1–1)
2006	0	(0–0)	322	(277–381)	2	(1–6)	4	(1–12)	6	(2–16)	9	(4–22)	2	(1–4)	0	(0–0)	1	(0–5)	82	(69–99)	1	(1–2)
2007	0	(0–0)	322	(280–376)	1	(0–3)	5	(2–14)	4	(1–10)	4	(2–7)	5	(3–9)	0	(0–0)	1	(0–2)	39	(30–52)	1	(0–1)
2008	0	(0–0)	249	(218–289)	3	(1–7)	4	(1–12)	4	(1–11)	3	(1–7)	2	(1–3)	0	(0–0)	1	(0–5)	84	(71–101)	0	(0–1)
2009	0	(0–0)	206	(172–247)	3	(1–9)	9	(3–25)	5	(2–14)	5	(3–10)	3	(2–5)	0	(0–0)	1	(0–5)	104	(79–142)	1	(0–1)
2010	0	(0–0)	429	(364–506)	3	(2–7)	11	(4–30)	8	(3–19)	6	(3–11)	5	(4–7)	0	(0–0)	0	(0–2)	63	(52–79)	1	(1–3)
2011	0	(0–1)	608	(504–763)	4	(1–15)	23	(8–65)	15	(6–41)	17	(9–38)	9	(6–15)	0	(0–1)	1	(0–6)	148	(115–195)	3	(2–6)
2012	0	(0–0)	336	(295–386)	1	(0–3)	9	(3–26)	8	(3–22)	6	(3–10)	7	(5–10)	0	(0–0)	1	(0–3)	66	(54–80)	2	(1–2)
2013	0	(0–0)	461	(406–538)	3	(1–8)	13	(4–41)	14	(5–39)	7	(4–12)	7	(6–10)	0	(0–0)	1	(0–5)	129	(109–157)	2	(2–3)
2014	0	(0–0)	249	(223–280)	3	(2–7)	6	(3–12)	4	(2–7)	5	(3–9)	10	(8–13)	0	(0–0)	1	(0–2)	121	(105–138)	3	(2–3)
2015	0	(0–0)	711	(616–820)	2	(1–3)	7	(4–14)	14	(10–21)	2	(1–4)	7	(6–10)	0	(0–0)	1	(0–3)	203	(177–236)	4	(3–5)
2016	0	(0–0)	567	(502–650)	2	(1–6)	13	(5–38)	11	(6–20)	5	(3–8)	9	(7–13)	0	(0–0)	0	(0–2)	149	(127–177)	3	(3–4)
2017	0	(0–0)	379	(334–433)	1	(0–2)	12	(7–22)	17	(10–27)	3	(2–5)	3	(2–4)	0	(0–0)	0	(0–1)	125	(110–144)	2	(2–3)
2018	0	(0–0)	499	(442–562)	1	(0–2)	17	(8–37)	9	(5–14)	2	(1–4)	3	(2–5)	0	(0–0)	1	(0–3)	137	(121–155)	2	(1–2)
2019	0	(0–0)	316	(286–354)	1	(0–2)	10	(4–27)	10	(7–16)	7	(4–11)	2	(1–2)	0	(0–0)	0	(0–1)	52	(45–61)	2	(1–2)
2020	0	(0–0)	249	(220–284)	0	(0–1)	2	(1–5)	7	(5–11)	5	(2–10)	1	(1–2)	0	(0–0)	0	(0–2)	48	(41–57)	1	(1–2)
2021	0	(0–0)	236	(215–260)	1	(0–2)	4	(1–11)	15	(9–24)	5	(3–8)	2	(1–2)	0	(0–0)	0	(0–1)	46	(39–54)	1	(1–1)
2022	0	(0–0)	327	(294–367)	0	(0–1)	2	(1–5)	5	(3–8)	5	(4–8)	1	(1–2)	0	(0–0)	1	(0–3)	53	(46–63)	1	(1–1)

Table A7: continued

SQU (Arrow squid)

FY	AUCK		CHAT		COOK		EAST		NORTH		PUYS		STEW		SUBA		WCNI		WCSI(BT)		WCSI(MW)	
2003	7	(3–13)	78	(63–96)	3	(2–5)	1	(0–3)	1	(0–2)	15	(10–24)	114	(90–144)	77	(51–119)	0	(0–1)	198	(162–243)	36	(29–45)
2004	1	(1–3)	61	(50–73)	2	(2–4)	1	(0–2)	1	(0–2)	12	(7–21)	59	(45–78)	10	(6–16)	0	(0–0)	188	(157–231)	61	(52–72)
2005	4	(2–10)	54	(47–63)	4	(3–6)	1	(0–2)	1	(0–2)	14	(9–22)	131	(105–165)	6	(3–11)	0	(0–0)	102	(85–122)	20	(17–23)
2006	1	(0–2)	61	(52–74)	2	(1–4)	0	(0–1)	1	(0–3)	44	(28–72)	137	(112–171)	1	(0–4)	0	(0–1)	148	(124–177)	11	(9–14)
2007	1	(0–4)	103	(84–127)	3	(2–6)	1	(0–3)	1	(0–4)	25	(15–42)	201	(162–254)	6	(2–17)	0	(0–1)	126	(92–178)	28	(22–35)
2008	1	(1–2)	53	(46–62)	4	(2–5)	0	(0–1)	1	(0–2)	17	(9–30)	88	(75–103)	4	(3–6)	0	(0–1)	90	(74–109)	9	(7–11)
2009	2	(1–4)	44	(35–56)	2	(1–4)	1	(0–2)	1	(0–2)	16	(10–26)	114	(94–140)	4	(2–6)	0	(0–1)	24	(17–35)	11	(8–14)
2010	1	(0–3)	95	(78–115)	3	(2–4)	1	(0–3)	2	(1–7)	21	(13–36)	135	(114–163)	3	(1–6)	0	(0–1)	51	(41–65)	29	(21–39)
2011	2	(1–6)	129	(101–166)	4	(2–7)	2	(1–7)	3	(1–7)	45	(25–89)	206	(161–280)	6	(3–12)	0	(0–2)	163	(122–226)	38	(27–55)
2012	1	(0–3)	54	(43–67)	2	(1–3)	1	(0–2)	1	(0–4)	21	(14–34)	88	(73–108)	1	(1–4)	0	(0–1)	88	(71–110)	34	(27–42)
2013	3	(1–9)	58	(48–71)	4	(2–6)	1	(0–4)	3	(1–10)	28	(18–49)	308	(257–382)	13	(7–25)	0	(0–2)	116	(95–147)	37	(31–47)
2014	4	(2–10)	42	(34–51)	4	(2–7)	2	(1–4)	2	(1–4)	43	(26–73)	353	(299–425)	5	(3–9)	0	(0–2)	160	(131–197)	37	(31–45)
2015	4	(2–9)	100	(84–121)	4	(3–6)	2	(1–4)	6	(3–10)	40	(26–66)	662	(560–798)	6	(3–11)	0	(0–2)	254	(216–308)	97	(83–116)
2016	5	(2–16)	97	(79–121)	4	(3–7)	2	(1–6)	4	(2–8)	66	(43–106)	320	(255–415)	3	(1–9)	0	(0–1)	155	(125–197)	71	(59–88)
2017	1	(0–3)	92	(76–115)	3	(2–5)	2	(1–4)	6	(3–11)	53	(32–90)	449	(365–566)	2	(1–4)	0	(0–2)	126	(106–153)	79	(64–99)
2018	3	(1–5)	89	(76–104)	2	(1–3)	1	(0–3)	1	(1–2)	15	(10–23)	161	(139–187)	5	(3–6)	0	(0–1)	65	(57–74)	36	(31–42)
2019	1	(1–4)	68	(59–80)	2	(2–3)	1	(0–3)	4	(2–7)	40	(26–62)	236	(196–289)	2	(1–3)	0	(0–1)	63	(51–76)	41	(35–48)
2020	1	(0–3)	24	(21–29)	2	(1–2)	0	(0–1)	1	(1–2)	21	(13–34)	160	(134–191)	6	(4–9)	0	(0–1)	38	(33–45)	18	(15–20)
2021	2	(1–6)	47	(39–56)	2	(1–3)	0	(0–1)	2	(1–6)	57	(36–92)	286	(234–361)	4	(3–8)	0	(0–1)	39	(31–50)	20	(16–25)
2022	1	(0–4)	37	(32–45)	1	(1–2)	0	(0–1)	1	(1–2)	30	(21–41)	148	(125–175)	2	(1–3)	0	(0–1)	22	(19–27)	15	(12–18)

Table A5: Total annual discard estimates (t) and estimated 95% CIs for selected categories and main non–target catch species for the target hoki, hake, ling, silver warehou, white warehou trawl fishery. The slope of a regression through the data points and *p*-values are shown (in bold if significant) in the bottom row for each species code (see Table A1 **for species code definitions).**

FY	Morids		Schedule 6		Rattails (all)		Slickheads		Sharks		BAR		BOE		BYX	
2003	9	(6–14)	3 422	(2 884–4 190)	5 213	(4 259–6 781)	8	(5–15)	4 634	(4 175–5 193)	24	(3–512)	0	(0–1)	2	(1–5)
2004	13	(6–38)	3 028	(2 492–3 700)	2 312	(1 722–3 284)	8	(3–34)	4 068	(3 586–4 651)	20	(3–440)	0	(0–2)	1	(0–6)
2005	6	(3–14)	1 068	(872–1 324)	1 021	(677–1 597)	1	(0–8)	1 761	(1 547–2 008)	2	(0–12)	0	(0–1)	0	(0–3)
2006	6	(3–15)	1 576	(1 254–2 050)	3 113	(2 120–4 955)	18	(11–34)	2 975	(2 589–3 472)	1	(0–28)	0	(0–1)	1	(0–6)
2007	4	(2–9)	1 674	(1 372–2 114)	2 236	(1 699–3 005)	8	(4–18)	2 666	(2 259–3 220)	1	(0–10)	0	(0–1)	0	(0–2)
2008	14	(10–19)	1 360	(1 069–1 805)	1 752	(1 479–2 128)	32	(26–40)	2 314	(2 017–2 724)	87	(21–486)	0	(0–1)	1	(0–5)
2009	17	(12–25)	1 750	(1 401–2 263)	4 246	(3 531–5 195)	24	(17–37)	2 862	(2 495–3 341)	6	(2–31)	0	(0–1)	0	(0–2)
2010	4	(3–6)	665	(562–791)	3 077	(2 462–3 938)	3	(1–6)	1 236	(1 098–1 403)	3	(2–5)	0	(0–2)	0	(0–6)
2011	8	(6–10)	1 458	(1 096–2 046)	3 607	(2 854–4 614)	4	(2–12)	1 886	(1 563–2 340)	12	(8–20)	0	(0–1)	0	(0–3)
2012	8	(6–10)	1 810	(1 514–2 206)	1 435	(1 151–1 809)	9	(5–21)	2 554	(2 211–2 997)	4	(2–9)	0	(0–1)	2	(1–4)
2013	10	(8–11)	1 418	(1 195–1 749)	2 246	(1 925–2 664)	3	(2–5)	2 248	(2 011–2 525)	19	(11–41)	0	(0–2)	2	(1–4)
2014	9	(8–11)	1 688	(1 445–2 014)	1 732	(1 509–2 021)	5	(3–9)	2 321	(2 079–2 620)	9	(6–17)	1	(0–13)	5	(2–17)
2015	28	(24–32)	1 735	(1 470–2 110)	3 125	(2 722–3 608)	7	(5–10)	2 376	(2 134–2 709)	24	(15–45)	1	(0–16)	2	(1–3)
2016	37	(30–46)	1 038	(899–1 214)	1 272	(1 064–1 554)	5	(3–8)	1 736	(1 550–1 948)	14	(8–26)	0	(0–6)	3	(2–6)
2017	24	(21–27)	1 762	(1 481–2 146)	1 485	(1 243–1 828)	8	(4–17)	1 981	(1 759–2 253)	22	(14–42)	0	(0–7)	2	(1–2)
2018	1	(1–2)	1 525	(1 303–1 851)	2 209	(1 860–2 704)	14	(9–24)	1 729	(1 539–1 949)	0	(0–0)	0	(0–1)	0	(0–0)
2019	3	(2–3)	1 397	(1 195–1 652)	1 075	(870–1 379)	1	(0–3)	1 884	(1 674–2 145)	0	(0–1)	0	(0–2)	0	(0–0)
2020	1	(1–1)	415	(337–536)	840	(680–1 092)	1	(1–4)	595	(508–715)	0	(0–2)	0	(0–0)	0	(0–0)
2021	2	(2–3)	649	(521–841)	557	(434–762)	0	(0–1)	814	(689–977)	0	(0–1)	0	(0–0)	0	(0–1)
2022	2	(1–2)	934	(762–1 168)	641	(532–786)	0	(0–1)	1 145	(998–1 336)	0	(0–1)	0	(0–1)	0	(0–0)
Slope (*p*-value)	–0.068	(0.087)	**–0.048**	(**0.008**)	**–0.070**	(**0.001**)	**–0.157**	(**0.006**)	**–0.062**	(**<0.001**)	**–0.218**	(**0.009**)	0.014	(0.627)	–0.052	(0.398)

Table A8: continued

FY		FRO		GIZ		GSH		GSP		JAV		JMA		LDO		RIB
2003	81	(38–253)	0	(0–1)	16	(6–60)	8	(4–18)	2 978	(2 359–3 828)	0	(0–3)	66	(53–82)	4	(2–6)
2004	9	(5–25)	0	(0–2)	4	(1–30)	1	(0–7)	1 194	(833–1 832)	0	(0–2)	73	(56–94)	4	(2–12)
2005	1	(0–5)	0	(0–2)	12	(4–58)	3	(1–11)	561	(358–934)	0	(0–1)	3	(1–8)	3	(1–18)
2006	0	(0–24)	0	(0–2)	6	(1–54)	1	(0–12)	2 198	(1 472–3 608)	0	(0–3)	0	(0–1)	3	(1–7)
2007	83	(12–1 387)	1	(0–6)	4	(2–16)	1	(0–22)	1 232	(909–1 765)	0	(0–1)	10	(6–19)	0	(0–4)
2008	3	(1–12)	0	(0–1)	5	(3–13)	5	(3–9)	1 200	(922–1 584)	2	(1–5)	1	(0–1)	1	(1–2)
2009	0	(0–1)	0	(0–2)	43	(16–232)	4	(2–8)	2 336	(1 900–2 936)	0	(0–1)	0	(0–1)	1	(1–4)
2010	0	(0–1)	0	(0–2)	79	(41–197)	2	(1–4)	1 383	(1 130–1 728)	0	(0–1)	3	(2–7)	1	(0–1)
2011	0	(0–1)	1	(1–2)	164	(72–520)	6	(3–13)	2 009	(1 541–2 774)	0	(0–1)	1	(1–2)	1	(0–2)
2012	0	(0–3)	1	(1–2)	48	(29–89)	2	(1–3)	613	(495–783)	1	(0–6)	1	(0–1)	3	(2–5)
2013	1	(0–3)	2	(2–4)	15	(9–31)	2	(1–3)	1 022	(859–1 244)	0	(0–1)	2	(2–3)	5	(4–6)
2014	2	(1–6)	2	(1–2)	16	(10–31)	3	(2–5)	811	(687–973)	0	(0–1)	3	(2–4)	4	(3–5)
2015	6	(3–19)	5	(4–6)	22	(14–39)	11	(9–14)	1 780	(1 538–2 107)	1	(0–1)	16	(13–20)	17	(14–20)
2016	9	(4–24)	7	(5–10)	48	(29–107)	16	(12–24)	642	(530–810)	1	(0–1)	26	(21–34)	29	(22–40)
2017	6	(3–16)	7	(6–10)	23	(15–40)	8	(7–11)	830	(654–1 136)	1	(0–1)	13	(11–15)	11	(9–14)
2018	0	(0–1)	0	(0–1)	0	(0–1)	0	(0–3)	1 659	(1 333–2 182)	0	(0–0)	0	(0–1)	0	(0–1)
2019	0	(0–5)	0	(0–0)	2	(1–9)	1	(0–2)	487	(386–652)	0	(0–0)	1	(0–2)	0	(0–1)
2020	0	(0–1)	0	(0–4)	0	(0–7)	0	(0–1)	475	(366–662)	0	(0–0)	0	(0–0)	0	(0–2)
2021	0	(0–1)	0	(0–0)	0	(0–1)	0	(0–1)	344	(265–487)	0	(0–0)	0	(0–0)	0	(0–2)
2022	0	(0–1)	0	(0–0)	0	(0–2)	0	(0–1)	341	(274–429)	0	(0–0)	0	(0–1)	0	(0–2)
Slope (*p*-value)	–0.182	(0.046)	0.049	(0.467)	–0.215	(0.014)	–0.134	(0.030)	**–0.071**	(**0.002**)	0.014	(0.745)	–0.175	(0.043)	–0.123	(0.093)

Table A8: continued

FY	RSO		SBW		SND		SPD		SPE		SQU	
2003	1	(1–3)	0	(0–1)	212	(168–277)	3 109	(2 571–3 820)	14	(9–21)	11	(7–22)
2004	0	(0–2)	0	(0–4)	226	(187–274)	2 694	(2 242–3 326)	4	(2–8)	9	(5–22)
2005	0	(0–5)	2	(0–14)	142	(120–169)	964	(790–1 199)	4	(2–7)	5	(2–14)
2006	0	(0–4)	0	(0–2)	406	(340–505)	1 393	(1 126–1 814)	2	(1–6)	1	(0–29)
2007	1	(0–9)	0	(0–3)	220	(176–281)	1 629	(1 327–2 053)	3	(1–8)	20	(12–39)
2008	1	(0–2)	1	(0–9)	200	(160–253)	1 317	(1 017–1 756)	1	(0–1)	10	(6–21)
2009	1	(0–7)	0	(0–3)	243	(191–319)	1 707	(1 364–2 245)	4	(2–8)	15	(11–21)
2010	0	(0–2)	0	(0–0)	66	(51–88)	658	(553–790)	5	(3–9)	16	(13–20)
2011	0	(0–1)	0	(0–0)	20	(12–38)	1 549	(1 138–2 238)	3	(1–6)	28	(21–37)
2012	0	(0–0)	0	(0–2)	77	(57–107)	1 816	(1 518–2 210)	2	(1–3)	10	(8–13)
2013	0	(0–1)	0	(0–1)	82	(64–109)	1 387	(1 175–1 705)	10	(8–14)	21	(17–25)
2014	1	(1–3)	6	(2–20)	65	(49–89)	1 703	(1 440–2 063)	8	(6–11)	27	(23–32)
2015	2	(1–3)	7	(4–16)	83	(65–106)	1 626	(1 342–2 062)	22	(18–27)	49	(42–59)
2016	13	(9–19)	0	(0–1)	109	(82–151)	978	(829–1 199)	31	(25–41)	39	(32–51)
2017	14	(10–22)	2	(1–4)	97	(73–136)	1 803	(1 470–2 277)	21	(17–28)	27	(22–35)
2018	0	(0–0)	0	(0–1)	80	(61–108)	1 579	(1 346–1 894)	0	(0–1)	0	(0–1)
2019	1	(0–2)	0	(0–1)	104	(74–150)	1 474	(1 248–1 769)	1	(1–2)	1	(1–3)
2020	0	(0–1)	0	(0–0)	43	(28–71)	510	(412–657)	0	(0–2)	0	(0–1)
2021	0	(0–1)	0	(0–1)	66	(50–92)	724	(586–941)	0	(0–1)	0	(0–1)
2022	0	(0–1)	0	(0–1)	83	(59–127)	1 029	(850–1 293)	0	(0–1)	0	(0–3)
Slope (*p*-value)	0.018	(0.786)	–0.004	(0.950)	**–0.070**	(**0.006**)	–0.037	(0.027)	–0.154	(0.029)	–0.196	(0.017)

8. APPENDIX B: QMS species list

Table B 1: Complete list of QMS species codes as at 01 October 2016, ordered from most recent to oldest addition, and alphabetically within each year of entry, along with: year of entry into the QMS; broad taxonomic group (Algae, Fish, Invertebrate); common and scientific names; and total observed catch (t) in the hoki, hake, ling, silver warehou, white warehou fishery between 2002–03 and 2021–22. * listed under Schedule 6 of the Fisheries Act 1996 (stocks which may be returned to the sea or other waters).

Species code	QMS year of entry	Group	Common name	Scientific name	Observed catch (t)
KBB*	2010	Algae	Bladder kelp	*Macrocystis pyrifera*	0.0
PTO*	2010	Fish	Patagonian toothfish	*Dissostichus eleginoides*	0.0
RBT	2009	Fish	Redbait	*Emmelichthys nitidus*	436.4
PRK*	2007	Inv.	Prawn killer	*Ibacus alticrenatus*	2.3
KWH*	2006	Inv.	Knobbed whelk	*Austrofucus glans*	0.2
PZL	2006	Inv.	King clam	*Panopea zelandica*	0.0
OYS*	2005	Inv.	Oysters dredge	*Ostrea chilensis*	0.0
PPI*	2005	Inv.	Pipi	*Paphies australis*	0.0
TUA	2005	Inv.	Tuatua	*Paphies subtriangulata*	0.0
BIG	2004	Fish	Bigeye tuna	*Thunnus obesus*	0.0
BWS*	2004	Fish	Blue shark	*Prionace glauca*	0.0
BYA*	2004	Inv.	Frilled venus shell	*Bassina yatei*	0.0
CHC*	2004	Inv.	Red crab	*Chaceon bicolor*	0.0
DAN*	2004	Inv.	Ringed dosinia	*Dosinia anus*	0.0
DSU*	2004	Inv.	Silky dosinia	*Dosinia subrosea*	0.0
GLM*	2004	Inv.	Green-lipped mussel	*Perna canaliculus*	0.0
GSC*	2004	Inv.	Giant spider crab	*Jacquinotia edwardsii*	43.8
HOR	2004	Inv.	Horse mussel	*Atrina zelandica*	16.4
KAH	2004	Fish.	Kahawai	*Arripis trutta, A. xylabion*	0.0
ATT	2004	Fish	Kahawai	*Arripis trutta*	0.0
KIC*	2004	Inv.	King crab	*Lithodes murrayi, Neolithodes brodiei*	1.8
LDO	2004	Fish	Lookdown dory	*Cyttus traversi*	1 436.3
LFE*	2004	Fish	Long-finned eel	*Anguilla dieffenbachii*	0.0
MAK*	2004	Fish	Mako shark	*Isurus oxyrinchus*	14.7
MDI*	2004	Inv.	Trough shell	*Mactra discors*	0.0
MMI*	2004	Inv.	Large trough shell	*Mactra murchisoni*	0.0
MOO	2004	Fish	Moonfish	*Lampris guttatus*	0.0
PAR	2004	Fish	Parore	*Girella tricuspidata*	0.0
PDO*	2004	Inv.	Southern tuatua	*Paphies donacina*	0.0
POR	2004	Fish	Porae	*Nemadactylus douglasii*	0.0
POS*	2004	Fish	Porbeagle shark	*Lamna nasus*	119.4
RBM	2004	Fish	Rays bream	*Brama brama*	355.3
RSN	2004	Fish	Red snapper	*Centroberyx affinis*	0.0
SAE*	2004	Inv.	Triangle shell	*Spisula aequilatera*	0.0
SCC*	2004	Inv.	Sea cucumber	*Stichopus mollis*	0.2
SCI	2004	Inv.	Scampi	*Metanephrops challengeri*	36.9
SPD*	2004	Fish	Spiny dogfish	*Squalus acanthias*	8 923.7
STN*	2004	Fish	Southern bluefin tuna	*Thunnus maccoyii*	39.8
SWO*	2004	Fish	Broadbill swordfish	*Xiphias gladius*	57.3
TOR	2004	Fish	Pacific bluefin tuna	*Thunnus orientalis*	0.0
YFN	2004	Fish	Yellowfin tuna	*Thunnus albacares*	0.0
KIN*	2003	Fish	Kingfish	*Seriola lalandi*	0.0
LEA	2003	Fish	Leatherjacket	*Meuschenia scaber*	0.0
RSK*	2003	Fish	Rough skate	*Zearaja nasuta*	271.0
SFE*	2003	Fish	Short-finned eel	*Anguilla australis, A. reinhardtii*	0.0
SSK*	2003	Fish	Smooth skate	*Dipturus innominatus*	795.7
ANC	2002	Fish	Anchovy	*Engraulis australis*	0.0
BUT	2002	Fish	Butterfish	*Odax pullus*	0.0
COC*	2002	Inv.	Cockle	*Austrovenus stutchburyi*	0.0
EMA	2002	Fish	Blue mackerel	*Scomber australasicus*	22.3
GAR	2002	Fish	Garfish	*Hyporhamphus ihi*	0.0
PAD*	2002	Inv.	Paddle crab	*Ovalipes catharus*	0.2
PIL	2002	Fish	Pilchard	*Sardinops sagax*	0.0
QSC*	2002	Inv.	Queen scallop	*Zygochlamys delicatula*	6.3
SPR	2002	Fish	Sprats	*Sprattus antipodum, S. muelleri*	0.0
SUR*	2002	Inv.	Kina	*Evechinus chloroticus*	0.2
ANG	2000	Fish	Anguillidae	Anguillidae	0.0
GSP	1999	Fish	Pale ghost shark	*Hydrolagus bemisi*	2 009.6
SBW	1999	Fish	Southern blue whiting	*Micromesistius australis*	1 052.5

Table B 1: continued

Species code	QMS year of entry	Group	Common name	Scientific name	Observed catch (t)
CDL	1998	Fish	Cardinalfish	Epigonidae	224.2
EPT	1998	Fish	Deepsea cardinalfish	*Epigonus telescopus*	0.0
FRO	1998	Fish	Frostfish	*Lepidopus caudatus*	2 630.8
GSH	1998	Fish	Ghost shark	*Hydrolagus novaezealandiae*	1 500.2
OYU	1998	Inv.	NA		0.0
RBY	1998	Fish	Rubyfish	*Plagiogeneion rubiginosum*	22.9
RIB	1998	Fish	Ribaldo	*Mora moro*	1 756.4
SPE	1998	Fish	Sea perch	*Helicolenus* spp.	1 708.8
TRU	1998	Fish	Trumpeter	*Latris lineata*	0.0
WWA	1998	Fish	White warehou	*Seriolella caerulea*	8 474.7
YEM	1998	Fish	Yellow-eyed mullet	*Aldrichetta forsteri*	0.0
SCA*	1992	Inv.	Scallop	*Pecten novaezelandiae*	0.3
CRA*	1990	Inv.	Rock lobster	*Jasus edwardsii*	0.0
PHC	1990	Inv.	Packhorse rock lobster	*Sagmariasus verreauxi*	0.0
JMA	1987	Fish	Jack mackerel	*Trachurus declivis, T. murphyi, T. nz*	520.6
JMD	1987	Fish	Greenback jack mackerel	*Trachurus declivis*	0.0
JMN	1987	Fish	Yellowtail jack mackerel	*Trachurus novaezelandiae*	0.0
JMM	1987	Fish	Slender jack mackerel	*Trachurus murphyi*	0.0
PAU	1987	Inv.	Black paua & yellowfoot paua	*Haliotis iris* & *H. australis*	0.0
SQU	1987	Inv.	Arrow squid	*Nototodarus sloanii* & *N. gouldi*	3 268.1
NOS	1987	Inv.	NZ southern arrow squid	*Nototodarus sloanii*	0.0
NOG	1987	Inv.	NZ northern arrow squid	*Nototodarus gouldi*	0.0
ASQ	1987	Inv.	NA		0.0
BAR	1986	Fish	Barracouta	*Thyrsites atun*	2 989.8
BCO	1986	Fish	Blue cod	*Parapercis colias*	19.0
BNS	1986	Fish	Bluenose	*Hyperoglyphe antarctica*	196.2
BYX	1986	Fish	Alfonsino & long-finned beryx	*Beryx splendens* & *B. decadactylus*	208.3
ELE	1986	Fish	Elephant fish	*Callorhinchus milii*	0.0
FLA	1986	Fish	Flats		0.0
ESO	1986	Fish	N.Z. sole	*Peltorhamphus novaezeelandiae*	0.0
LSO	1986	Fish	Lemon sole	*Pelotretis flavilatus*	0.0
SFL	1986	Fish	Sand flounder	*Rhombosolea plebeia*	0.0
TUR	1986	Fish	Turbot	*Colistium nudipinnis*	0.0
YBF	1986	Fish	Yellowbelly flounder	*Rhombosolea leporina*	0.0
BFL	1986	Fish	Black flounder	*Rhombosolea retiaria*	0.0
GFL	1986	Fish	Greenback flounder	*Rhombosolea tapirina*	0.0
BRI	1986	Fish	Brill	*Colistium guntheri*	0.0
GMU	1986	Fish	Grey mullet	*Mugil cephalus*	0.0
GUR	1986	Fish	Gurnard	*Chelidonichthys kumu*	22.3
HAK	1986	Fish	Hake	*Merluccius australis*	42 414.2
HOK	1986	Fish	Hoki	*Macruronus novaezelandiae*	462 579.5
HPB	1986	Fish	Hāpuku & bass	*Polyprion oxygeneios* & *P. americanus*	19.5
BAS	1986	Fish	Bass groper	*Polyprion americanus*	7.8
HAP	1986	Fish	Hāpuku	*Polyprion oxygeneios*	139.8
JDO	1986	Fish	John dory	*Zeus faber*	0.0
LIN	1986	Fish	Ling	*Genypterus blacodes*	32 949.2
MOK	1986	Fish	Moki	*Latridopsis ciliaris*	0.0
OEO	1986	Fish	Oreos	*P. maculatus, A. niger,* & *N. rhomboidalis*	0.0
BOE	1986	Fish	Black oreo	*Allocyttus niger*	1 325.1
SSO	1986	Fish	Smooth oreo	*Pseudocyttus maculatus*	127.0
SOR	1986	Fish	Spiky oreo	*Neocyttus rhomboidalis*	191.6
WOE	1986	Fish	Warty oreo	*Allocyttus verrucosus*	0.0
ORH	1986	Fish	Orange roughy	*Hoplostethus atlanticus*	142.2
RCO	1986	Fish	Red cod	*Pseudophycis bachus*	909.0
SCH	1986	Fish	School shark	*Galeorhinus galeus*	238.4
SKI	1986	Fish	Gemfish	*Rexea* spp.	0.0
RSO	1986	Fish	Gemfish	*Rexea solandri*	789.0
SNA	1986	Fish	Snapper	*Pagrus auratus*	0.0
SPO*	1986	Fish	Rig	*Mustelus lenticulatus*	0.0
STA	1986	Fish	Giant stargazer	*Kathetostoma* spp.	0.0
GIZ	1986	Fish	Giant stargazer	*Kathetostoma giganteum*	1 009.4
SWA	1986	Fish	Silver warehou	*Seriolella punctata*	24 380.2
TAR	1986	Fish	Tarakihi	*Nemadactylus macropterus* & *N.* sp. (king tarakihi)	0.0
NMP	1986	Fish	Tarakihi	*Nemadactylus macropterus*	96.6
TRE	1986	Fish	Trevally	*Pseudocaranx georgianus*	0.0
WAR	1986	Fish	Common warehou	*Seriolella brama*	193.0

9. APPENDIX C: Model convergence diagnostics

Figure C1: Standard model convergence diagnostics (MCMC trace plots) for estimation of QMS species non-target catch. Top, annual non-target catch; bottom, model parameters.

Figure C2: Standard model convergence diagnostics (MCMC trace plots) for estimation of non-QMS fish species non-target catch. Top, annual non-target catch; bottom, model parameters.

Figure C3: Standard model convergence diagnostics (MCMC trace plots) for estimation of non-QMS invertebrate species non-target catch. Top, annual non-target catch; bottom, model parameters.

Figure C4: Standard model convergence diagnostics (MCMC trace plots) for estimation of TOTAL non-target catch. Top, annual non-target catch; bottom, model parameters.

REVISED MODEL DIAGNOSTICS

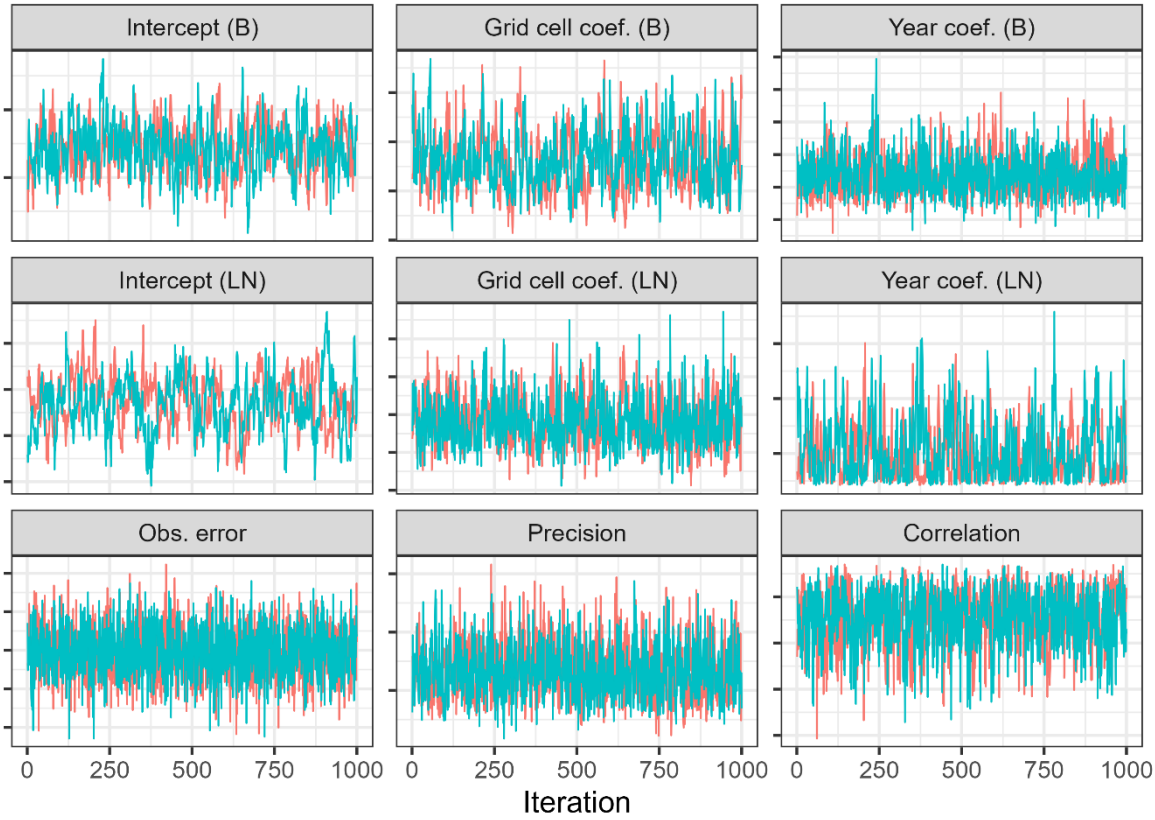

Figure C5: Revised model visual convergence diagnostics for estimation of TOTAL non-target catch for the best fitting model ('vessel'). MCMC trace plots with two chains of 500 iterations each are shown for two model parts: Binomial (B) and log-Normal (LN). Observation error refers to the standard error in the log-Normal model part. The Precision and Correlation are parameters in the covariance matrix used to define the Conditional Autoregressive prior on the spatial grid cell coefficients.

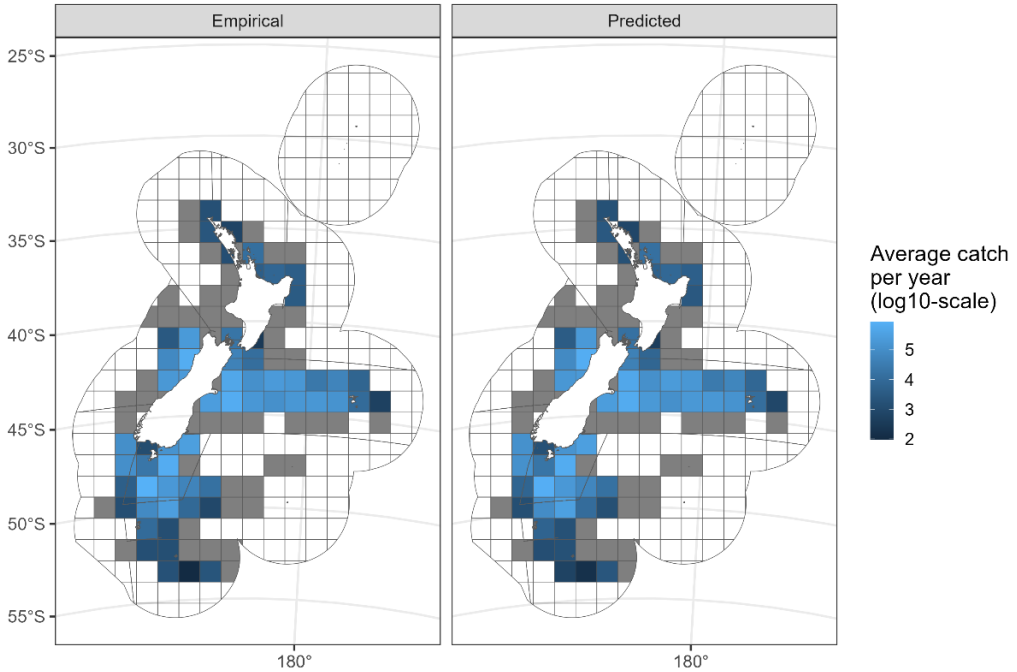

Figure C6: Spatial diagnostic of posterior predicted TOTAL non-target catch for the best fitting model ('vessel'). Predicted model outputs were calculated as the mean of the posterior predicted distribution of the average annual non-target catch.

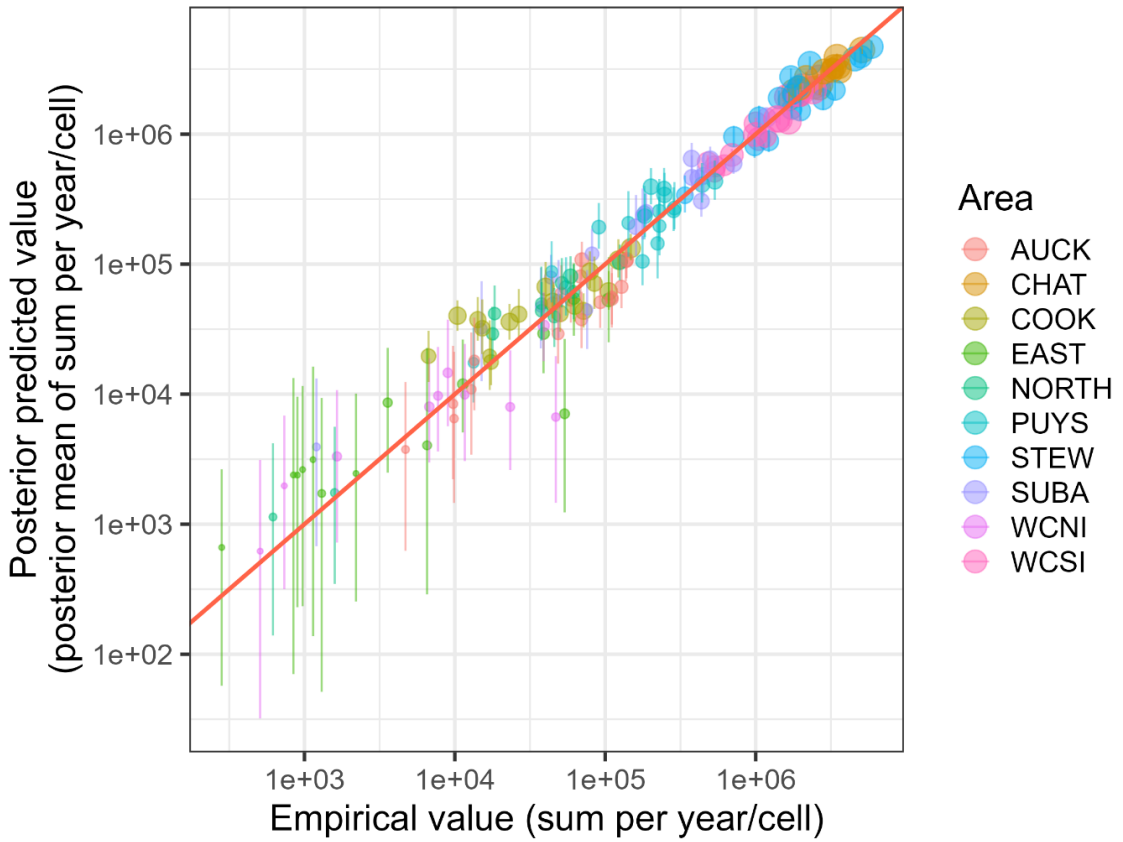

Figure C7: Posterior prediction of the TOTAL non-target catch for the best fitting model ('vessel'), shown as the mean of the posterior sum per year and grid cell, compared with empirical observations. Values are shown on a log-10 scale. The colour of each point relates to the non-target catch area. The size of each point is relative to the total observer effort. Clustering of values close to the one-to-one line of equivalence (in red) indicates a good prediction of the data by the model.

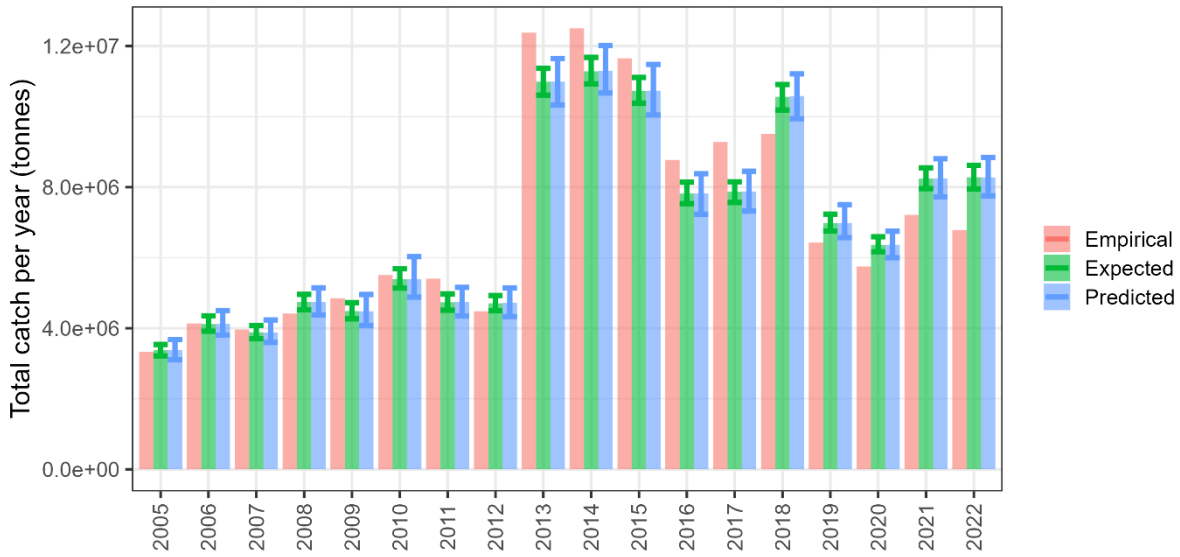

Figure C8: Posterior prediction and expected model outputs of the TOTAL non-target catch for the best fitting model ('vessel'), shown as the posterior mean of the sum per year. Credibility Intervals (95%) are shown for the predicted and expected outputs. Close correspondence between the posterior predicted and expected values indicate correct parameterisation of the posterior prediction. Close correspondence between the expected and predicted values, and the empirical data, indicate a good model fit.

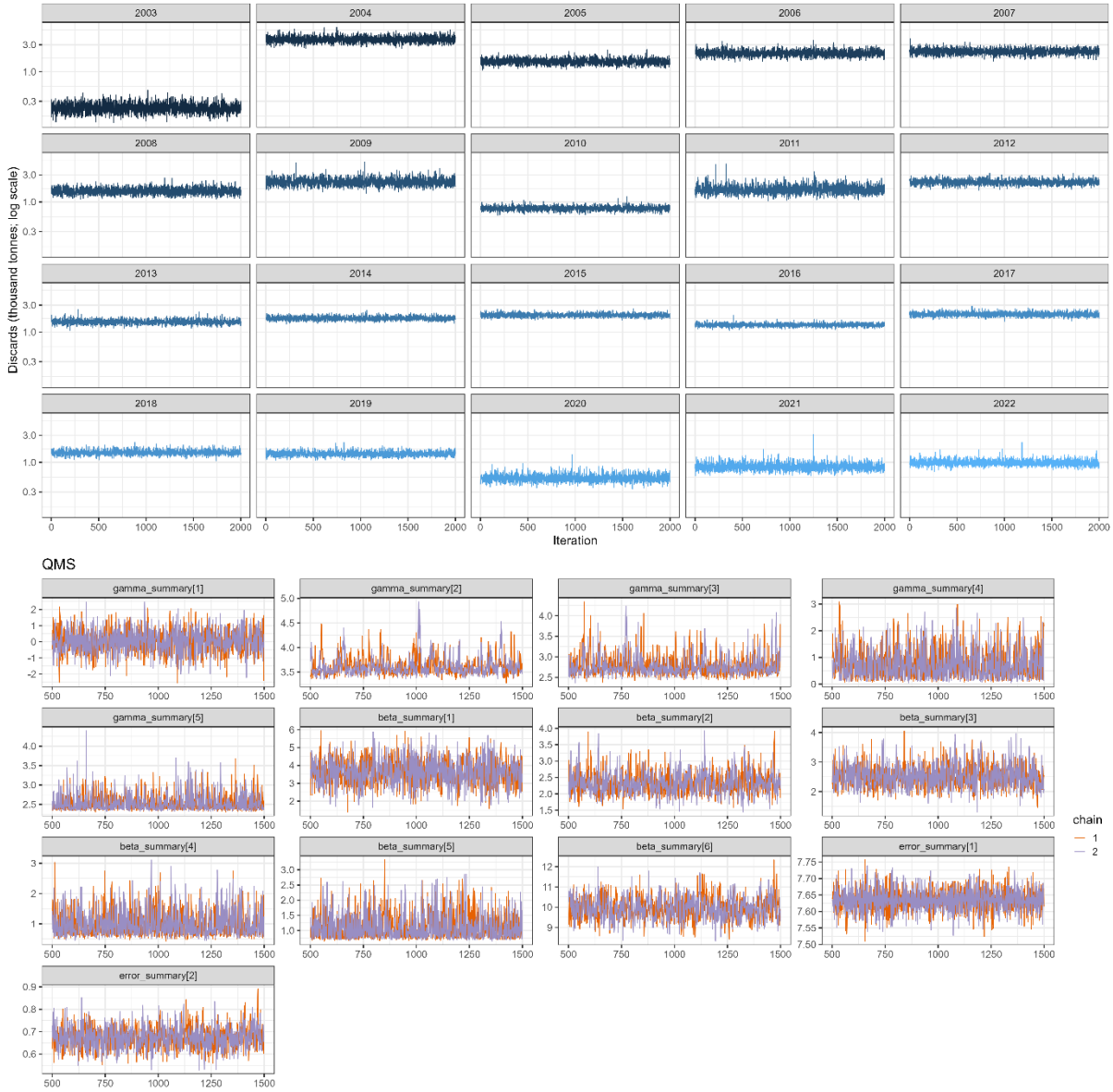

Figure C9: Standard model convergence diagnostics (MCMC trace plots) for estimation of QMS species discards. Top, annual discards; bottom, model parameters.

Figure C10: Standard model convergence diagnostics (MCMC trace plots) for estimation of non-QMS fish species discards. Top, annual discards; bottom, model parameters.

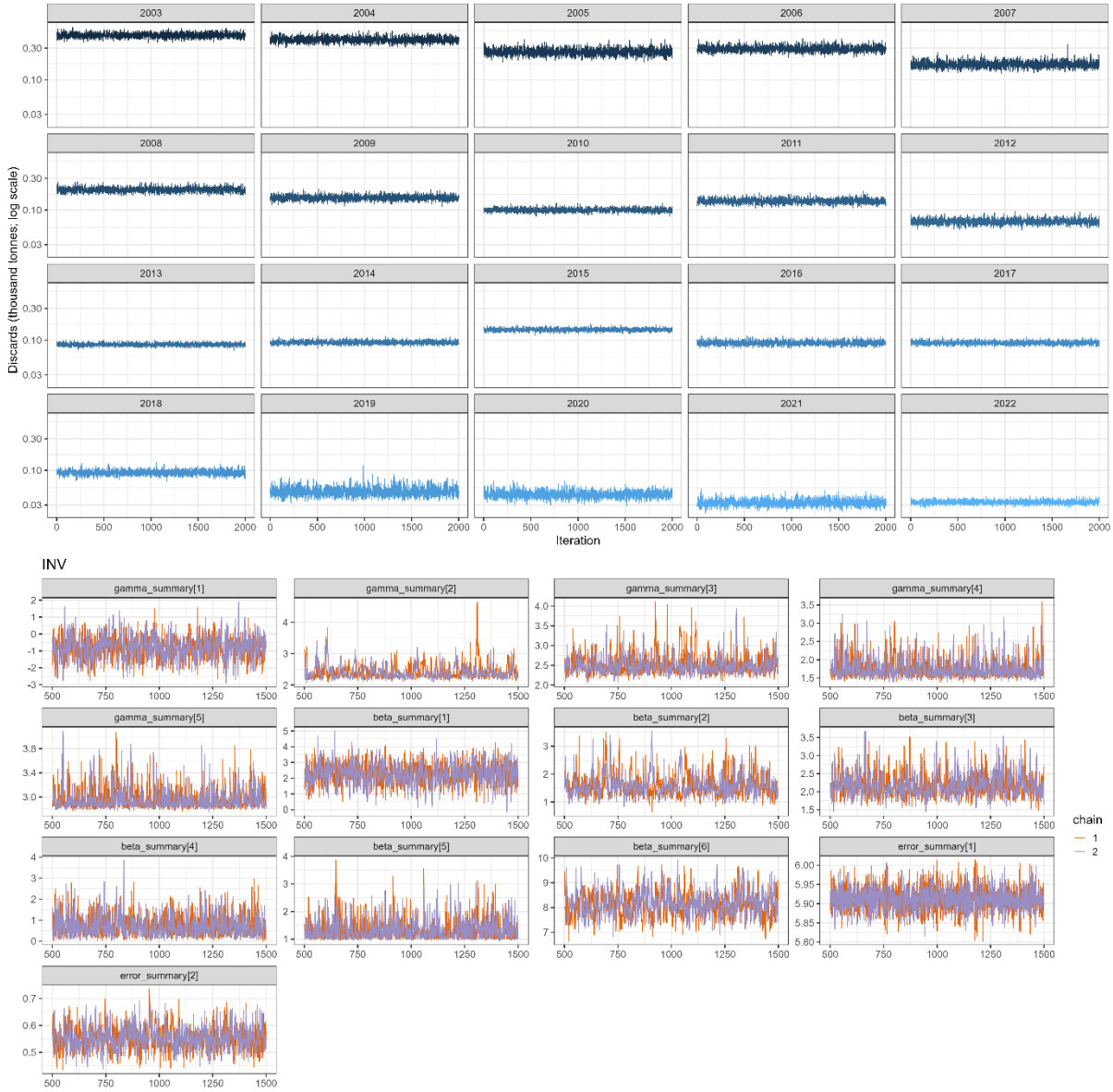

Figure C11: Standard model convergence diagnostics (MCMC trace plots) for estimation of non-QMS invertebrate species discards. Top, annual discards; bottom, model parameters.

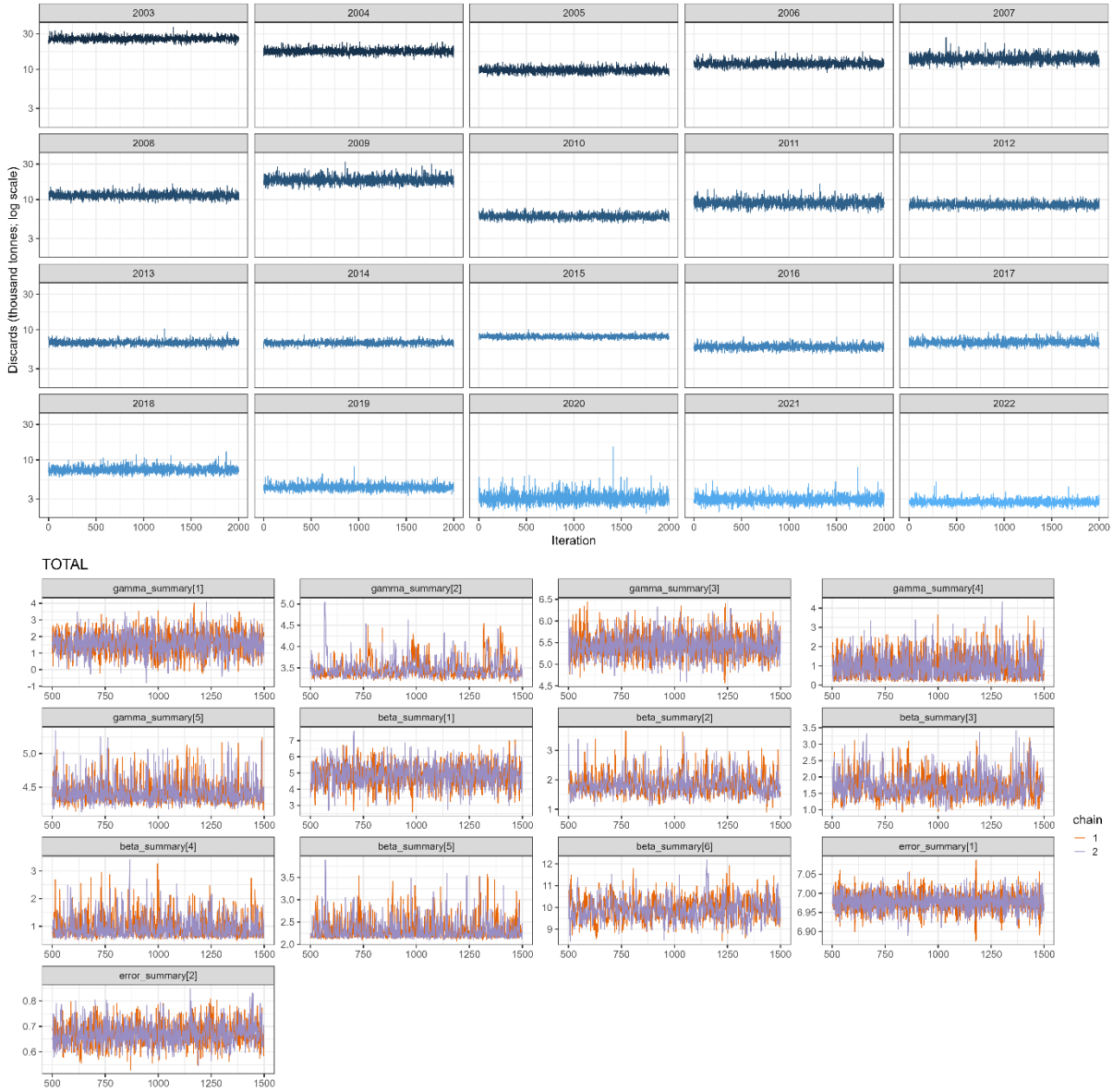

Figure C12: Standard model convergence diagnostics (MCMC trace plots) for estimation of TOTAL discards. Top, annual discards; bottom, model parameters.

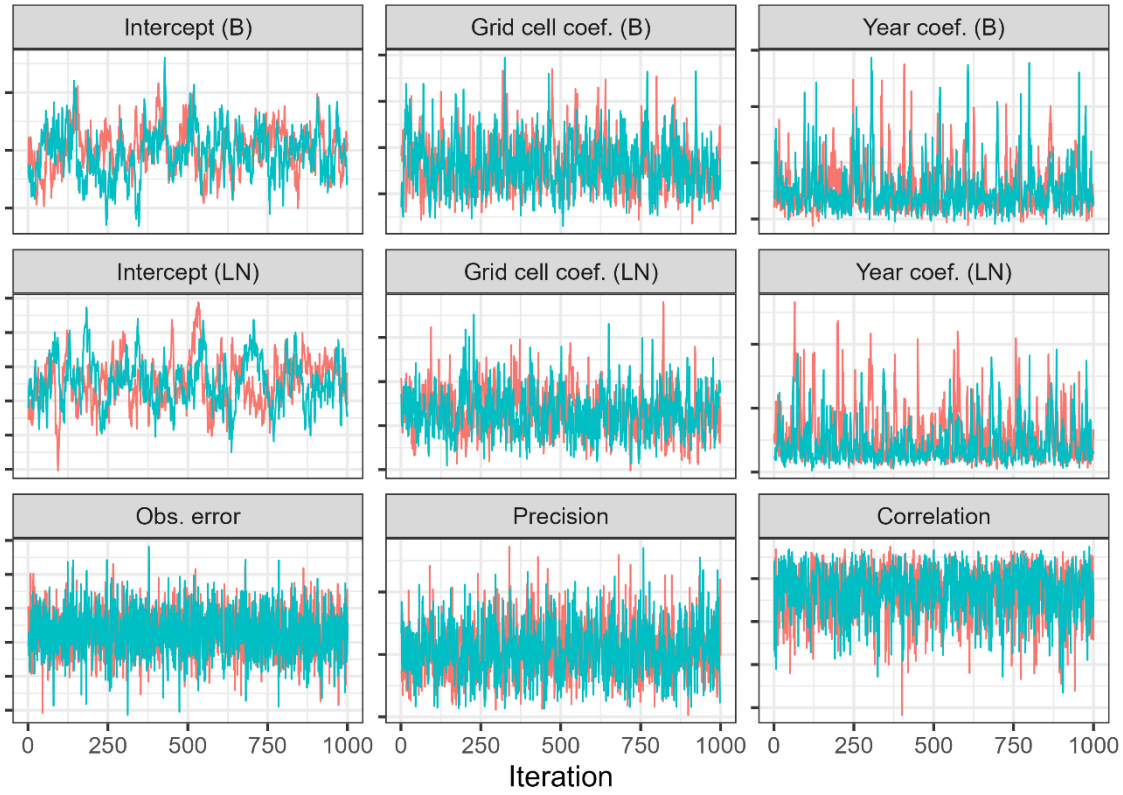

Figure C13: Revised model visual convergence diagnostics for estimation of TOTAL discards for the best fitting model 'vessel'. MCMC trace plots with two chains of 500 iterations each are shown for two model parts: Binomial (B) and log-Normal (LN). Observation error refers to the standard error in the log-Normal model part. The Precision and Correlation are parameters in the covariance matrix used to define the Conditional Autoregressive prior on the spatial grid cell coefficients.

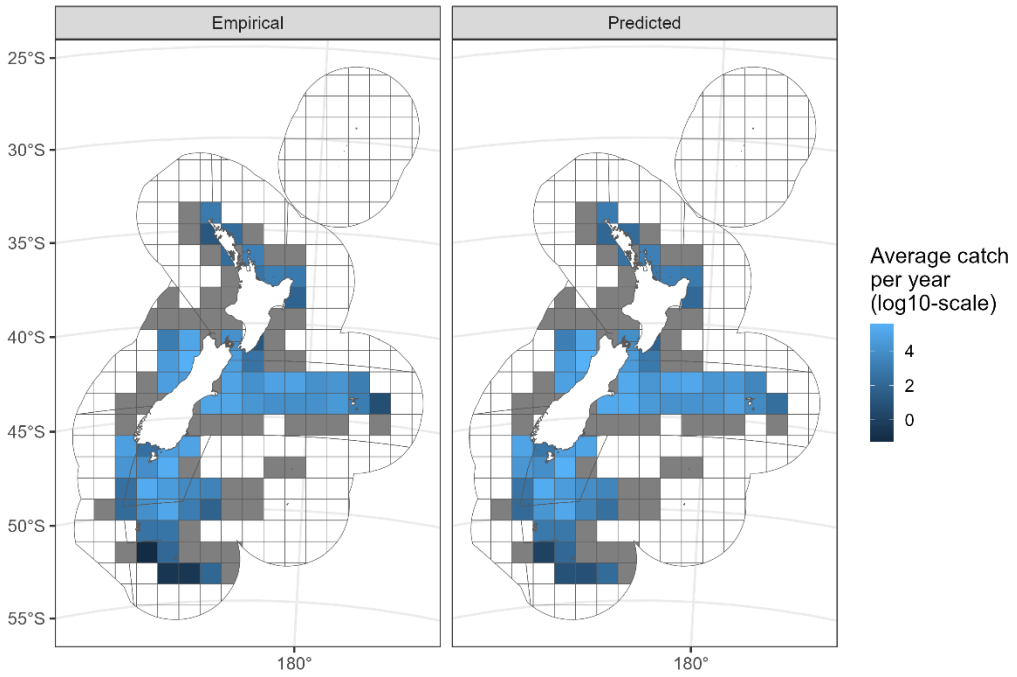

Figure C14: Spatial diagnostic of posterior predicted TOTAL discards. Model outputs are shown as the mean of the posterior distribution of the average annual discards.

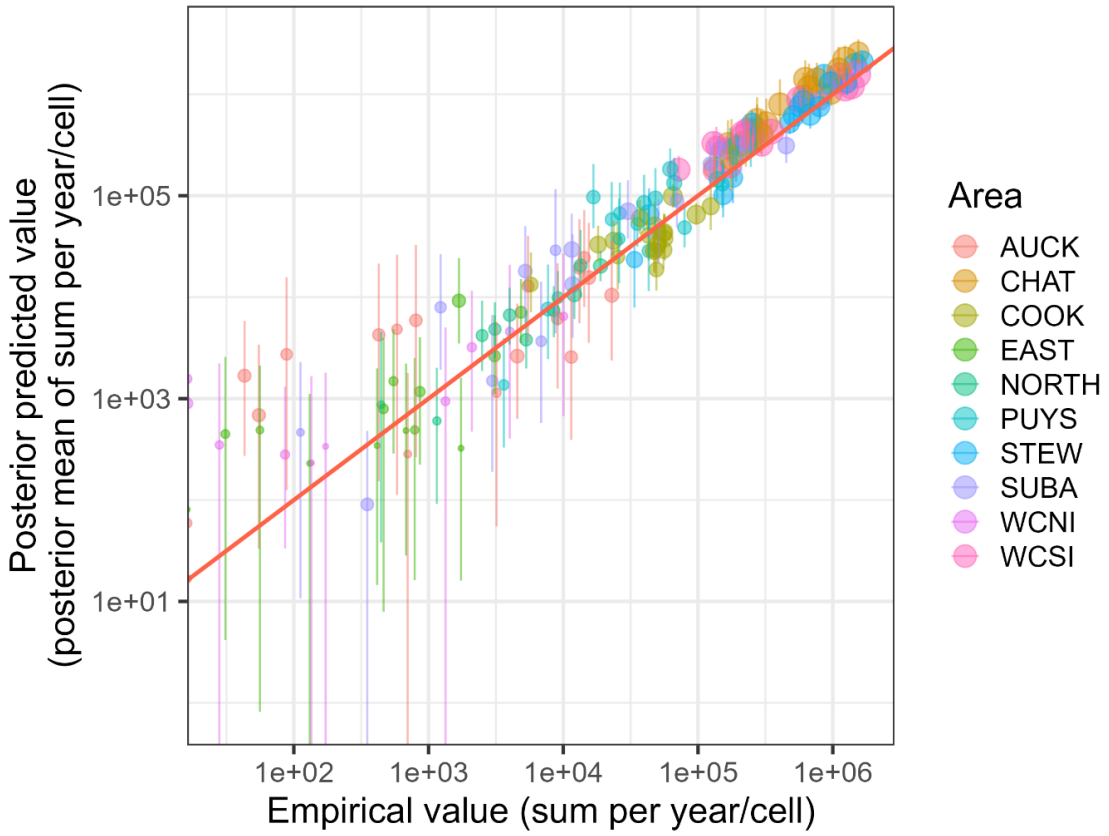

Figure C15: Posterior prediction of the TOTAL discards for the best fitting model ('vessel'), shown as the mean of the posterior sum per year and grid cell, compared with empirical observations. Values are shown on a log-10 scale. The colour of each point relates to the non-target catch area. The size of each point is relative to the total observer effort. Clustering of values close to the one-to-one line of equivalence (in red) indicates a good prediction of the data by the model.

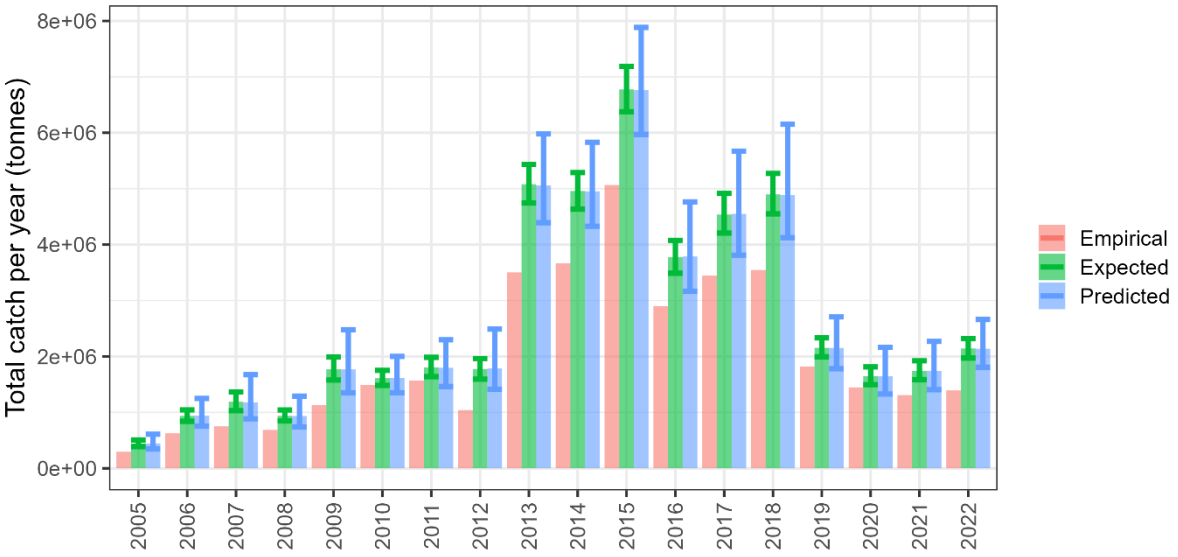

Figure C16: Posterior prediction and expected model outputs of the TOTAL discards, shown as the posterior mean of the sum per year. Credibility Intervals (95%) are shown for the predicted and expected outputs. Close correspondence between the posterior predicted and expected values indicate correct parameterisation of the posterior prediction. Close correspondence between the expected and predicted values, and the empirical data, indicate a good model fit.