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Fishery description and catch per unit effort analyses for silver warehou in SWA 3 and SWA 4 to the 2024–25 fishing year

New Zealand Fisheries Assessment Report 2026/35

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PLAIN LANGUAGE SUMMARY

Silver warehou (*Seriolella punctata,* SWA) are found all around New Zealand and are relatively common around the South Island and on Chatham Rise at depths of 200–800 m. This report provides a fishery characterisation and Catch-Per-Unit-Effort (CPUE) indices for silver warehou in management areas SWA 3 and SWA 4 using data to the end of the 2024–25 fishing year. Silver warehou catches were almost exclusively taken by trawling and predominantly by bottom trawl. Most silver warehou was taken as a bycatch whilst targeting other species such as hoki and squid. Silver warehou were caught on Chatham Rise and along the South Island east coast shelf edge, with some catches also around the Subantarctic Auckland, Campbell and Bounty Islands, and on Pukaki Rise. In recent years, silver warehou catches from silver warehou target tows were mostly absent from Chatham Rise except for one small 'hot spot' on south Chatham Rise just east of 180°. Standardised CPUE increased in the early 2000s and then was variable around this higher level.

EXECUTIVE SUMMARY

Holmes, S.J.[1]; Dunn, M.R.; Bian, R. (2026). Fishery description and catch per unit effort analyses for silver warehou in SWA 3 and SWA 4 to the 2024–25 fishing year.

***New Zealand Fisheries Assessment Report 2026/35* 46 p.**

Silver warehou (*Seriolella punctata,* SWA) are a type of medusafish that are relatively common around the New Zealand South Island and on Chatham Rise at depths of 200–800 m. The report describes a fishery characterisation and standardised Catch-Per-Unit-Effort (CPUE) analyses for silver warehou in management areas SWA 3 and SWA 4, using data to the end of the 2024–25 fishing year.

The fishery characterisation was focused on SWA 3 and SWA 4, but also included some information for SWA 1. In all management areas, catches were almost exclusively taken by trawl gears and predominantly by bottom trawls. Trawl tows targeting silver warehou made up only a small proportion of tows catching silver warehou, but in terms of catches the target fishery was an important component, along with bycatch in fisheries targeting hoki and arrow squid. The silver warehou, hoki, and squid target fisheries operated at different modal depths, but together the three fisheries encompassed the preferred depth range of silver warehou; the squid fishery included tows shallower, and the hoki fishery tows deeper, than this range.

The spatial distribution of catches was fairly consistent through time, except for a reduction in catches on north Chatham Rise east of 180° and around Puysegur in recent years (2022–25). The hoki target fishery showed considerably greater spatial spread on Chatham Rise than the other target fisheries. In recent years, silver warehou catches from silver warehou target tows were mostly absent on Chatham Rise except for one small 'hot spot' on south Chatham Rise just east of 180°.

Results from the characterisation did not suggest the SWA 3 and 4 area should be divided into separate stocks, and the CPUE analyses assumed a single stock. Standardised CPUE analyses used only catch and effort data from commercial trips when an MPI observer was aboard. The indices showed an increase in the early 2000s, followed by variable CPUE but without strong trend, indicating that silver warehou abundance increased in the early 2000s and then remained at this higher level.

[1] All authors: Earth Sciences New Zealand (ESNZ).

1. INTRODUCTION

Silver warehou (*Seriolella punctata,* SWA) are a type of medusafish, a family that includes other fishes that similarly feed on gelatinous zooplankton and small crustaceans (Horn et al. 2011). In New Zealand, silver warehou are relatively common around the South Island and on Chatham Rise at depths of 200–800 m, and they can be one of the most abundant species by weight caught during Chatham Rise trawl surveys (e.g., Stevens et al. 2024). Most of the commercial catch has been taken from the Chatham Rise, Canterbury Bight, southeast of Stewart Island, and off the west coast of the South Island (Fisheries New Zealand 2026). The quota management areas (QMA) for SWA are shown in Figure 1.

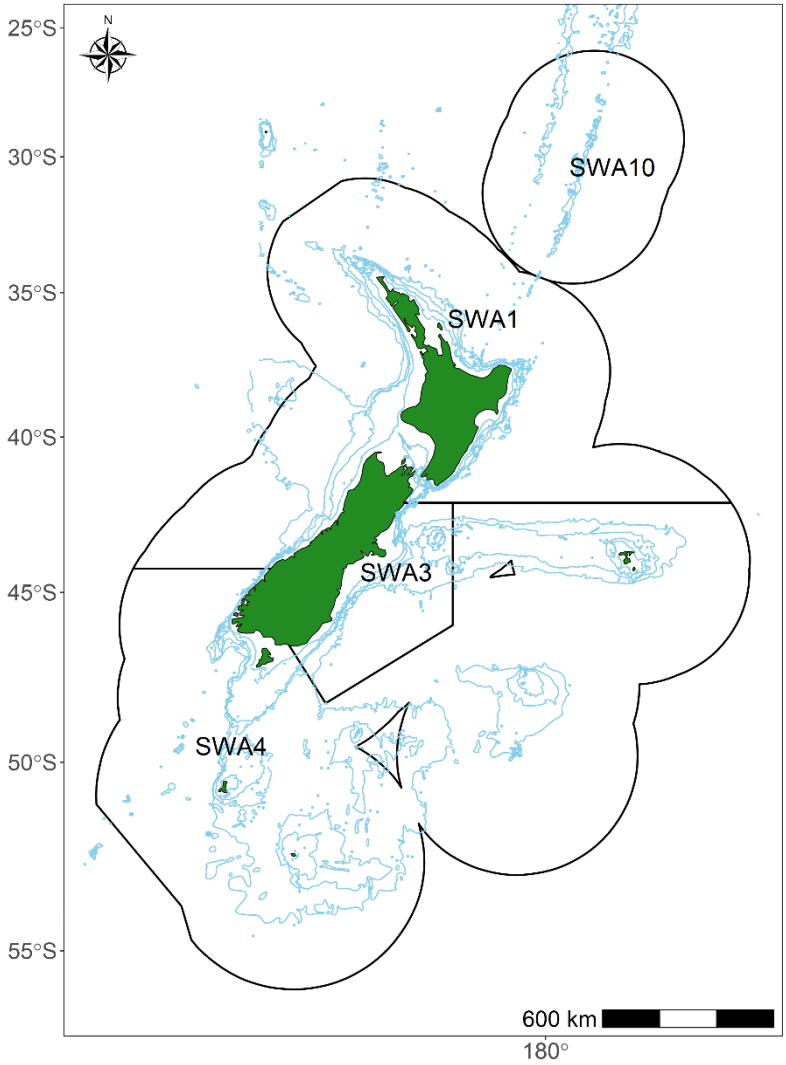


Figure 1: Management areas for silver warehou.

A quantitative stock assessment model has not been accepted for silver warehou (despite several attempts), and an assessment evaluating a range of data sources has instead been used to provide stock status advice (Fisheries New Zealand 2025). One of the main problems has been deriving an acceptable biomass index, with a focus on using commercial CPUE. About thirty standardised CPUE indices were reported in Dunn et al. (2020) and Dunn & McGregor (2023) as potential biomass indices, and covered inshore fisheries, offshore fisheries, specific depths (including year-depth/area interactions), specific times of year, specific groups of vessels, trying environmental covariates, and spatial-temporal statistical analyses; the data used in these analyses have been at event, daily, or trip level, and from commercially reported data or data recorded by Scientific Observers. Dunn & McGregor (2023)

concluded that there may have been mis-reporting or non-reporting of silver warehou catches in some years under restrictive TACCs, meaning that the most credible CPUE series were those derived from only Scientific Observer data. The Plenary report ultimately provided a range of standardised CPUE indices and research trawl survey biomass indices as potential indicators of stock biomass trends (Fisheries New Zealand 2025).

The overall objective of Fisheries New Zealand project SWA2025–01 was: "To develop an assessment of biomass in relation to management targets for silver warehou (*Seriolella punctata*) in SWA 3 and 4". This report fulfils the reporting requirements for specific objective 1 of project SWA2025–01: "To update the descriptive analysis of the commercial catch and effort data for silver warehou on the Chatham Rise and Southland and update standardised catch and effort analyses." This report updates the fishery descriptions of McGregor (2019), Dutilloy & Dunn (2020) and Dunn & McGregor (2023) and updates standardised catch per unit effort (CPUE) based on the approach recommended by the Fisheries New Zealand Deepwater Working Group (DWWG) after investigations by Dunn & McGregor (2023); a focus on using catch and effort data from Scientific Observer data only . Although the focus of the project was silver warehou in areas SWA 3 and 4, catch-effort data were requested for the whole of New Zealand and therefore, where it required little additional time, the characterisation of the fisheries included SWA 1. Almost no catch is taken from SWA 10.

This report should be read in conjunction with another report, for specific objective 2 of SBW2025-01, describing the application of length-based spawning potential ratio (LB-SPR) to silver warehou in SWA 3 and SWA 4 (Holmes & Dunn 2026).

2. METHODS

The data available for silver warehou in SWA 3 and SWA 4 included catch and effort data, Ministry for Primary Industry (MPI) observer data from observed trips, and resource trawl surveys. Commercial catch and effort data were analysed to summarise and characterise the silver warehou fisheries, and observer catch and effort data used to update the CPUE indices for the stock.

2.1 Catch and effort data

Catch and effort data were extracted by Fisheries New Zealand from the Electronic Data Warehouse (EDW) database for the period from 1 October 1989 to 30 September 2025 (extracted 22 January 2026, REPLOG 17212). Two extracts were performed. The first included all trips recorded as landing silver warehou into any silver warehou quota management area (QMA). An extract including data from all areas allowed for data grooming to correct for misallocated management area on the SWA 3 or SWA 4 boundaries. The second extract included all trips on which the fishing methods of bottom trawl (BT), precision bottom trawl (PRB), midwater trawl (MW), or precision midwater trawl (PRM) were used, regardless of whether silver warehou catch was recorded or not. The latter extract was for potential CPUE analyses and, to maintain reasonable file sizes, was restricted to trips where use of the prescribed fishing methods took place within fisheries management areas FMA 2, FMA 3, FMA 4, FMA 5, FMA 6 or Statistical Area 017 of FMA 7. Analyses of CPUE using this extract were ultimately rejected, and no analyses using this dataset are reported here.

Catch and effort data were also extracted from the *cod* observer database, where the method used was bottom trawl, bottom depth was 20–900 m, and area was SWA 3 or SWA 4. Data were extracted for all tows, regardless of whether they caught silver warehou or not.

2.2 Data checks

Data were checked for errors, using a package developed and used internally by Earth Sciences New Zealand and using the statistical software package 'R' (R Core Team 2024). Individual tow or set

locations were investigated and errors were corrected using median imputation for start/finish latitude or longitude, fishing method, target species, tow speed, net depth, bottom depth, wingspread, duration, and headline height for each fishing day for a vessel. Range checks were defined for the remaining attributes to identify outliers in the data. The outliers were checked and corrected if possible with mean imputation using vessel id, target species and fishing method for all data within the same month or year, or the record was removed from the data set. Missing statistical areas were calculated from positions where these were available.

2.3 Fishery characterisation

The characterisation was conducted by silver warehou QMA, focused on the most recent fishing years (New Zealand fishing years run from 1 October, and when referenced as a single year will refer to the year-ending, i.e., 2025 means 1 October 2024 to 30 September 2025).

2.4 Catch per unit effort (CPUE) analyses

Data, from catches using the bottom trawl method, were retained only when seabed depth was greater than 20 m and less than 900 m; when none of the data fields required were missing; and after the application of continuity rules, under which vessels were retained only if they had completed at least ten tows with positive silver warehou catch a year for at least five years.

The CPUE analyses used Generalised Additive Models (GAMs) and the hurdle (delta) method, where the probability of a positive silver warehou catch was modelled using a binomial distribution, and positive catch size per tow modelled using a lognormal distribution. The final index was the product of the binomial and lognormal indices. Model predictors are shown in Table 1. Model fits were evaluated using standard residual diagnostics, including variable influence plots (Alistair Dunn, github.com/alistairdunn1/gamInflu). Predictors were retained if their effects were significant.

Table 1: Explanatory variables offered to the GAM CPUE models. All variables were significant in all model runs.

Variable	Type	Description
Year	Categorical	Fishing year
Vessel	Categorical	Unique vessel identifier, fitted as a random effect
Location	Continuous latitude and longitude	Fitted using a tensor product (a 2D latitude and longitude surface, fixed over time)
Spot	Categorical half-degree latitude and longitude cells	Ultimately excluded in favour of the tensor product approach
Target species	Categorical	Ultimately excluded; declared target species, suspected to be unreliable
Bottom depth	Continuous	Depth of sea floor (m)
Tow duration	Continuous	Duration of tow (hours)
Month	Categorical	Ultimately removed from analyses in favour of day of fishing year
Day of fishing year	Continuous	Fitted with a cyclic spline
Time of day	Continuous	Fitted with a cyclic spline

The vessel continuity rule reduced the number of vessels from 100 to 27 (2000–2025) or 30 (1991–2025). The dataset included few tows at depths less than 100 m, therefore the final analysis dataset was truncated to depths 100–900 m.

3. RESULTS

3.1 Fisheries characterisation

In most fishing years from 2000–01 to 2006–07, landings in SWA 3 and SWA 4 were well above the TACCs (Figure 2). Fishers landed catches in excess of their Annual Catch Entitlement (ACE) holdings and paid penalties (deemed values) for the over-catch. From 1 October 2007, the deemed values were increased for all SWA stocks and two differential rates introduced, a second and higher rate applying to all catch over 130% of ACE holding. As a result, fishing without ACE was reduced in 2007–08 and catch fell below the TACCs in both SWA 3 and SWA 4. In subsequent years landings again exceeded the TACC in SWA 3, including after the TACC was increased in 2020–21, and again in 2023–24. SWA 4 landings consistently exceeded the TACC during the fishing years 2016–17 to 2018–19. The TACC was increased in SWA 4 in 2020–21 and again in 2024–25.

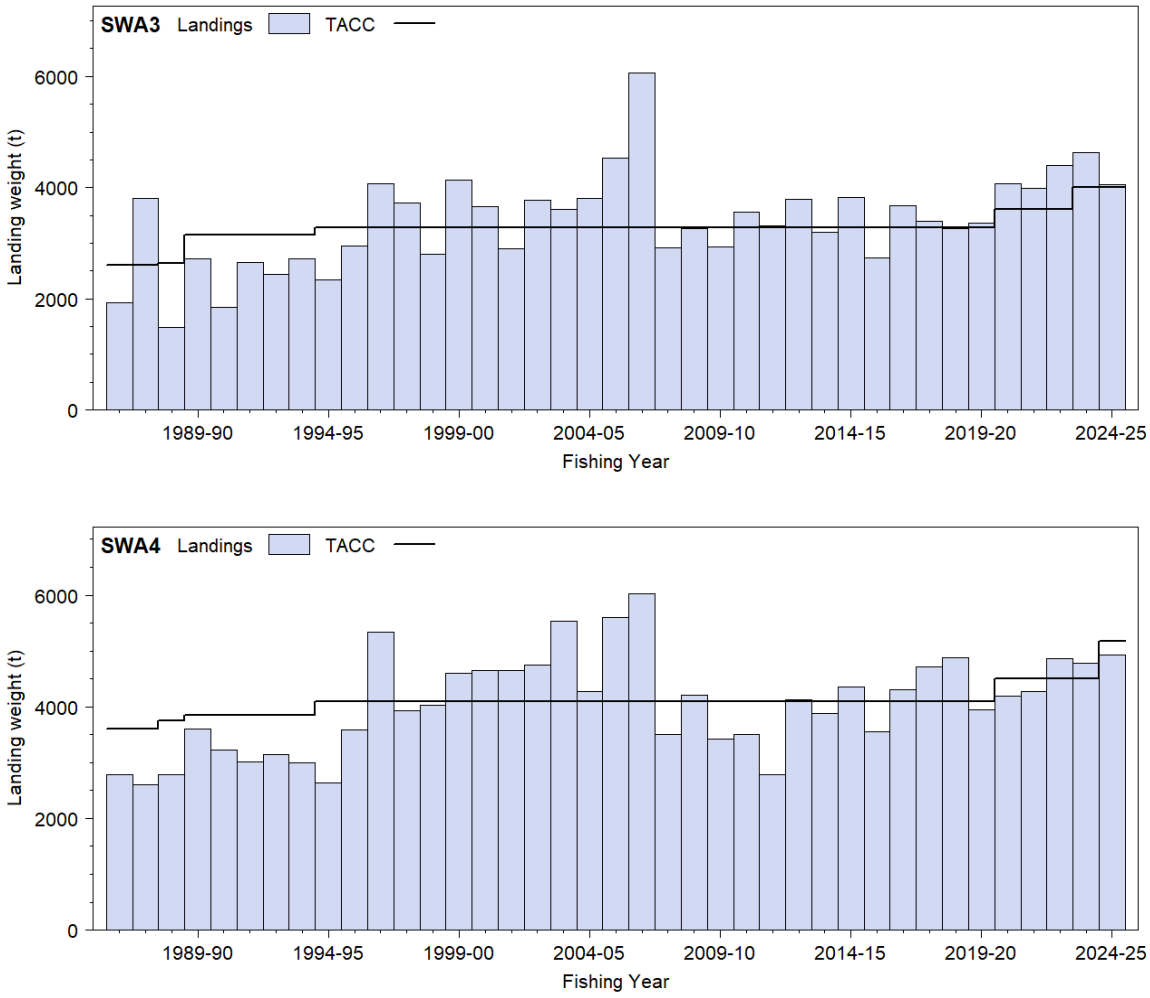


Figure 2: Silver warehou SWA 3&4, reported commercial landings and TACC by Quota Management Area. Reproduced from Fisheries New Zealand (2026).

During 1990–96 a substantial proportion of the landed catch was not recorded on the estimated (at-sea) catch forms (Figure 3). In these years, a large proportion of the landed catch from SWA 3 and 4 had Destination Code 'T' (transferred to another vessel) or 'R' (retained onboard), therefore these records were removed for subsequent characterisation and CPUE analyses.

Catch of silver warehou was almost exclusively by trawl gears, and predominantly by bottom trawl (Figure 4). Catches were predominantly recorded on trawl catch effort and processing return (TCEPR) forms until the New Zealand fleet transitioned to the electronic reporting system from 2018 (Figure 5);

this means the estimated catch data are mostly at the event (tow) resolution. Most silver warehou was landed dressed, with green weight fish the second most dominant category, especially in SWA 3 (Figure 6). In recent years (from 2018) there has been an increase in silver warehou used for fish meal. The increase in meal was attributed to technical innovations in fish meal processing; previously the heads and oil content of silver warehou made them unsuitable for fish meal processing (Ben Steele-Mortimer, Seafood New Zealand, pers comm.).

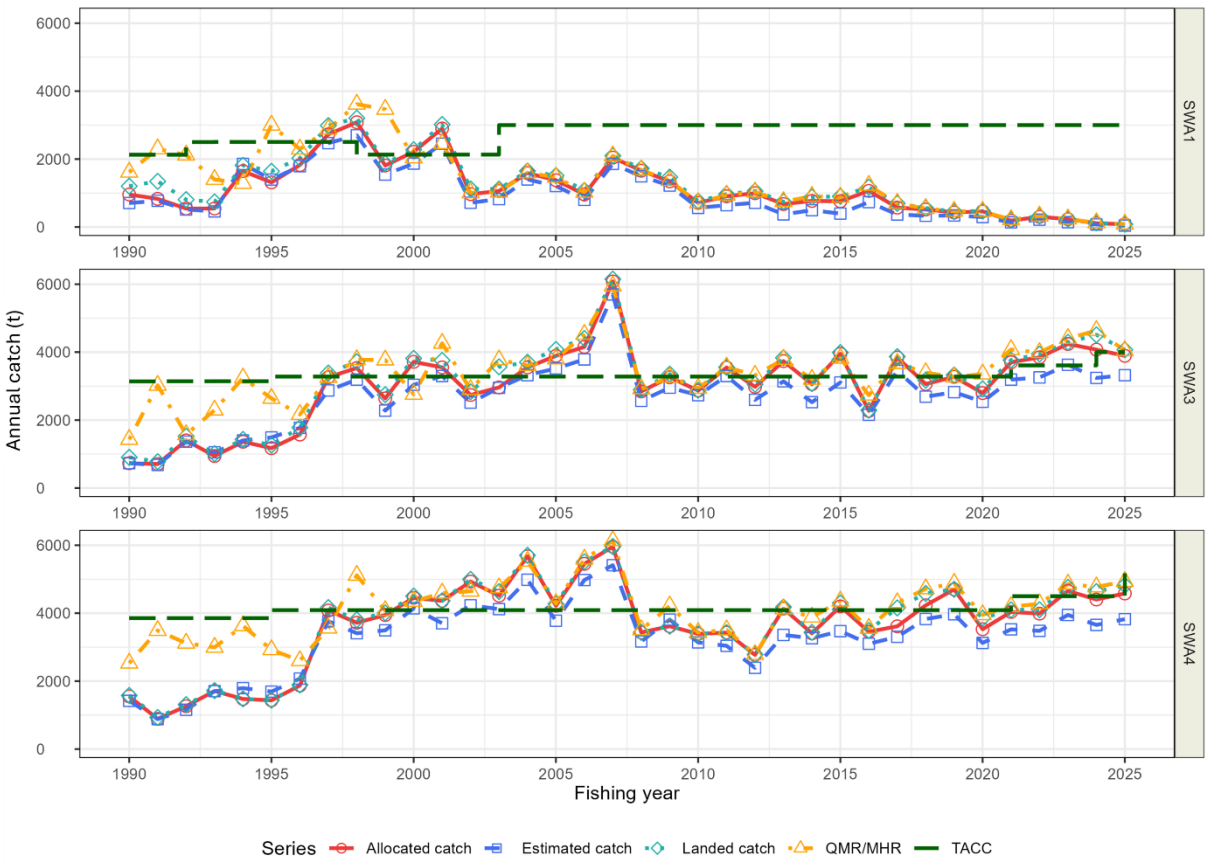


Figure 3: Silver warehou SWA 1, 3 and 4. Estimated catch: estimated catch from at-sea catch and effort reporting forms; Landed catch: reported landed catch; QMR/MHR: landings from quota management returns (QMR) (to 2001) and monthly harvest return (MHR) data; Allocated catch: landed catch allocated to the fishing effort (and therefore QMA) proportionally to the estimated catches.

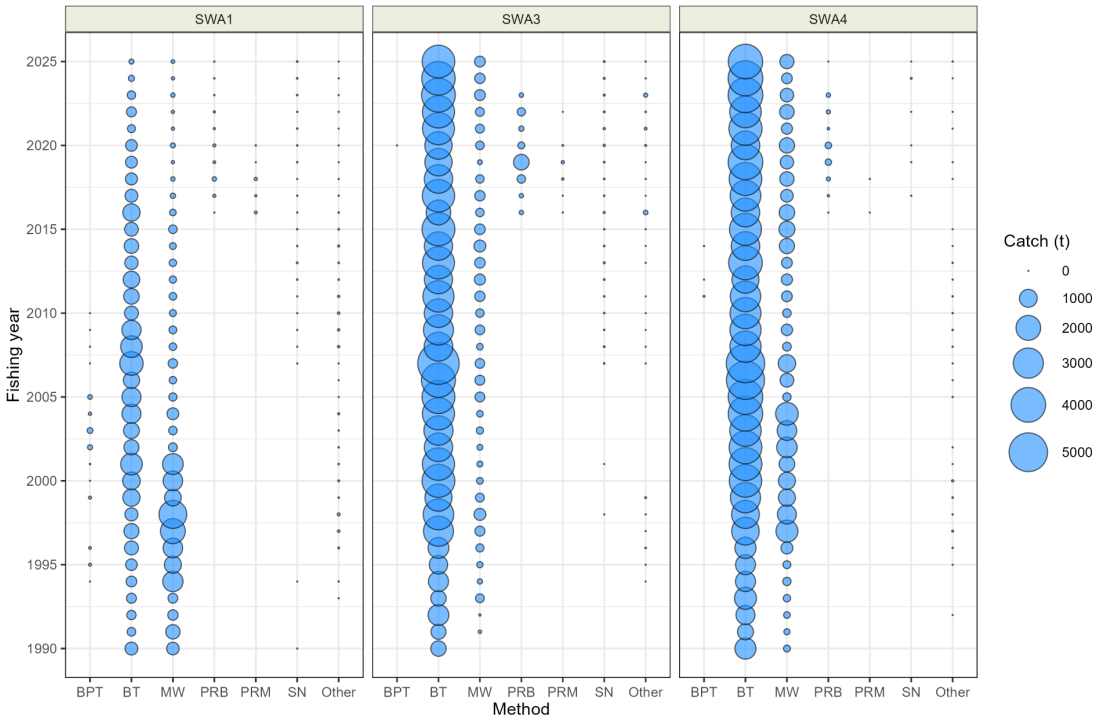


Figure 4: **Silver warehou SWA 1, 3 and 4, catches by fishing method and fishing year. Circle area is proportional to catch. BPT: bottom pair trawl; BT: bottom trawl; PRB: precision bottom trawl; PRM: precision midwater trawl; SN: seine net; Other: all other fishing methods combined.**

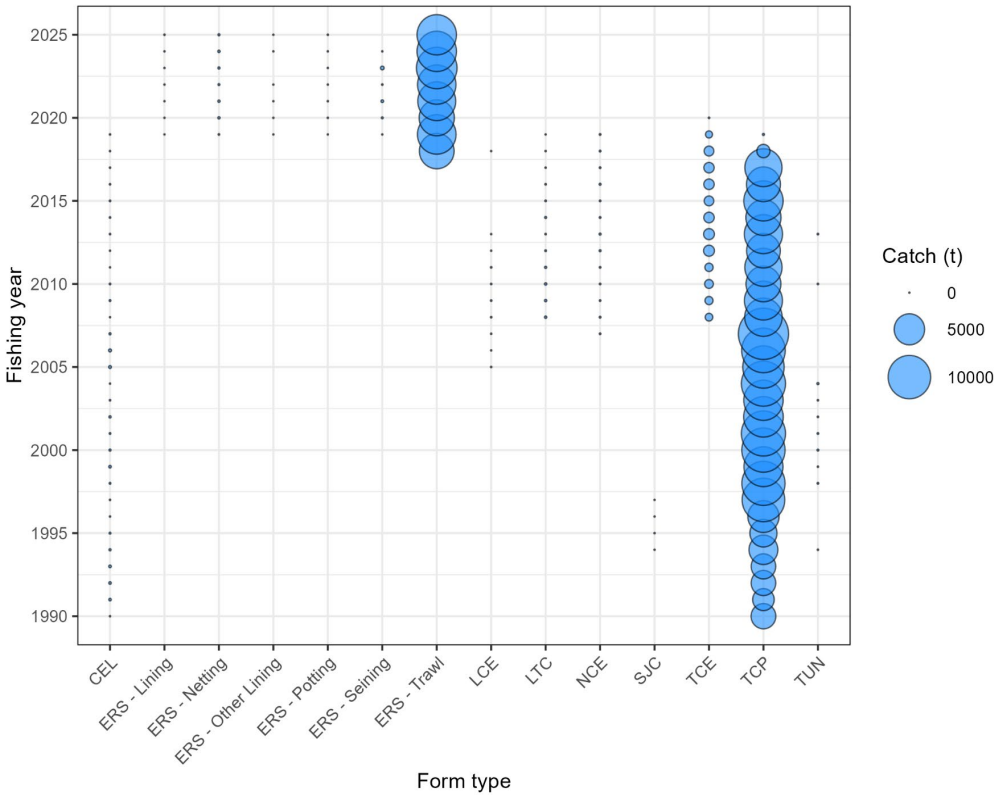


Figure 5: **Silver warehou SWA 1, 3 and 4 combined, catches by form type and fishing year. CEL: catch effort landing return; ERS: electronic reporting system return; LCE: lining catch effort return; LTC: lining trip catch effort return; NCE: netting catch effort return; SJC: squid jigging catch effort return; TCE: trawl catch effort return; TCP: trawl catch effort and processing return; TUN: tuna longlining catch effort return. Circle area is proportional to catch.**

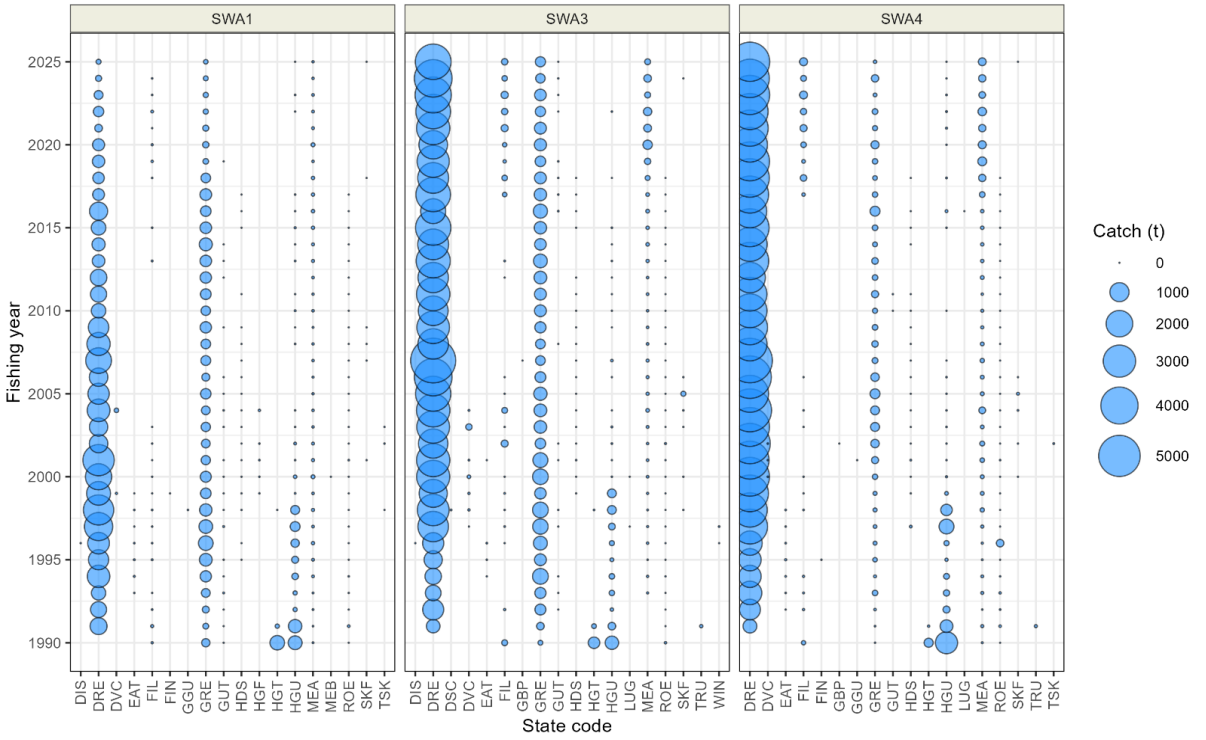


Figure 6: Silver warehou SWA 1, 3 and 4, landings by state code. DRE: dressed; DSC: dressed-straight cut; DVC: dressed-V cut; EAT: eaten on board the vessel; FIL: fillets, skin-on; GBP: gut by-product; GRE: green weight; GUT: gutted; HDS: heads; HGF: headed, gutted, and finned; HGT: headed, gutted, and tailed; HGU: minced, headed and gutted; LUG: lugs or collars; MEA: fish meal; MEB: fish meal by-product; ROE: roe; SKF: fillets, skin-off; TSK: fillets, skin-off trimmed; WIN: squid wings; DIS, GGU and TRU: unrecognised code. Circle area is proportional to catch.

In SWA 3, catches were lower in July and August, and in SWA 4 catches were lower in August, September and, to a lesser extent, October (Figure 7), whereas these were the months with higher catches in SWA 1. Effort, measured as fishing events (tows), was more evenly spread across the year than catch in SWA 3 since 2017, although in earlier years had been lower in both SWA 3 and 4 in August and September (Figure 8). Where effort was more evenly spread across the year lower catches had lower unstandardised CPUE.

In SWA 3, some catches were taken by small vessels (less than 30 m length), whereas in SWA 4 little catch was taken by vessels less than 40 m length (Figure 9). Most silver warehou catch was from vessels between 50–70 m overall length using bottom trawl gear but, in both QMAs, a substantial amount of catch was taken by large vessels (over 90 m) using midwater trawl gear. Catches from vessels 50–60 m and 60–70 m in length were similar, but vessels 60–70 m in length recorded a larger number of fishing events (Figure 10).

In SWA 3 and SWA 4, most silver warehou catch came from fisheries targeting hoki (HOK), squid (SQU), or silver warehou (Figure 11). In SWA 4, from 2014 the next most important fishery for silver warehou bycatch was one targeting barracouta (BAR) predominantly using midwater trawl gear. Catches of silver warehou in the SWA target fishery were comparable to catches from the HOK and SQU target fisheries, but the effort was much lower and catch rate higher (Figure 12). In SWA 4, comparable effort to the SQU target fishery was seen in the scampi (SCI) target fishery, but the catches of silver warehou in the SCI target fishery were much lower.

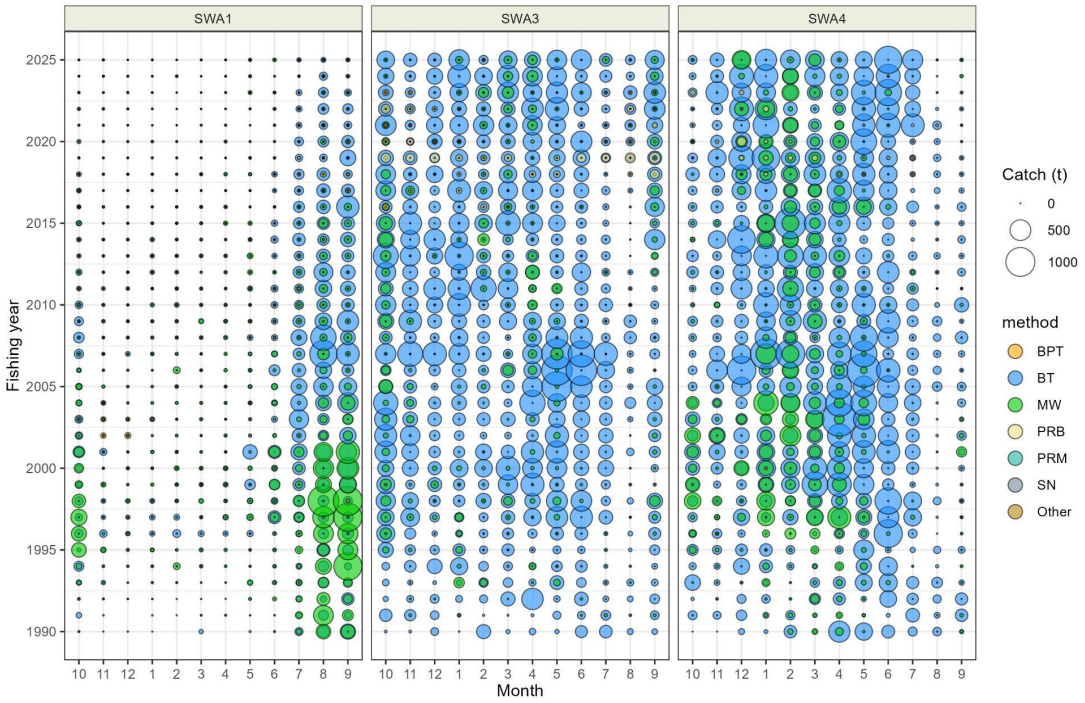


Figure 7: Silver warehou SWA 1, 3 and 4, catch by month, year and fishing method and year. When catch from more than one method has been recorded circles are plotted on top of each other. For explanation of method codes see Figure 3. Note the months start in October to reflect the fishing year for SWA, e.g., month 10 for year 1990 represents data from October 1989. Circle area is proportional to catch.

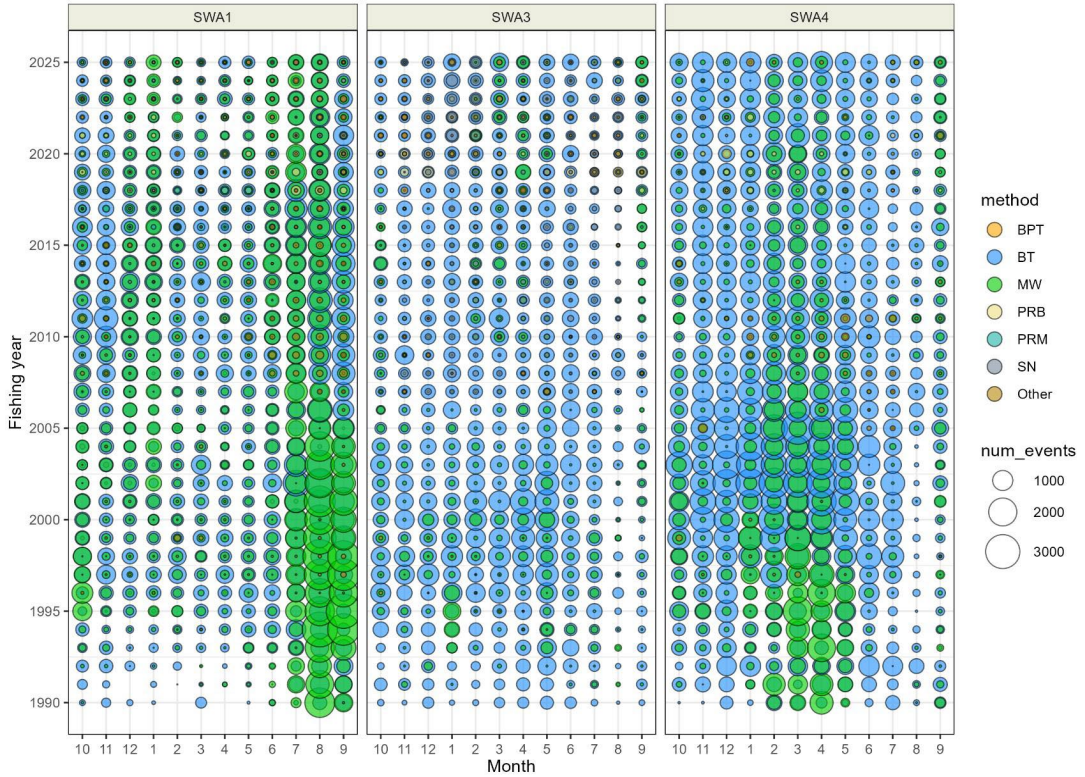


Figure 8: Silver warehou SWA 1, 3 and 4, number of fishing events by month, year and fishing method. When catch from more than one method has been recorded circles are plotted on top of each other. For explanation of method codes see Figure 3. Note the months start in October to reflect the fishing year for SWA, e.g., month 10 for year 1990 represents data from October 1989. Circle area is proportional to number of tows.

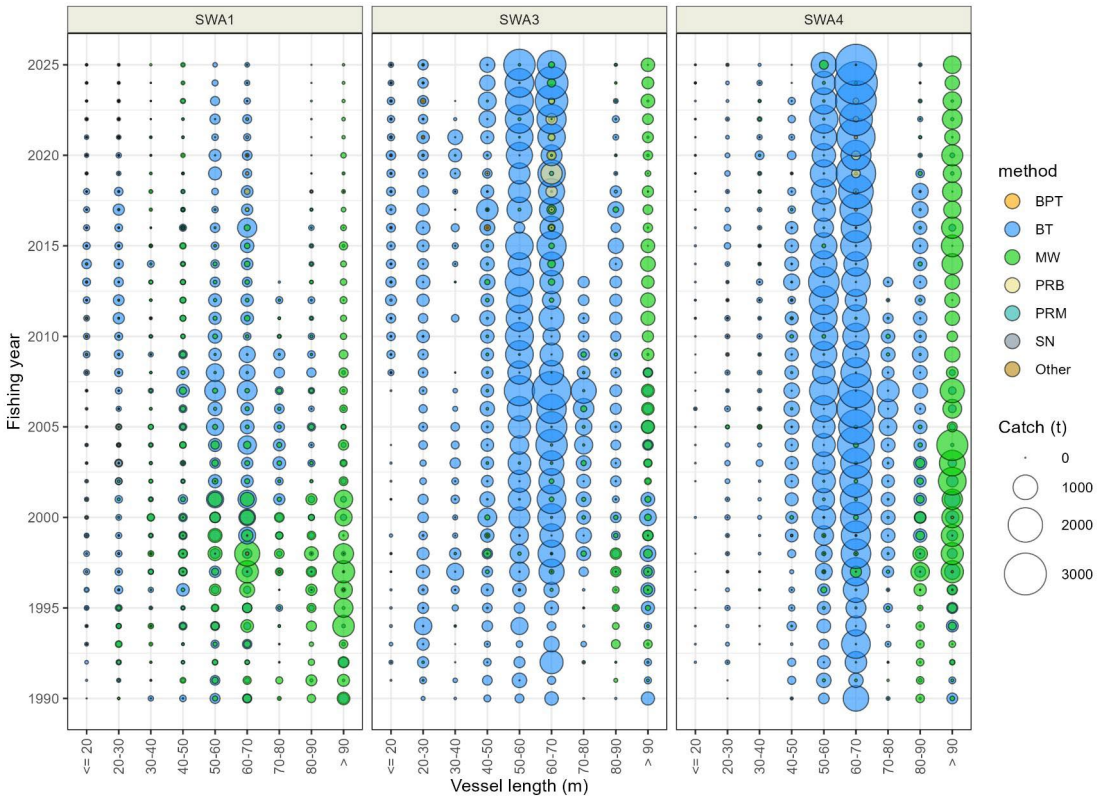


Figure 9: Silver warehou SWA 1, 3 and 4, catch by fishing vessel length category, year and fishing method. When catch from more than one method has been recorded circles are plotted on top of each other. For explanation of method codes see Figure 3. Circle area is proportional to catch.

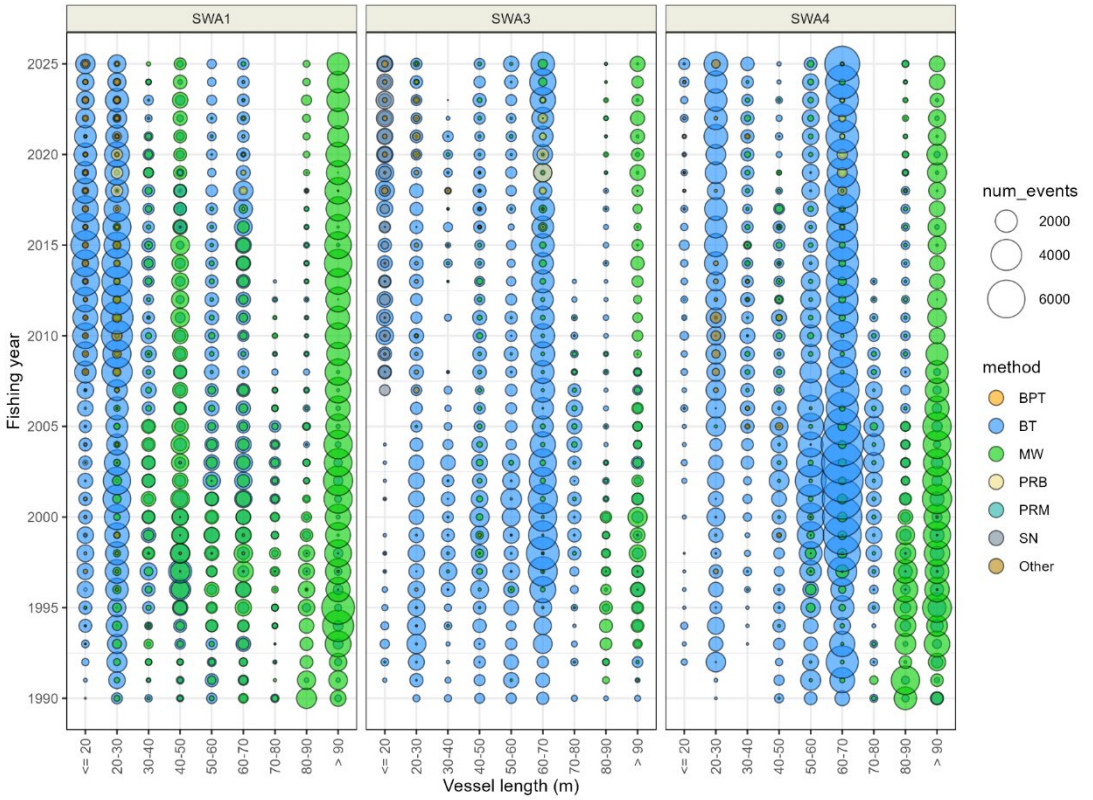


Figure 10: Silver warehou SWA 1, 3 and 4, number of fishing events by vessel length category, year and fishing method. When catch from more than one method has been recorded circles are plotted on top of each other. For explanation of method codes see Figure 3. Circle area is proportional to number of tows.

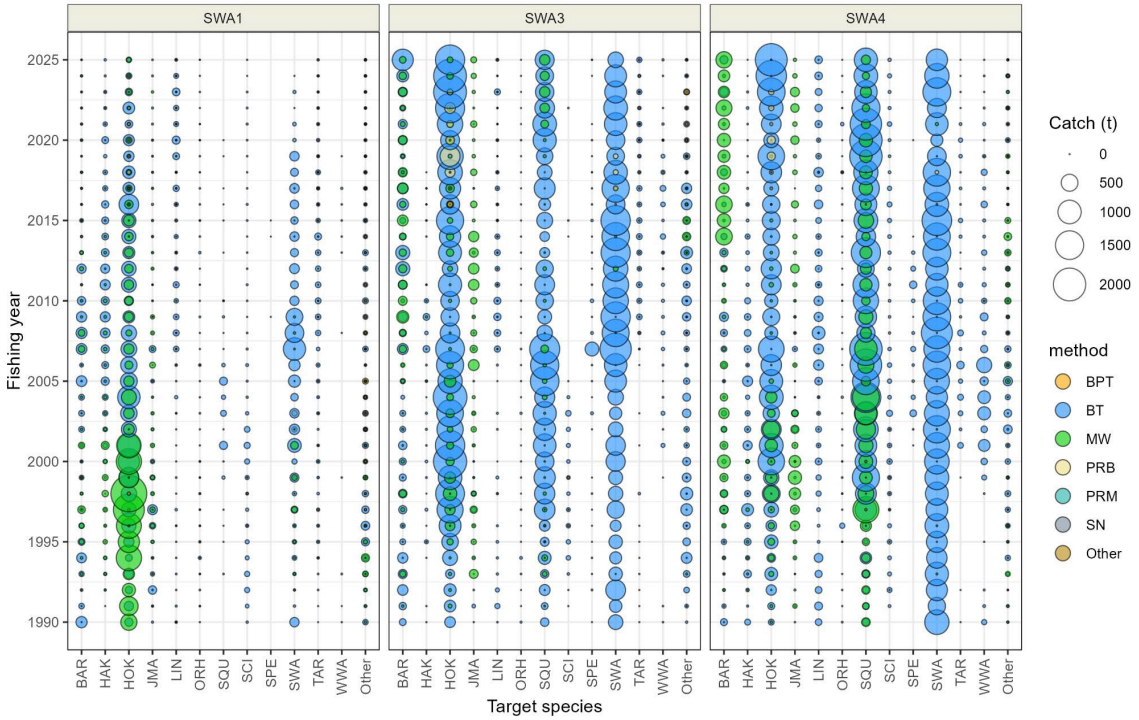


Figure 11: Silver warehou SWA 1, 3 and 4, catch by target species, year and fishing method. When catch from more than one method has been recorded circles are plotted on top of each other. For explanation of method codes see Figure 3. BAR: barracouta; HAK: hake; HOK: hoki; JMA: jack mackerel; LIN: ling; ORH: orange roughy; SQU: arrow squid; SCI: scampi; SPE: sea perch; SWA: silver warehou; TAR: tarakihi; WWA: white warehou; other: all other target species combined. Circle area is proportional to catch.

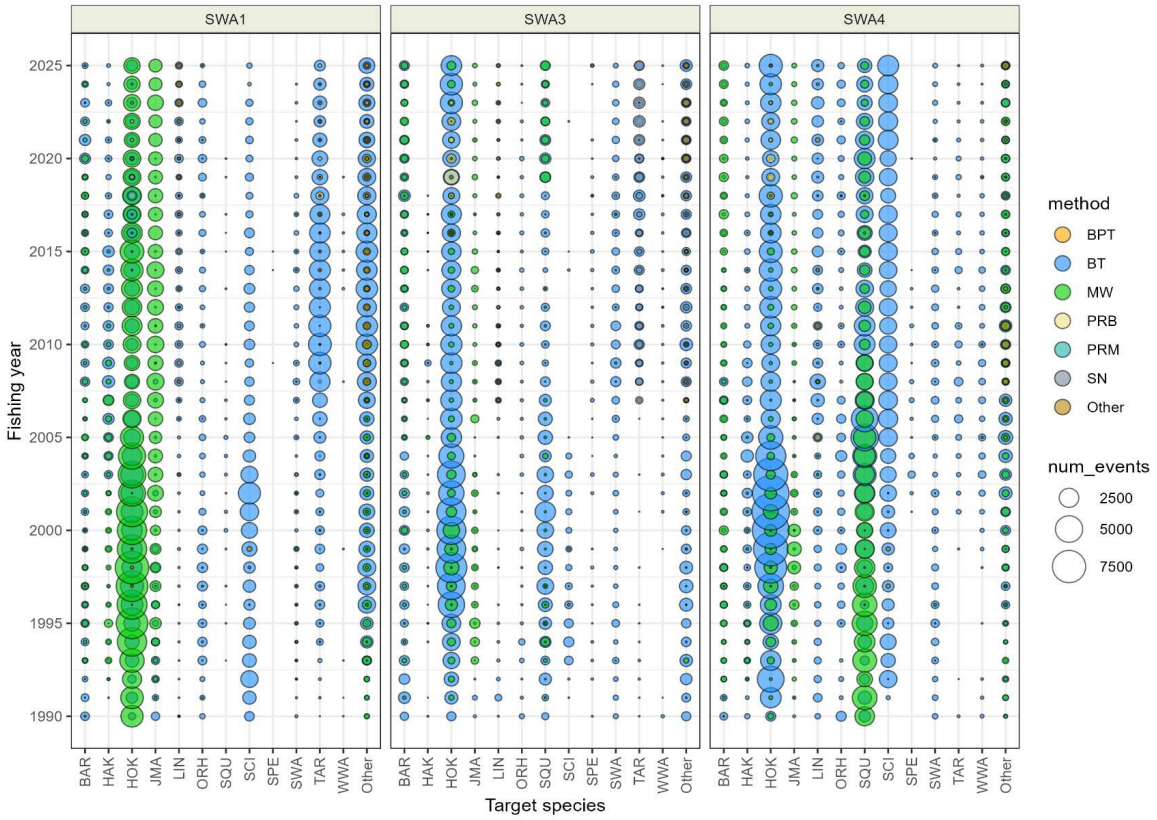


Figure 12: Silver warehou SWA 1, 3 and 4, number of fishing events by target species, year and fishing method. When catch from more than one method has been recorded circles are plotted on top of each other. For explanation of method codes see Figure 3. For target species codes see Figure 11. Circle area is proportional to number of tows.

In SWA 1, 3 and 4 (but especially SWA 3 and 4) the proportion of catch-effort records with associated depth information was very high, with 100% reporting in most years (Figure A1.1 and A1.2). For tows using bottom trawl gear: in SWA 3, from 2008 there were two distinct and consistent depth modes of fishing effort associated with silver warehou catch; in SWA 4, effort took place at three distinct depth modes (Figure 13). In SWA 1, the depth mode shifted from just below 400 m depth to around 100 m depth starting around 2004. This may be associated with a reduction in bottom trawl effort for the hoki target and scampi target fisheries, and increases in tows targeting tarakihi or 'other' species (Figure 12). The depth mode for catches in SWA 1 remained closer to 400 m. In SWA 3, although the pattern of catches somewhat reflected that of effort, there were also modes of catch at intermediate depth. In SWA 4, since 2010 the depth distribution of catches reflected that of effort but with less distinct modes.

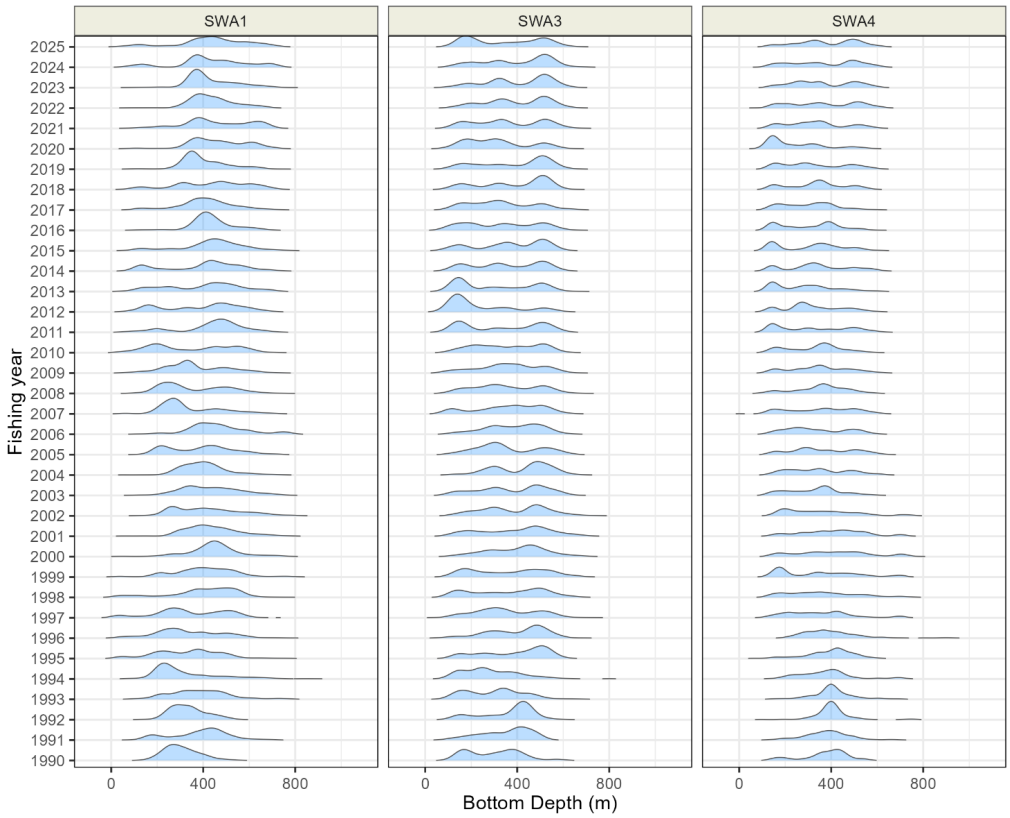
In SWA 3, HOK target effort silver warehou catches evolved to a narrow depth distribution centred at 500 m bottom depth (Figure 14). SQU target tows rarely occurred below 375 m bottom depth, with a mode often closer to 200 m and the depth mode of silver warehou catch was often at greater depth than that of effort (Figure 14). The depth distribution of catches reflected that of effort in the SWA target fishery but was quite broad and variable between years. The depth mode for SWA catches was quite often between those of the SQU and HOK target fisheries and explained the additional depth mode of catches seen in Figure 13.

In SWA 4, HOK target effort extended to deeper waters than in SWA 3 but silver warehou catch was not taken in waters deeper than 625 m in most years (Figure 15), and in recent years the mode for catches was similar or shallower than in SWA 3. There was a clear and very consistent mode of effort in the SQU target fishery at around 200 m depth, however modes in silver warehou catch could be

anywhere between 200 m and over 350 m. Similar to SWA 3, the depth distribution of catches reflected that of effort in the SWA target fishery, was quite broad, and variable between years.

For tows using midwater trawl gear, in SWA 3 and SWA 4, the depth modes for silver warehou largely reflected the modes for effort (Figure 16). The single mode at shallow depth from 2006 in SWA 3 reflected a reduction in MW trawl effort by hoki target vessels (Figure 12). The single mode at shallow depth throughout the time series in SWA 4 was associated with most MW trawl effort in the area conducted by squid target vessels (Figure 12). In SWA 1, a distinct mode at shallow bottom depth since 2005 was seldom reflected in the catch data.

a) Catch



b) Effort

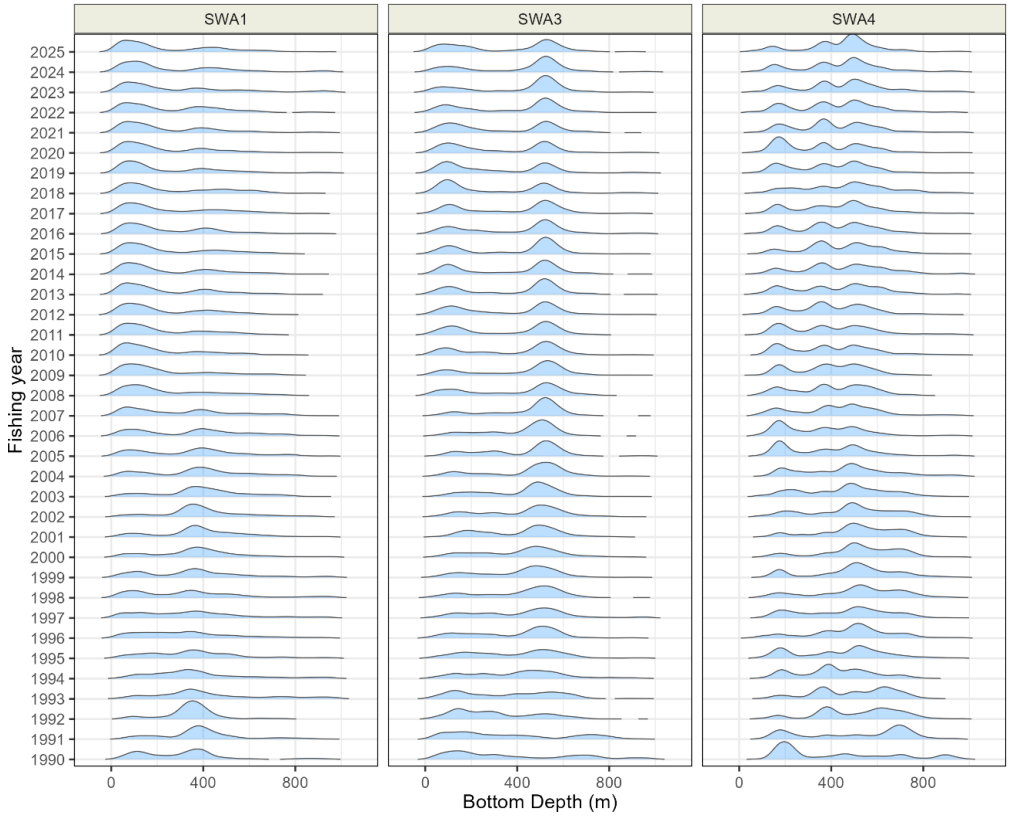
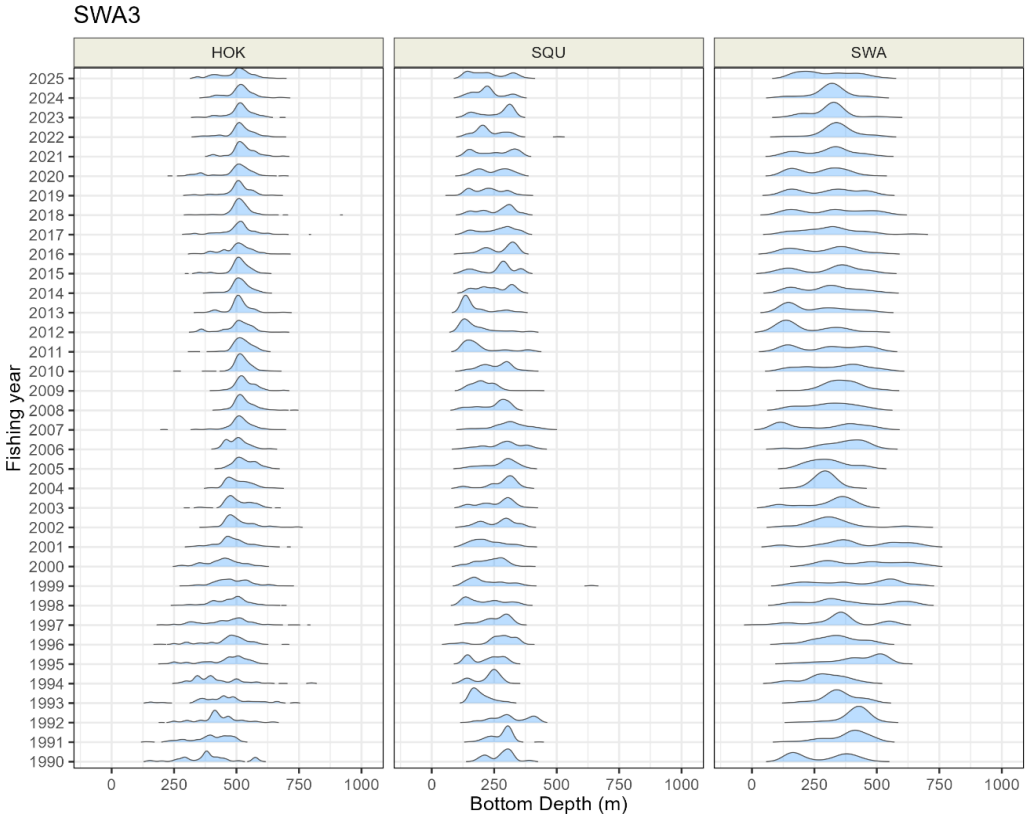


Figure 13: Silver warehou SWA 1, 3 and 4, ridge plots of: a) catch (t) of silver warehou by bottom depth; and b) effort (fishing events) by bottom depth for bottom trawl method.

a) Catch



b) Effort

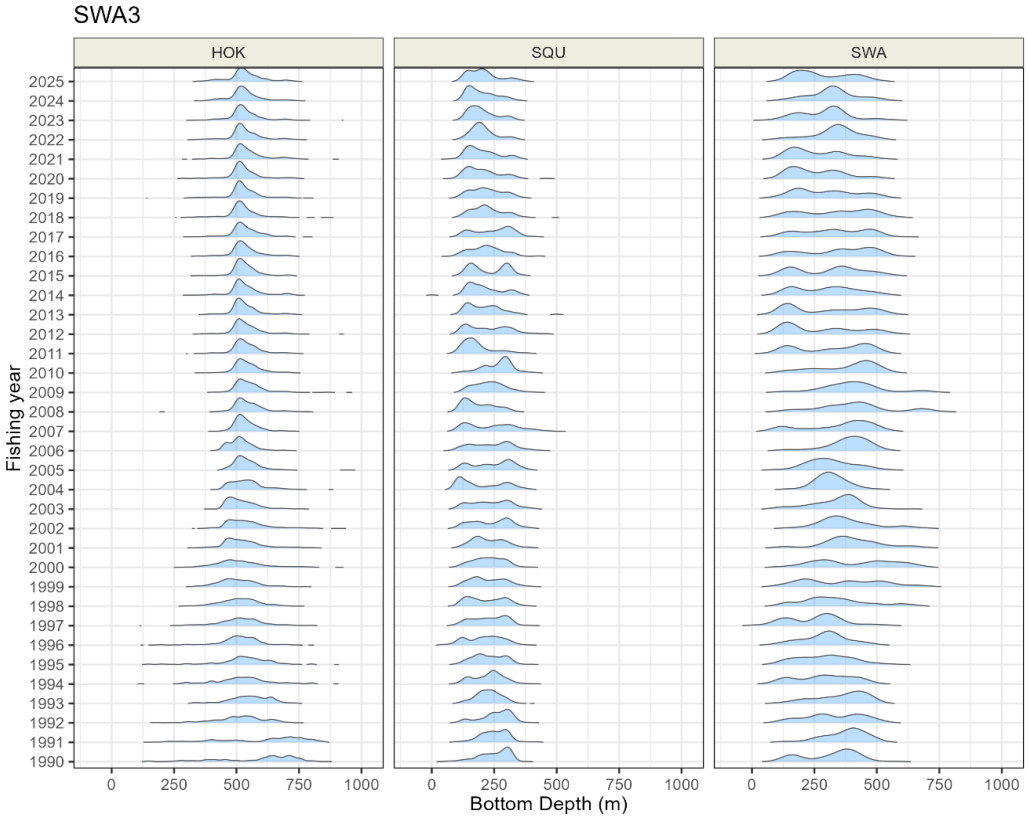
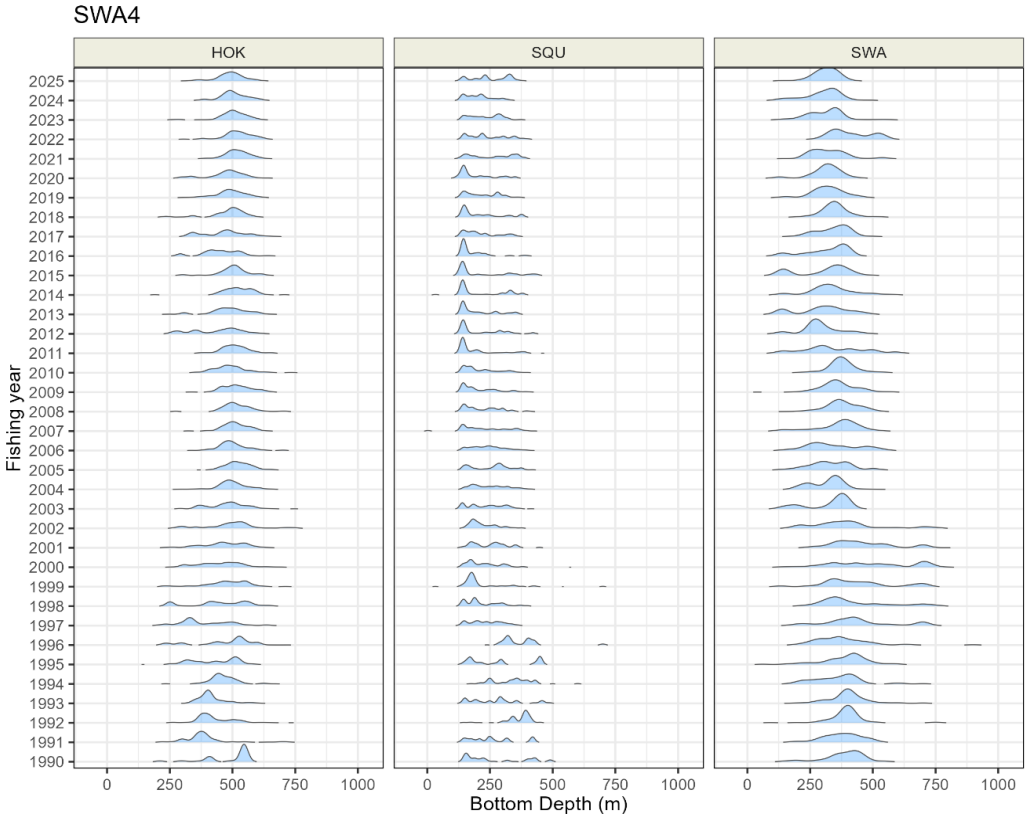


Figure 14: Silver warehou SWA 3, ridge plots of: a) catch (t) of silver warehou by bottom depth; and b) effort (fishing events) by bottom depth for the hoki (HOK) arrow squid (SQU) and silver warehou (SWA) target fisheries.

a) Catch



b) Effort

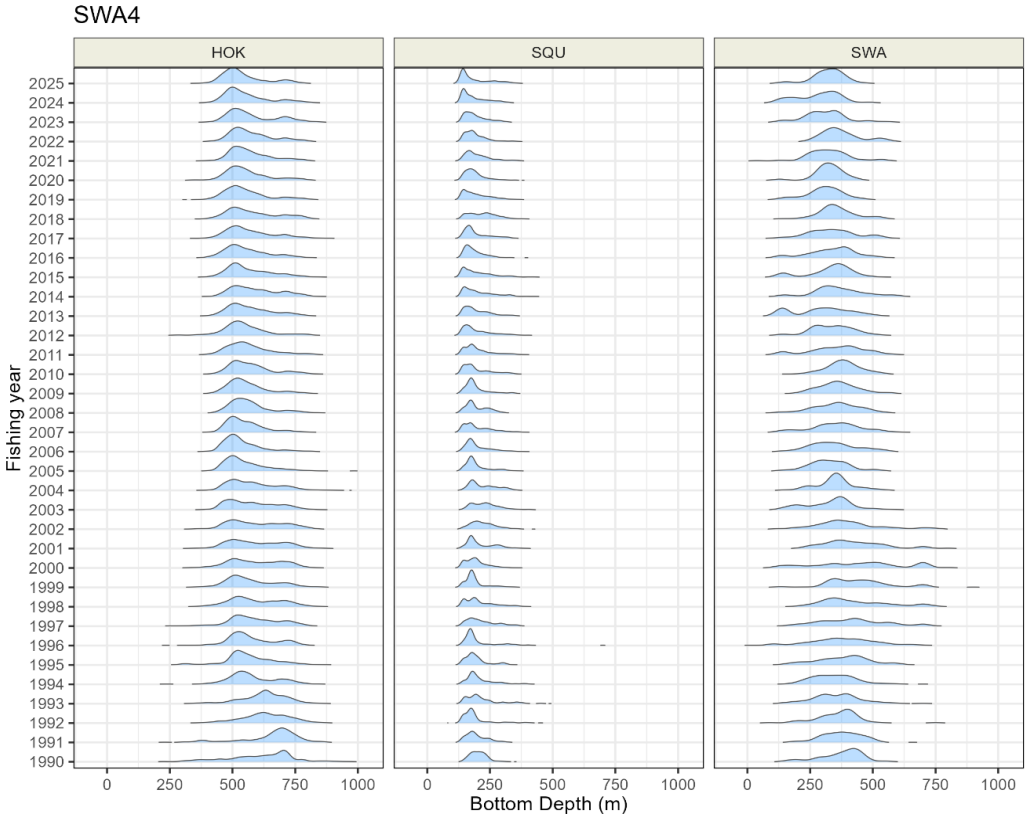
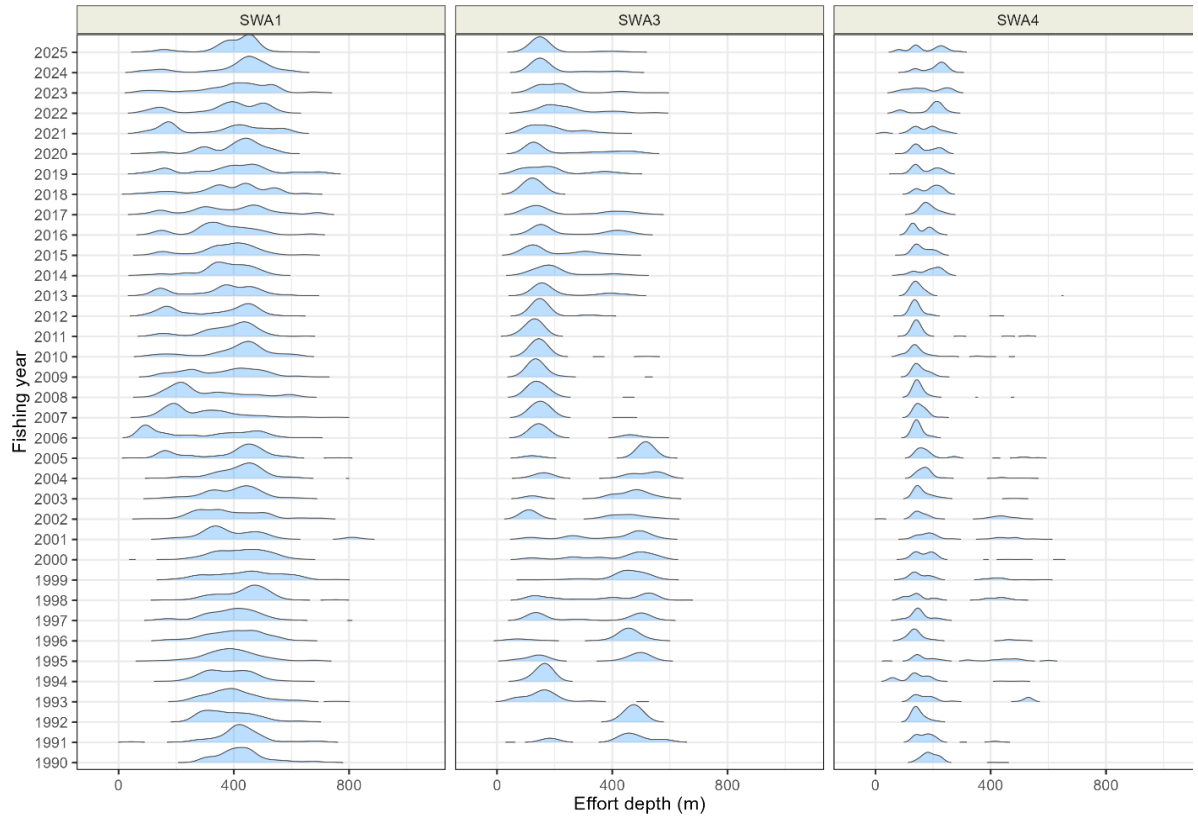


Figure 15: Silver warehou SWA 4, ridge plots of: a) catch (t) of silver warehou by bottom depth; and b) effort (fishing events) by bottom depth for the hoki (HOK) arrow squid (SQU) and silver warehou (SWA) target fisheries.

a) Catch



b) Effort

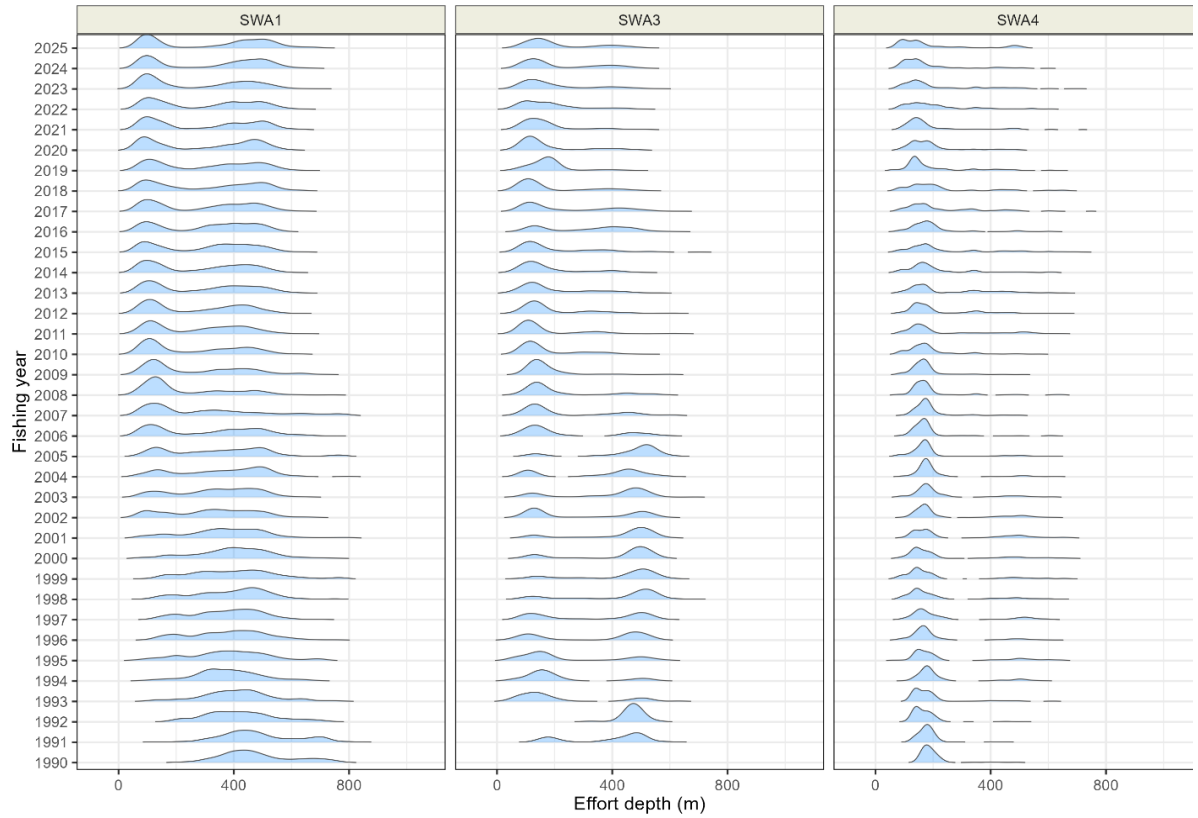


Figure 16: Silver warehou SWA 1, 3 and 4, ridge plots of: a) catch (t) of silver warehou by bottom depth; and b) effort (fishing events) by bottom depth for midwater trawl method.

In all three QMAs, the number of vessels reflects the number of permit holders (Figure 17). In SWA 3, the number of vessels rose rapidly to a peak in 1996 but then fell again as quickly, reaching a near time series low in 2006. The number of vessels (and permit holders) increased again after 2006 and since 2015 remained around 25 permit holders and 50 vessels. From 2009, however, there was a diversification of fishing methods associated with silver warehou catch, with vessels recorded using seine net. In SWA 4, the number of permit holders and vessels peaked in the late 1990s followed by a long-term decline to about 2015 after which the numbers fluctuated without trend. Since the late 2000s the number of permit holders and vessels landing silver warehou from SWA 4 has been lower than in SWA 3, but the number using BT or MW method is comparable. In SWA 1, there have been two distinct periods of rise and subsequent decline in number of permit holders and vessels. The second rise was associated with a diversification of methods with vessels recording bottom long lining, seine netting, and precision bottom trawl as their catch methods. Methods other than BT and MW account for very little silver warehou catch (Figure 4).

A simple measure of the spatial occurrence of the fishery is provided by counting the number of 0.1° longitude and latitude cells within which the start position of an event with silver warehou catch was reported. Focusing on BT and MW methods, the cumulative number of cells ever fished by trips recording silver warehou catch began to plateau from about 2010 in each of SWA 3 and 4 (Figures 18 and 19) but has a greater continued increase in SWA 1 (Figure 20). The lower overall number of cells fished in SWA 3 reflects the smaller size of the area, and the number of cells fished per year has remained relatively stable since the early 1990s except for a decrease centred on 2005. This dip in cells fished in 2005 reflects the decrease in number of vessels landing silver warehou in the area (Figure 17). The area fished per year in SWA 4 rose to a high in the early 2000s but then reduced again to 2009 after which it remained relatively stable. The number of cells fished per year in SWA 1 peaked in 2014; the fall in number of vessels seen in the late 1990s (Figure 17) resulted in only a modest and short-term reduction in number of unique cells fished.



Figure 17: Silver warehou SWA 1, 3 and 4, number of unique permit holders and vessels operating trips landing silver warehou.

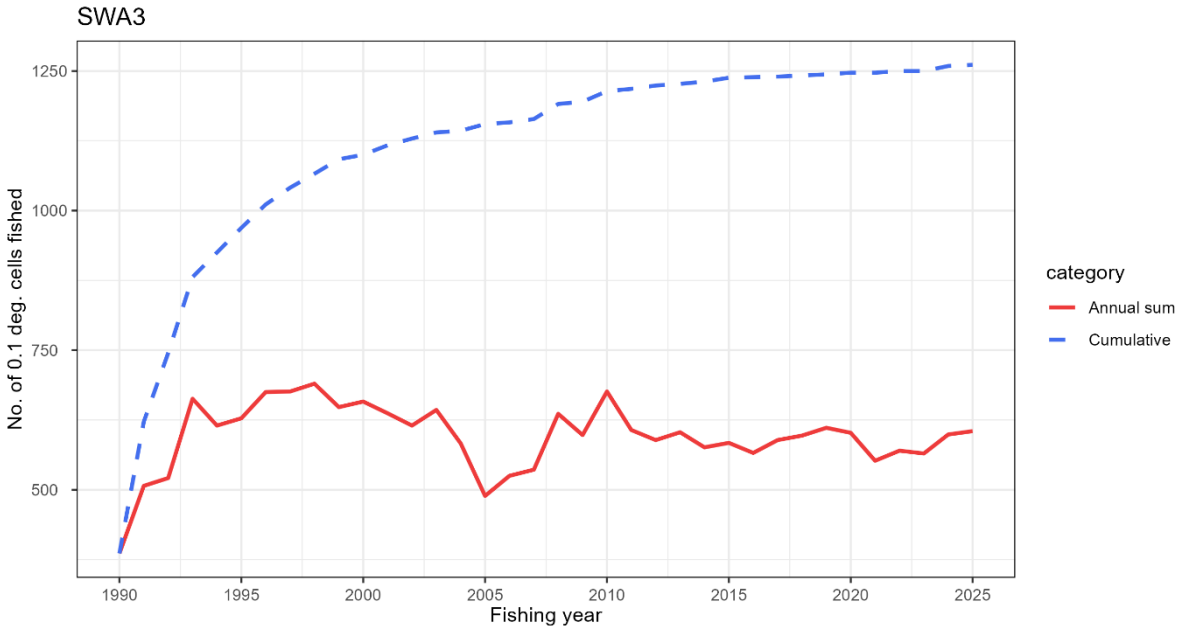


Figure 18: Silver warehou SWA 3, number of cells of 0.1° latitude and longitude fished in any one year and cumulative number of new cells fished over time for trips landing silver warehou.

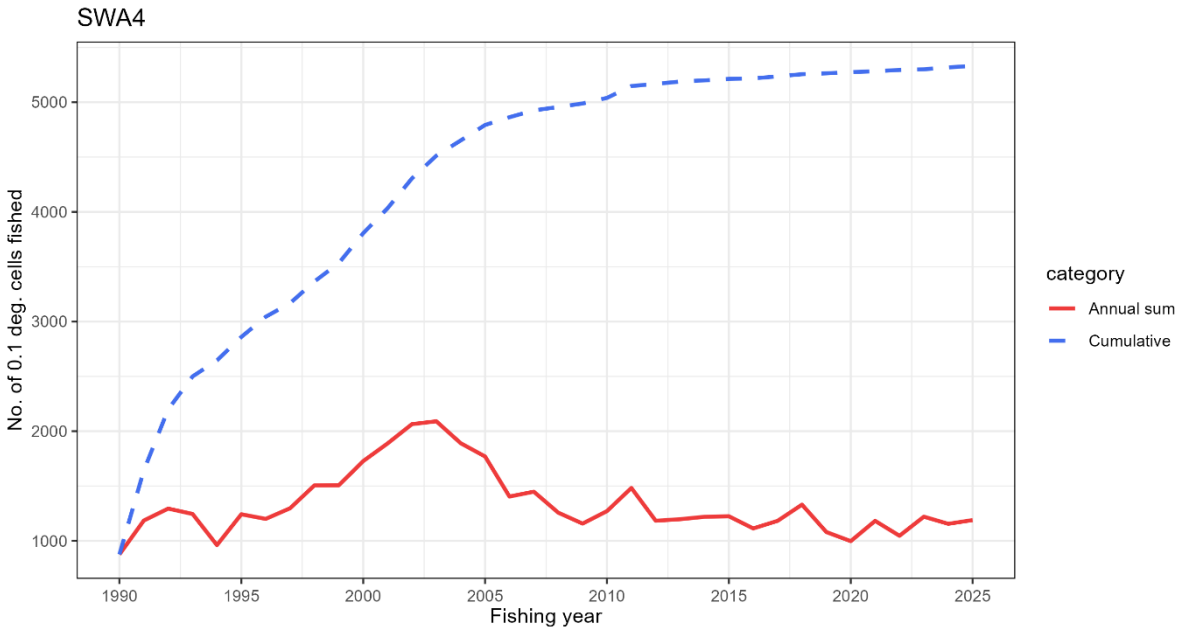


Figure 19: Silver warehou SWA 4, number of cells of 0.1° latitude and longitude fished in any one year and cumulative number of new cells fished over time for trips landing silver warehou.

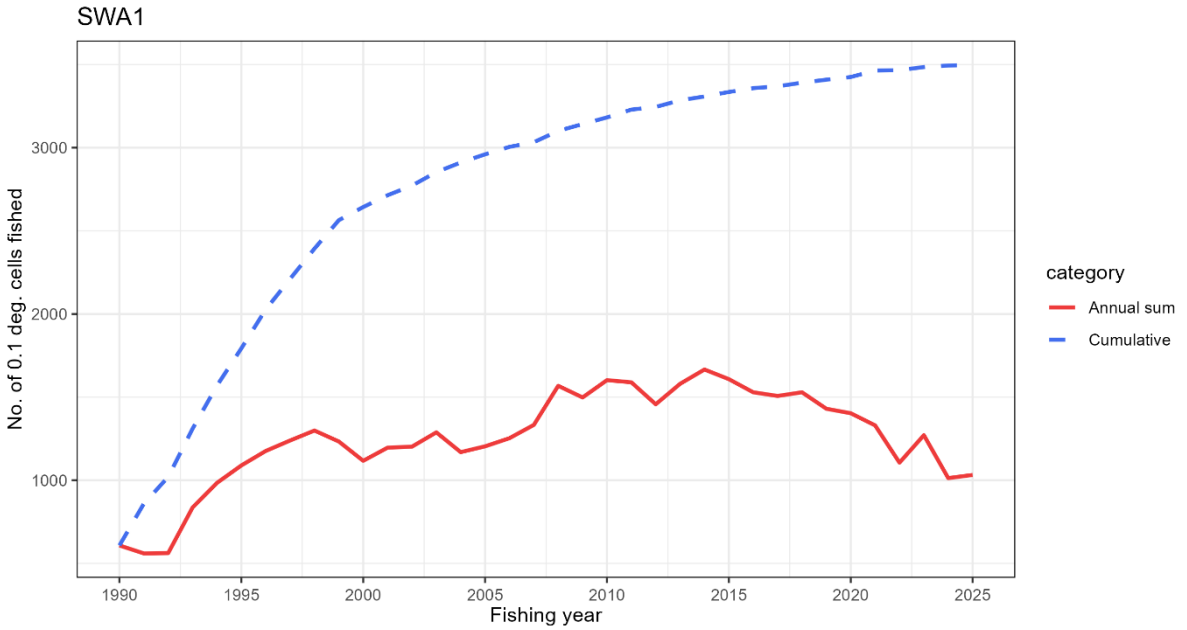


Figure 20: Silver warehou SWA 1, number of cells of 0.1° latitude and longitude fished in any one year and cumulative number of new cells fished over time for trips landing silver warehou.

To consider spatial patterns of silver warehou catch in more detail, heat maps at a resolution of 0.08° latitude and longitude were prepared and presented to the DWWG. These figures cannot be included in this report because of data confidentiality rules, but the general trends they revealed are described here.

Overall catches between 1990 and 2025 occurred around the whole of New Zealand. On the east coast South Island, there was a concentration of catch along the continental shelf edge as far south as Statistical Area 028 to the south of The Snares, but with a 'gap' of less intense catch at the latitude of the Otago peninsula. On Chatham Rise, catches were widespread at depths between 250 and 750 m. Catches were also taken around the Auckland, Campbell, and Bounty Islands, and on Pukaki Rise, again mostly between 250 and 750 m bottom depth.

In SWA 3 and 4, the pattern of midwater trawl catches resembled a subset of bottom trawl catches, i.e., there were no areas fished by the midwater trawl method that were not fished by bottom trawl. Considering all trawl gears in SWA 3 and 4, the pattern of catches in each of the four years 2022–25 were consistent, and these years were consistent with the pattern of 1990–2021 except that the years 2022–25 had low catches on north Chatham Rise east of 180° and at Puysegur. Filtering data according to the main target species (HOK, SQU and SWA), the distribution of silver warehou catches in the hoki target fishery was much more widespread on Chatham Rise than the squid or silver warehou target fisheries. Concentrations of silver warehou catch from the squid target fishery occurred at shallower depths than for the other two fisheries, especially around Auckland Island (compared to the hoki target fishery). Catches from Chatham Rise from the squid fishery were from small areas at around 250 m depth. Silver warehou catches from the silver warehou target fishery were almost absent from the Auckland Island area but historically showed a greater occurrence on Chatham Rise when compared to the squid target fishery. For the silver warehou target fishery, very little catch was taken on Chatham Rise in each of the four years 2022–25, except at a small 'hot-spot' area on south Chatham Rise a little east of 180°.

Summary tables of fishing effort and catch using the BT and MW fishing methods are given for area SWA 3 in Table 2 and SWA 4 in Table 3 (and for SWA 1 in Table A1.1). In SWA 3, there was an increase in the number of tows (and hours fished) associated with trips catching silver warehou through the 1990s, before values declined in the early 2000s (peak number of tows was in 1997–98, peak hours fished in 2000–01). At the same time the number of tows and hours fished were high, the percentage of tows declared as silver warehou target tows fell to very low levels, while average catch rate in

tonnes/hour showed no trend. Since 2004–05, tow and hours fished values fluctuated without trend and the percentage target tows were again similar to values from the early and mid-1990s (except for a brief increase between 2007–08 and 2010–11), but the tows and hours fished in 2024–25 were the highest, and percentage target tows the lowest, since 2003–04. Tonnes/hour catch rate was consistently higher since 2003–04 compared to earlier years.

In SWA 4, the percentage target tows were generally lower than in SWA 3 and often below 1%. The average catch rate in tonnes/hour was also consistently low, but the percentage of tows with greater than 10 tonnes caught was high in some years, indicating occasional large catches. The SWA 4 area also saw a rise and then fall in the number of tows and hours fished catching silver warehou, but the peaks were in later years compared to SWA 3, between 2001–02 and 2004–05.

Table 2: Silver warehou SWA 3, number of permit holders, vessels, tows and hours fished from trips using fishing methods BT or MW that recorded landings of silver warehou. The percentage of tows for which silver warehou was recorded as the target species, the total catch of silver warehou in the fishing year, the average tonnes per tow and tonnes per hour caught, average duration of tows (hours) and the percentage of tows where more than 10 tonnes was caught in the tow.

Fishing year	Permit holders	Vessels	Tows	Hours fished	% target	Catch (t)	t/tow	t/hr	Duration (hr)	% >10 t
1989–90	14	33	1 888	6 162	5.93	731	0.39	0.12	3.33	50.21
1990–91	19	44	3 179	13 179	3.74	707	0.22	0.05	4.00	6.62
1991–92	25	47	3 987	16 328	2.31	1 402	0.35	0.09	4.00	47.79
1992–93	29	52	5 294	19 084	3.78	943	0.18	0.05	3.42	37.41
1993–94	22	57	5 712	18 807	1.40	1 362	0.24	0.07	3.08	29.51
1994–95	24	60	6 014	21 334	5.15	1 172	0.19	0.05	3.38	18.55
1995–96	32	77	9 342	32 600	1.78	1 569	0.17	0.05	3.25	9.22
1996–97	30	82	9 821	35 748	0.81	3 260	0.33	0.09	3.50	30.73
1997–98	29	78	11 366	43 646	0.58	3 532	0.31	0.08	3.83	25.98
1998–99	26	64	9 741	38 059	0.51	2 635	0.27	0.07	4.00	31.66
1999–00	24	61	10 936	42 581	0.69	3 716	0.34	0.09	4.00	35.27
2000–01	21	60	10 328	44 574	0.88	3 552	0.34	0.08	4.33	27.83
2001–02	21	59	7 722	31 921	1.93	2 739	0.35	0.09	4.08	35.69
2002–03	25	60	9 075	38 853	1.13	2 961	0.33	0.08	4.33	23.42
2003–04	23	53	6 680	28 082	0.54	3 552	0.53	0.13	4.25	26.38
2004–05	16	43	5 136	23 442	2.88	3 891	0.76	0.17	4.50	36.09
2005–06	18	40	5 482	24 336	4.72	4 155	0.76	0.17	4.33	33.53
2006–07	16	39	4 976	22 860	6.15	6 080	1.22	0.27	4.25	48.74
2007–08	27	54	5 493	22 846	10.92	2 843	0.52	0.12	4.00	38.78
2008–09	22	45	5 846	26 157	11.00	3 260	0.56	0.12	4.00	37.93
2009–10	25	46	6 351	27 350	6.68	2 868	0.45	0.10	4.05	33.02
2010–11	24	49	5 872	25 632	9.06	3 549	0.60	0.14	4.17	24.91
2011–12	23	46	4 550	18 154	5.19	2 976	0.65	0.16	4.00	49.81
2012–13	25	50	4 869	19 729	6.10	3 734	0.77	0.19	4.00	44.27
2013–14	24	47	5 218	21 972	6.08	3 057	0.59	0.14	4.25	37.31
2014–15	20	45	4 841	21 161	6.28	3 951	0.82	0.19	4.50	45.46
2015–16	19	44	4 498	17 261	5.85	2 187	0.49	0.13	4.00	32.08
2016–17	18	41	5 547	21 903	5.71	3 804	0.69	0.17	4.02	51.12
2017–18	17	41	5 367	21 103	5.72	2 864	0.53	0.14	4.00	41.00
2018–19	18	43	5 350	20 985	3.74	2 502	0.47	0.12	3.92	26.07
2019–20	20	44	5 116	21 056	3.81	2 667	0.52	0.13	4.07	41.18
2020–21	18	38	5 234	20 927	5.24	3 624	0.69	0.17	3.98	41.63
2021–22	18	40	5 088	21 384	4.23	3 663	0.72	0.17	4.23	38.54
2022–23	19	39	5 657	23 165	3.57	4 165	0.74	0.18	4.10	34.88
2023–24	20	39	6 050	24 153	3.11	4 072	0.67	0.17	4.05	29.09
2024–25	19	40	6 520	28 388	1.50	3 890	0.60	0.14	4.38	41.76

Table 3: Silver warehou SWA 4, number of permit holders, vessels, tows and hours fished from trips that recorded landings of silver warehou. The percentage of tows for which silver warehou was recorded as the target species, the total catch of silver warehou in the fishing year, the average tonnes per tow and tonnes per hour caught, average duration of tows (hours) and the percentage of tows where more than 10 tonnes was caught in the tow.

Fishing year	Permit holders	Vessels	Tows	Hours fished	% Target	Catch (t)	t/tow	t/hr	Duration (hr)	% >10 t
1989–90	18	39	5 521	18 774	2.52	1551	0.28	0.08	3.17	56.67
1990–91	18	54	9 374	34 262	1.65	888	0.09	0.03	3.67	12.53
1991–92	24	62	10 186	40 411	1.34	1262	0.12	0.03	4.00	45.86
1992–93	29	72	9 953	39 693	2.35	1709	0.17	0.04	3.83	48.53
1993–94	22	60	8 656	34 691	3.34	1474	0.17	0.04	3.83	49.89
1994–95	21	70	13 398	49 881	2.86	1434	0.11	0.03	3.67	29.38
1995–96	23	72	11 575	44 447	2.98	1866	0.16	0.04	3.72	50.35
1996–97	29	75	14 391	56 093	1.60	4069	0.28	0.07	3.77	50.92
1997–98	31	73	16 239	62 836	1.53	3719	0.23	0.06	3.75	45.56
1998–99	29	66	18 238	70 912	0.66	3945	0.22	0.06	4.00	55.78
1999–00	24	58	18 245	73 437	1.12	4448	0.24	0.06	4.00	45.54
2000–01	25	58	19 145	80 053	0.90	4361	0.23	0.05	4.17	45.11
2001–02	28	66	20 607	88 490	1.45	4930	0.24	0.06	4.25	50.30
2002–03	26	62	19 696	88 245	0.50	4515	0.23	0.05	4.50	58.56
2003–04	23	58	18 664	85 223	0.35	5676	0.30	0.07	4.67	40.24
2004–05	22	54	19 041	90 520	0.78	4219	0.22	0.05	4.75	41.55
2005–06	23	54	15 681	82 255	1.65	5453	0.35	0.07	5.10	39.16
2006–07	23	50	14 032	75 944	2.24	5956	0.42	0.08	5.25	38.74
2007–08	20	47	12 327	69 353	2.30	3433	0.28	0.05	5.58	49.37
2008–09	18	41	10 654	59 879	2.79	3616	0.34	0.06	5.58	42.30
2009–10	18	42	10 688	59 915	2.08	3391	0.32	0.06	5.47	36.97
2010–11	20	46	11 258	58 088	1.88	3425	0.30	0.06	5.00	47.07
2011–12	20	43	10 945	58 164	2.17	2771	0.25	0.05	5.25	36.40
2012–13	18	41	9 972	51 770	2.79	4136	0.41	0.08	5.00	51.99
2013–14	17	42	9 940	50 979	2.13	3407	0.34	0.07	5.08	59.82
2014–15	18	43	10 143	54 093	2.03	4199	0.41	0.08	5.25	59.64
2015–16	18	41	9 565	48 575	1.63	3454	0.36	0.07	5.00	64.94
2016–17	19	43	9 592	51 515	1.89	3608	0.38	0.07	5.42	53.55
2017–18	16	41	9 897	51 235	1.48	4200	0.42	0.08	5.17	54.12
2018–19	20	46	9 766	51 520	1.08	4600	0.47	0.09	5.33	34.37
2019–20	19	44	9 720	51 000	0.27	3423	0.35	0.07	5.18	66.64
2020–21	16	40	10 405	55 886	0.83	4029	0.39	0.07	5.53	54.21
2021–22	19	43	9 298	51 044	0.72	3954	0.43	0.08	5.61	59.17
2022–23	18	42	9 389	51 711	1.19	4618	0.49	0.09	5.60	54.60
2023–24	19	42	10 040	55 397	0.96	4401	0.44	0.08	5.48	47.77
2024–25	19	45	10 865	60 912	0.84	4580	0.42	0.08	5.67	47.52

3.2 CPUE analyses

Short series (2000 – 2025)

The binomial GAM explained 30.1% of the deviance, and the lognormal 26.4%. The model diagnostics indicated an acceptable model fit (Appendix 2). Residual patterns were generally consistent with the assumed error distribution, although minor departures from expectation were evident. These departures were not considered sufficient to materially affect the resulting CPUE index.

The mode in the catch rate effect was at around 300 m depth in the binomial and 360 m in the lognormal (Figure 21). There was also a mode in the catch at about 300 m (Figures 14 & 15). A transition from predominantly smaller fish inshore to larger fish offshore at around 300 m has previously been described (Dutilloy & Dunn 2020). Therefore, whilst we considered splitting CPUE into an inshore index (<300 m) and an offshore index because each area might have a different selectivity ogive, a categorical variable for depth categories (split at 300 m) was not significant in the GAM; this would also have split catch and effort data at the likely depth mode of the stock.

Silver warehou were most likely caught on southern Chatham Rise, with a distribution 'hotspot' on the western Chatham Rise (Figure 22). Effort around the 'hotspot' area decreased in the early 2000s, when abundance was thought to have increased (Fisheries New Zealand 2025), and then increased in the last few years.

The vessel effect was variable, with a positive 2008–2017 to negative 2019–2024 influence on the CPUE trend in the lognormal (Figure 23). Vessel was associated with, and may be aliasing for, other covariates (Appendix 2, Figure A2.1). Other covariates showed plausible effects but had no material influence on the CPUE trend, so are not reported here but in Appendix 2.

The combined index showed an increase in the early 2000s, driven by the binomial model (Figure 24). This indicates that silver warehou were being caught more often in the early 2000s, but with little change in the catch per tow. This CPUE increase was not caused by the standardisation, and was present in the unstandardised CPUE, most clearly for SWA 3 (Tables 2 and 3). The CPUE index suggests that abundance remained relatively high after the early 2000s increase.

Long series (1991 – 2025)

The binomial GAM explained 30.7% of the deviance, and the lognormal 23.6%. The model diagnostics indicated an acceptable model fit (Appendix 2).

The mode in the catch rate effect was at around 300–360 m depth (Figure 25). Data before 2000 were relatively sparse. Splitting CPUE analyses at 300 m depth was considered but would have made the data in inshore and offshore indices even sparser. The standardisation had some very large influences in the years before 1996 for all model variables, which was not surprising given few and patchy data.

The spatial pattern of catch rates (Figure 26) was similar to the short index over the period that they overlapped (unsurprisingly given that they have the same data), but with a less pronounced areal 'hotspot'. The vessel effect was very large in the early years but otherwise did not have a large influence on the CPUE trend (Figure 27). Other covariates showed generally plausible effects but had no material influence on the CPUE trend (Appendix 2).

The combined index showed a general increase in the early 2000s, both in the binomial and lognormal models (Figure 28), although with greater variability in the binomial.

The sparsity of catch and effort data before 2000 was why the Deepwater Working Group preferred the short CPUE series, both historically and again in 2026.

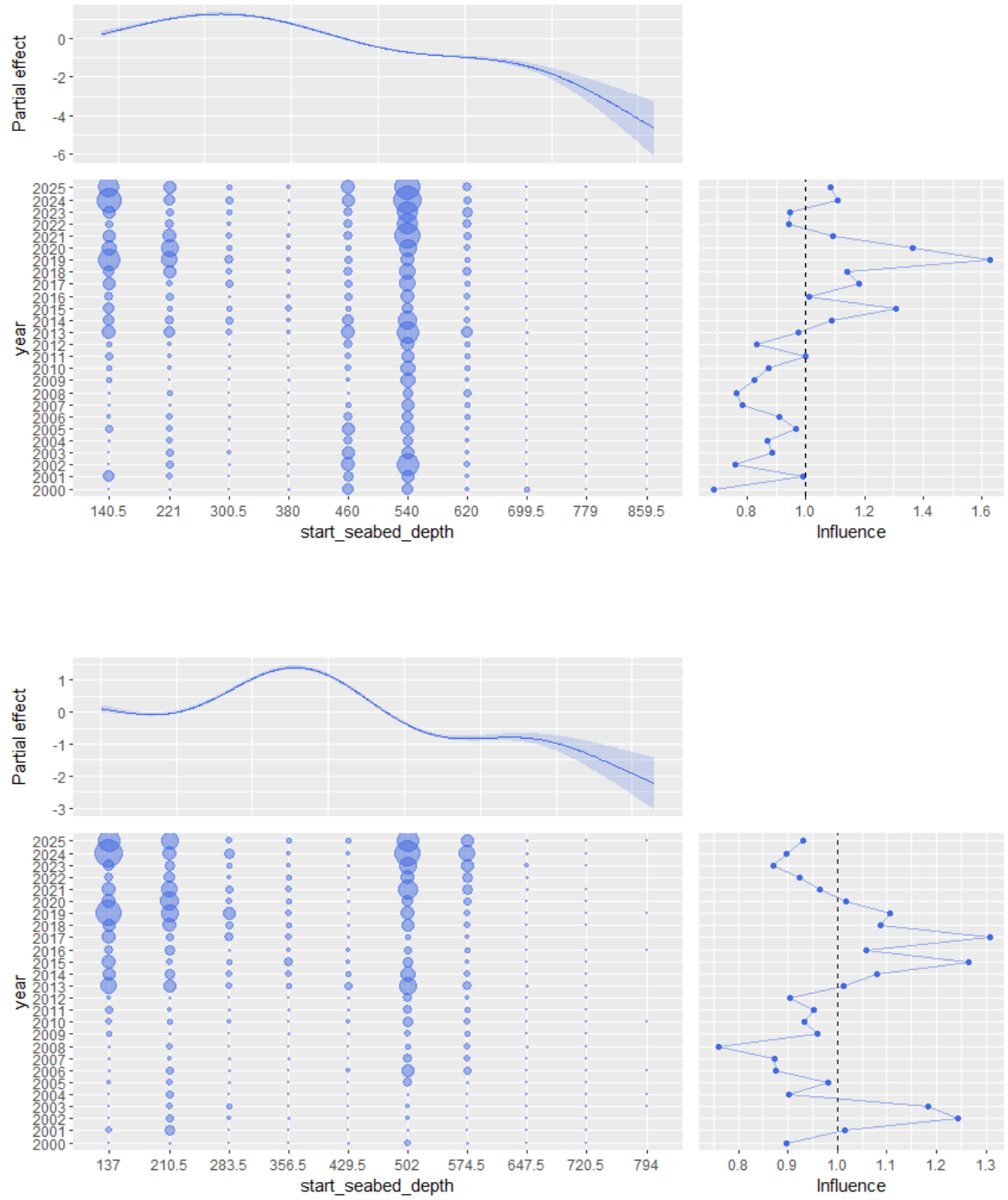


Figure 21: Silver warehou SWA 3&4, short year series GAM coefficient-distribution-influence (CDI) plot for seabed depth. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

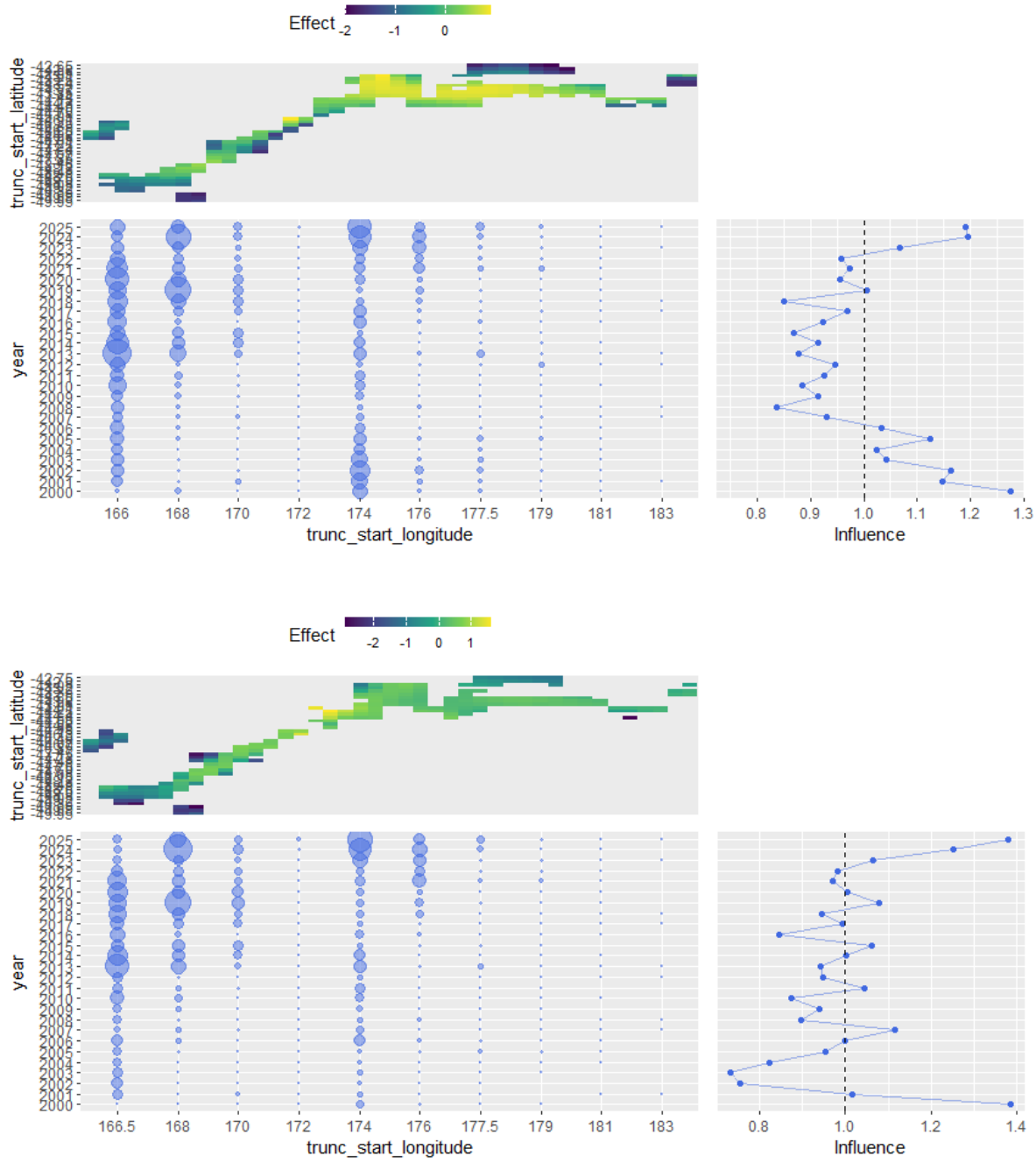


Figure 22: Silver warehou SWA 3&4, short year series GAM CDI plot for latitude and longitude. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

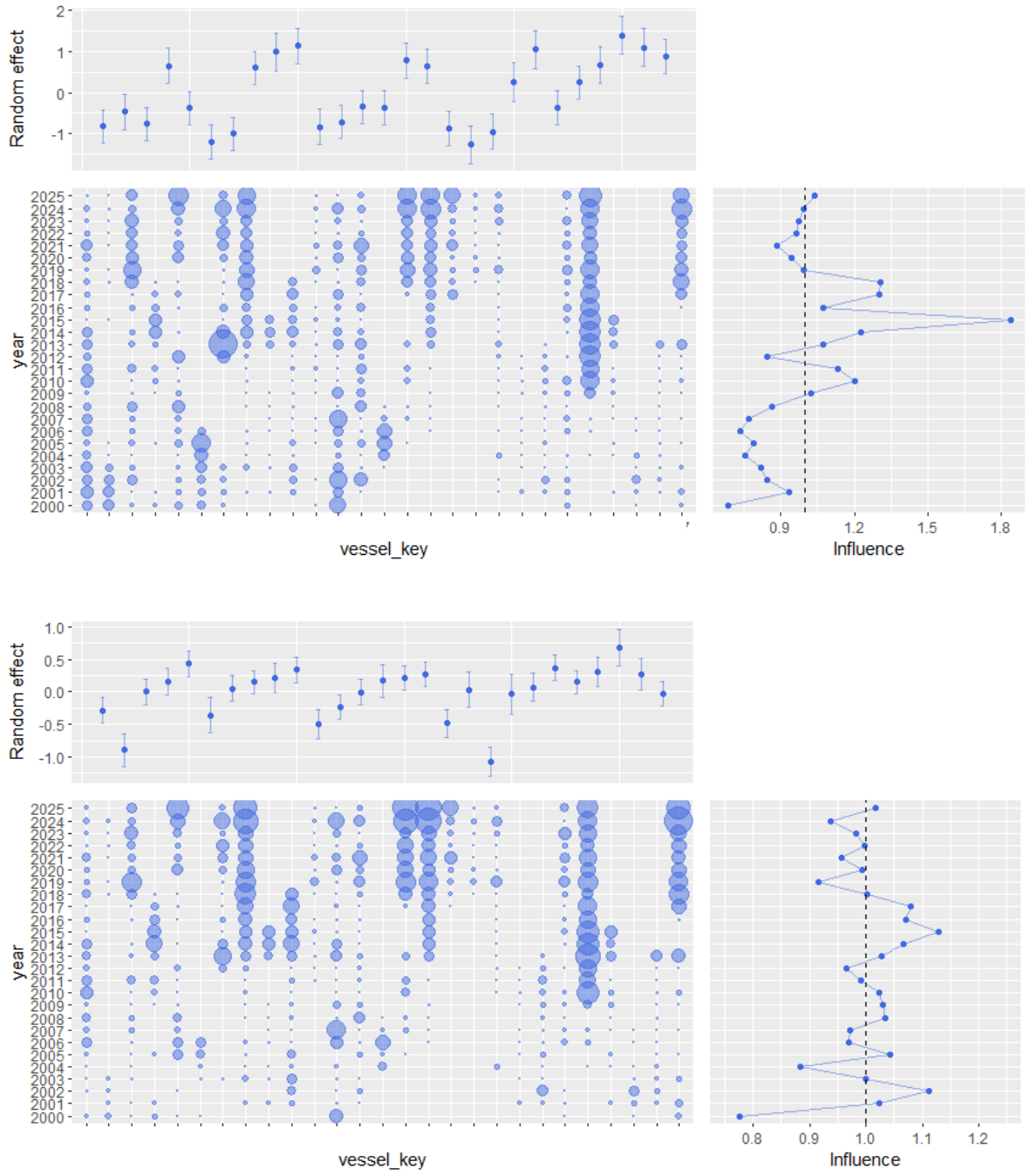


Figure 23: Silver warehou SWA 3&4, short year series GAM CDI plot for vessel. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

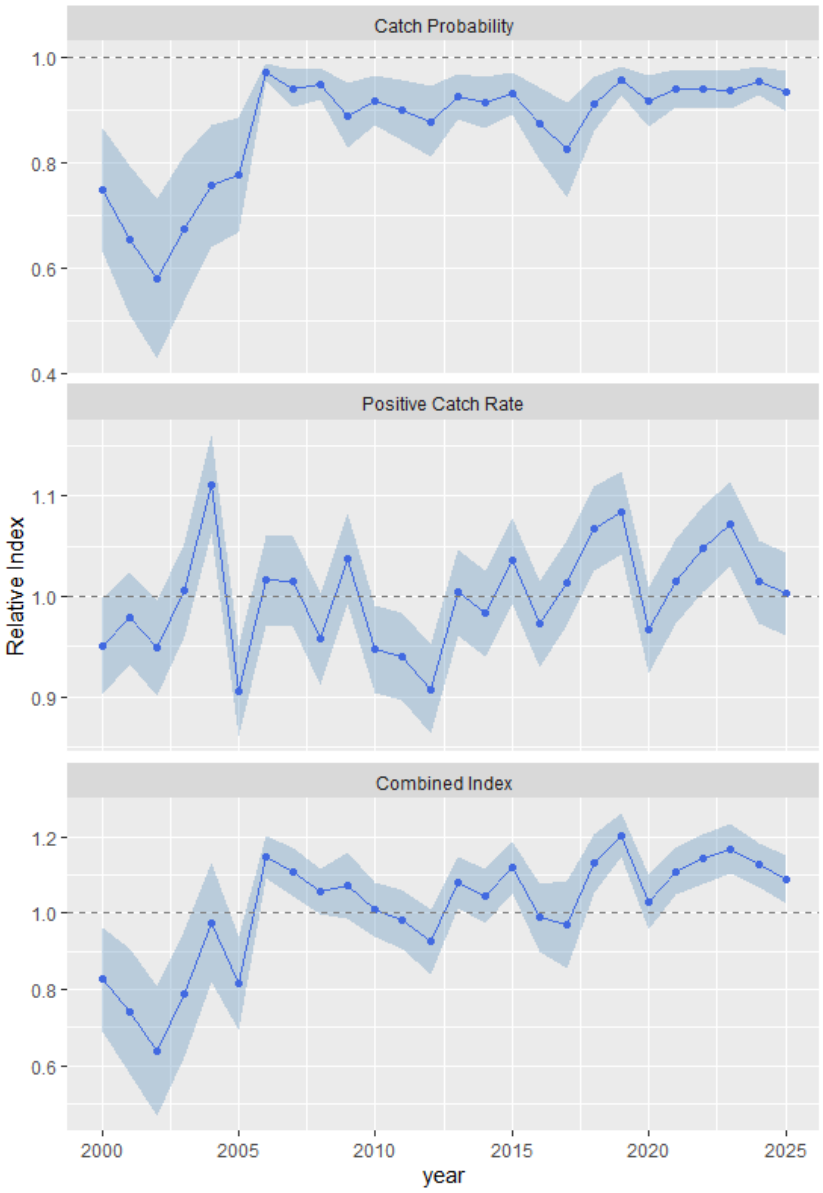


Figure 24: Silver warehou SWA3&4, short year series predicted year effects for the binomial GAM (catch probability), lognormal GAM (positive catch rate), and combined.

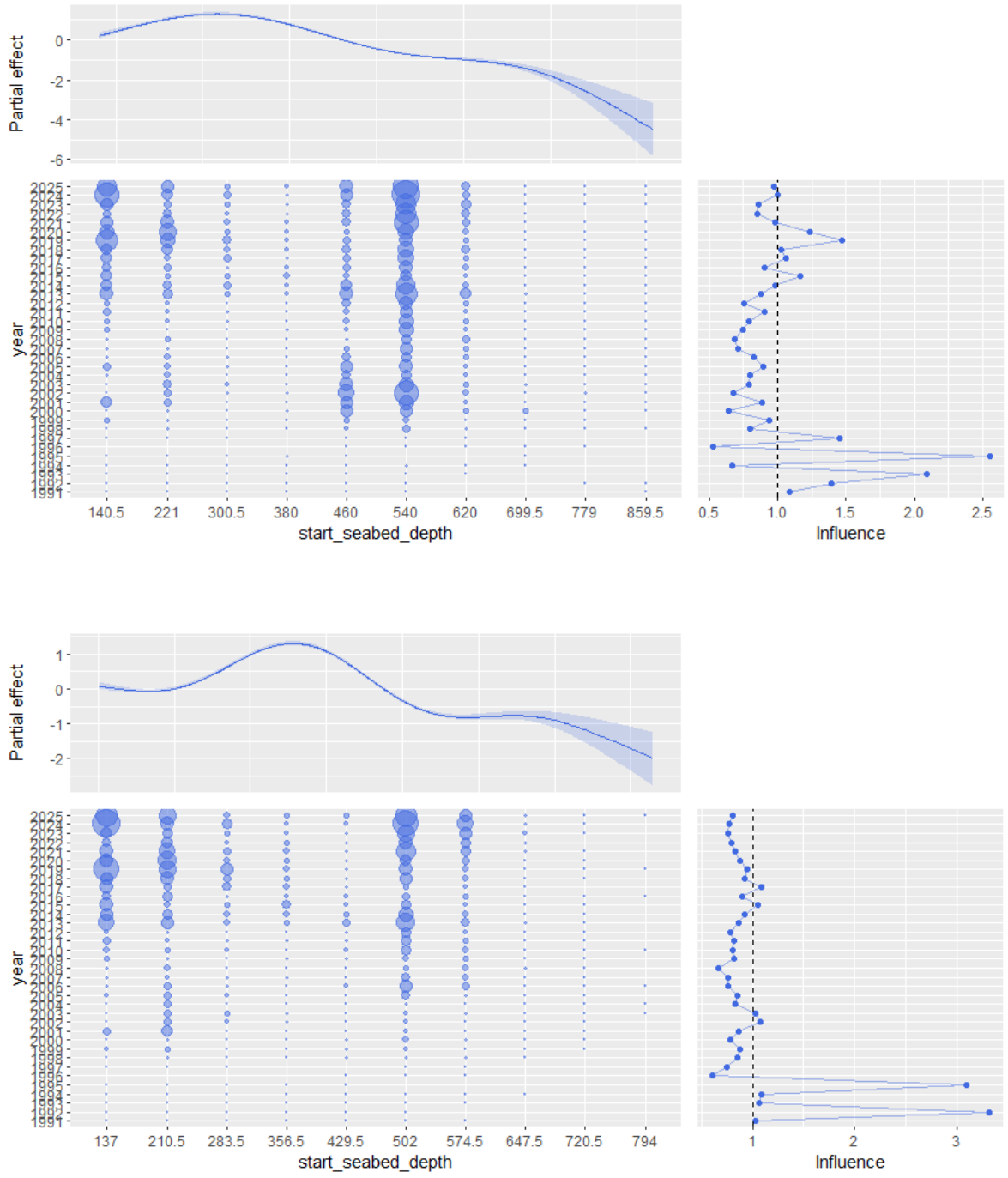


Figure 25: Silver warehou SWA 3&4, long year series GAM CDI plot for seabed depth. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

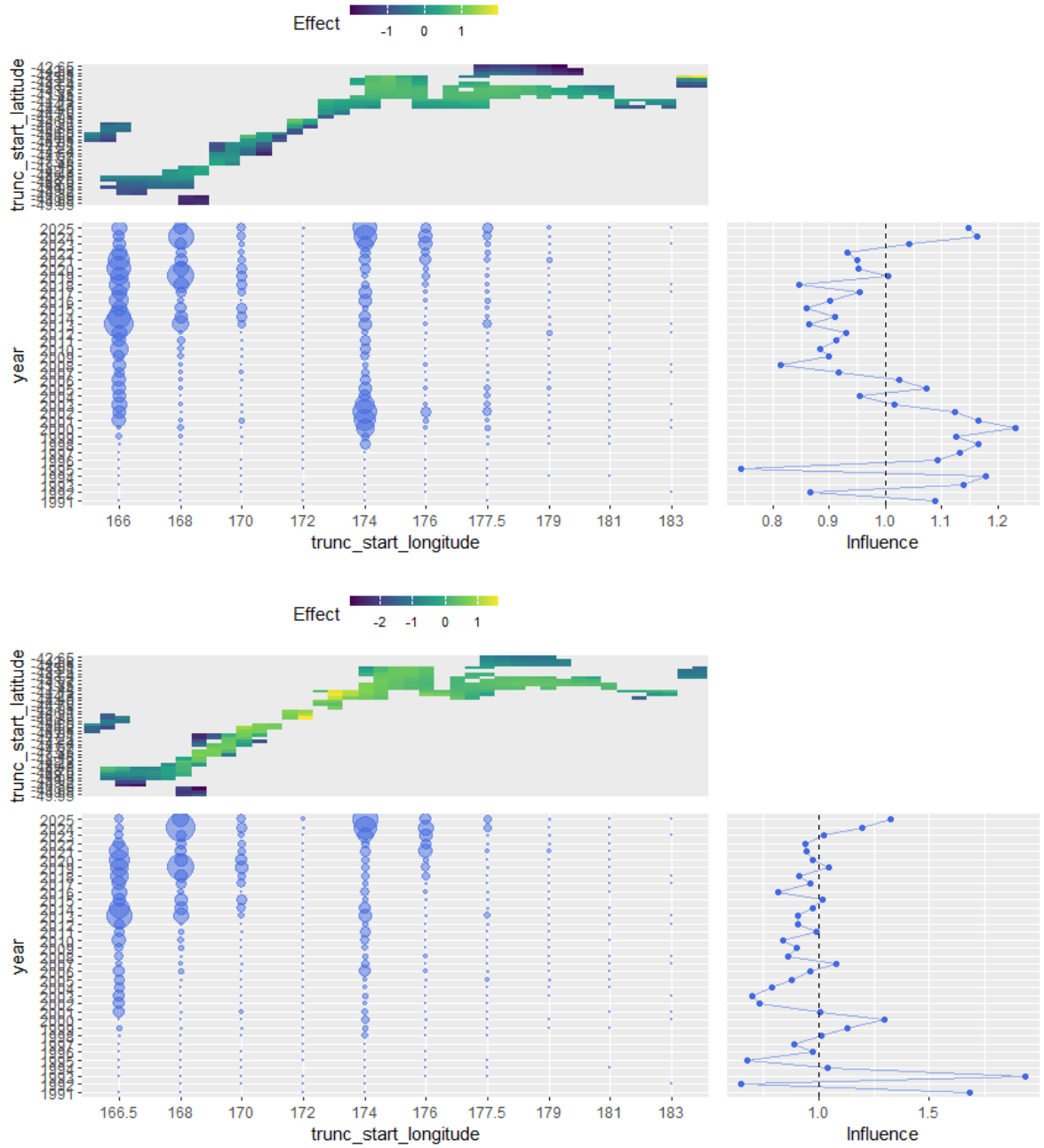


Figure 26: Silver warehou SWA 3&4, long year series GAM CDI plot for latitude and longitude. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

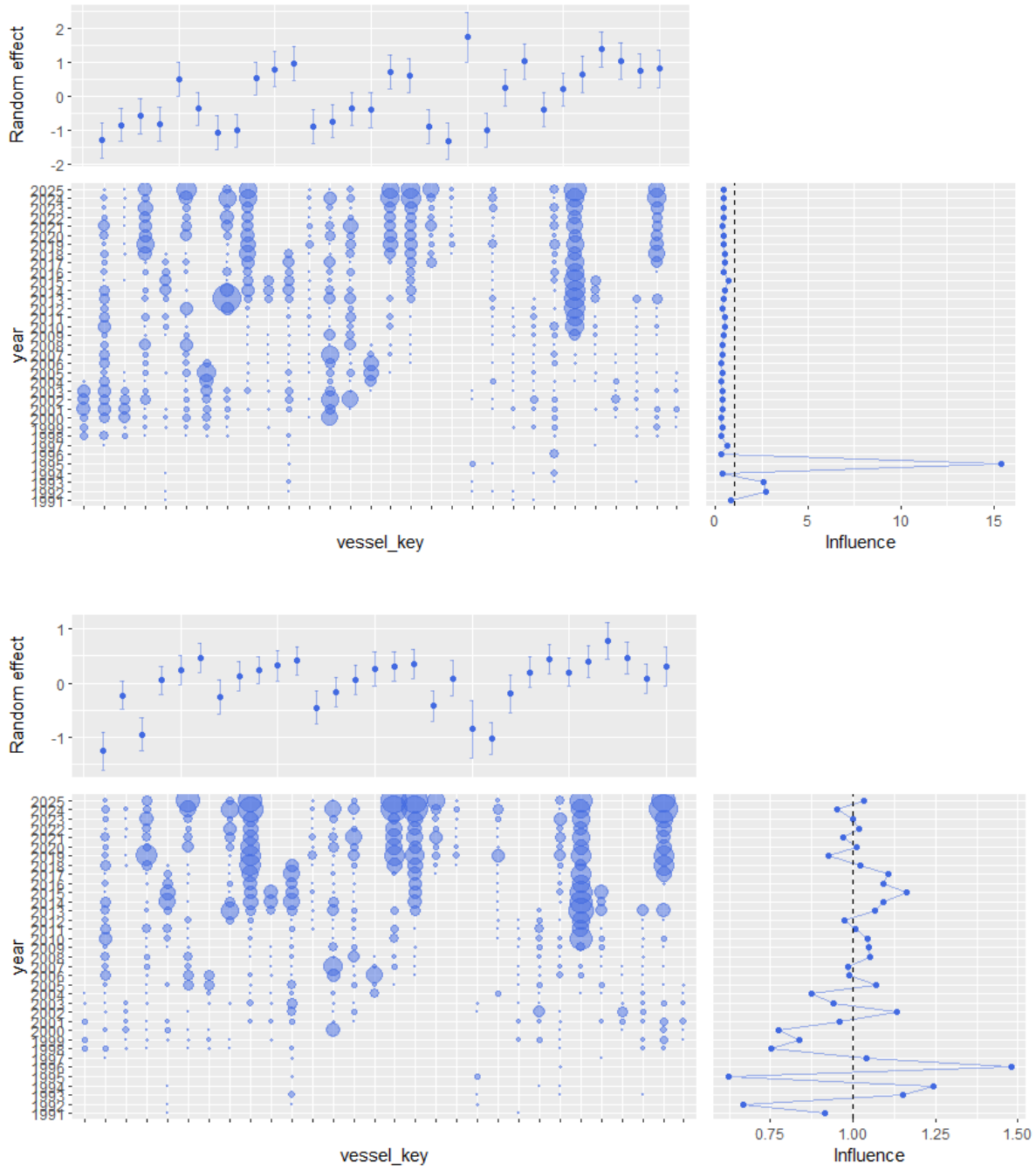


Figure 27: Silver warehou SWA 3&4, long year series GAM CDI plot for vessel. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

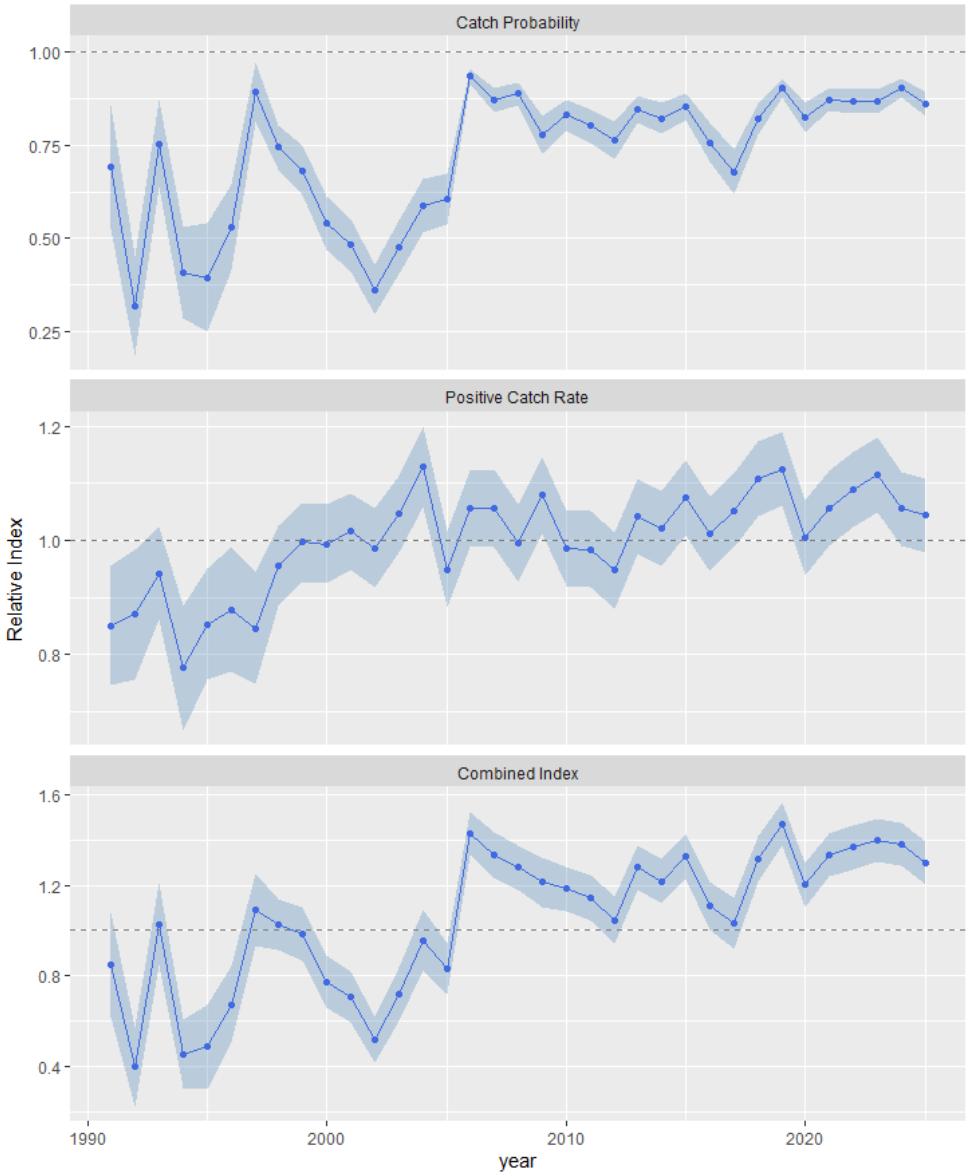


Figure 28: Silver warehou SWA 3&4, long year series predicted year effects for the binomial GAM (catch probability), lognormal GAM (positive catch rate), and combined.

4. DISCUSSION

The fishery characterisation was conducted according to the silver warehou quota management areas, rather than the assumed stock structure (see Fisheries New Zealand 2025). The summary statistics for SWA 3 and SWA 4 (Tables 2 and 3) showed an increase in tows from trips with silver warehou catch in SWA 3 in the very late 1990s a little ahead of a similar increase in SWA 4 (which, coupled with decreases in percent target tows, indicate increased abundance). The latter area includes both the Chatham Rise east of 176° E and the continental shelf to the south of the South Island. Further studies would be needed to evaluate whether the stock initially increased in SWA 3 and then spread out from the SWA 3 area and, if so, whether the spread was both to the east and south.

In terms of seasonality, the lower effort in August and September in SWA 3 and 4 seen in earlier years (Figure 8), aligned with the hoki spawning season, as does the greater effort seen in SWA 1 for the same months. The change to effort being more evenly spread across months in SWA 3 since 2017 coincides with a change in fleet behaviour to fish more for hoki on the east coast South Island in

spawning months (Ballara et al. 2024 table A1, sub-tables for ECSI target fishery), but analyses of effort by fishery are needed to confirm the link.

A regression tree analysis of median fish length per tow made a first split at about longitude 172° east, effectively separating fishing grounds south of the Otago Peninsula from those to the north and east (Dutilloy & Dunn 2020; this analysis was repeated in 2026 with a very similar result). McGregor (2016) concluded that, despite the knowledge of several spawning areas and that largely distinct adult distributions existed, the overall distribution of silver warehou was continuous within their preferred depth range. Results from the 2026 fishery characterisation do not suggest the SWA 3 and 4 area should be divided into separate stocks.

In both SWA 3 and SWA 4, there were three main target species associated with silver warehou catches: hoki, arrow squid, and silver warehou itself. These target fisheries had modes of effort at bottom depth that were clearly distinct from each other. The preferred depth range of silver warehou was evident from the mode of silver warehou catch being generally at greater depths than the mode of effort for the squid target fishery, and at shallower depths than the mode of effort for the hoki target fishery.

Dutilloy & Dunn (2020), using observer data from all around New Zealand, demonstrated a transition in median fish length per tow at about 300 m depth, and McGregor (2019), using data for the western Chatham Rise, showed catches at depths less than 300 m contained both adult and juvenile (3-year-old and under) fish whereas catches at depths 300 m and greater almost exclusively contained adult fish. The squid target fishery would therefore be expected to more often catch juvenile silver warehou, which was confirmed using observer length frequency data (Holmes & Dunn 2026).

A fishery characterisation for SWA 1 was not included in the formal objectives for this study. A drop in silver warehou catches in SWA 1 in the early 2000s has been attributed to a large reduction in hoki target effort in winter in the area (Fisheries New Zealand 2026), but it is striking that since 2015 the landings of silver warehou have continued to decline (Figure 3), even though effort in the hoki target fishery has remained relatively constant (Figures 8 and 12).

The working group considered catch and effort data from the observer programme to be the most credible source for estimating CPUE. Whether CPUE tracks abundance is unknown, but the index is supported by a broad similarity between the CPUE series and the *Tangaroa* biomass index. The standardised CPUE series produced a temporal trend similar to previous analyses (Fisheries New Zealand 2026). The new data points, for the 2022–25 period, have remained at a relatively high level, suggesting that the biomass increase in the early 2000s, as discussed by Fisheries New Zealand (2026), is still persisting.

5. POTENTIAL RESEARCH

A more complete fishery characterisation for SWA 1, including standardised CPUE, should be completed. Analyses may also include potential environmental/climate covariates.

A spatio-temporal analysis of CPUE (using e.g., VAST) could be completed for SWA 1, SWA 3, and SWA 4, using only the observer catch and effort data.

6. FULFILMENT OF BROADER OUTCOMES

As required under Government Procurement rules[2], Fisheries New Zealand considered broader outcomes (secondary benefits such as environmental, social, economic or cultural benefits) that would be generated by this project. This project delivered against two aspects of broader outcomes.

Building capacity and capability in the research sector
Within this project Earth Sciences NZ used a team approach that brought together one of our most experienced researchers, including experience from the most recent SWA stock assessment research, with a less experienced but complementary researcher.

Supporting and partnering with Māori
While the work undertaken in this project did not involve direct interactions with Māori, iwi entities own quota in most fisheries stocks, and the work undertaken here will help support the fish stocks that underpin these Māori owned resources.

7. ACKNOWLEDGEMENTS

This work was completed under Objective 1 of Fisheries New Zealand project SWA2025-01. We thank members of the Fisheries New Zealand Deepwater Working Group for suggestions and providing contextual knowledge. Thank you to Vidette McGregor-Tiatia and Richard O'Driscoll (Earth Sciences New Zealand) for reviewing the draft manuscript, to Gretchen Skea (Fisheries New Zealand) for guiding the project, Ian Blixt (Fisheries New Zealand) for reviewing the draft manuscript, and to Marianne Vignaux (Fisheries New Zealand) for editorial review of the final draft.

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[2] https://www.procurement.govt.nz/procurement/principles-charter-and-rules/government-procurement-rules/planning-your-procurement/broader-outcomes/

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APPENDIX 1: ADDITIONAL CHARACTERISATION RESULTS

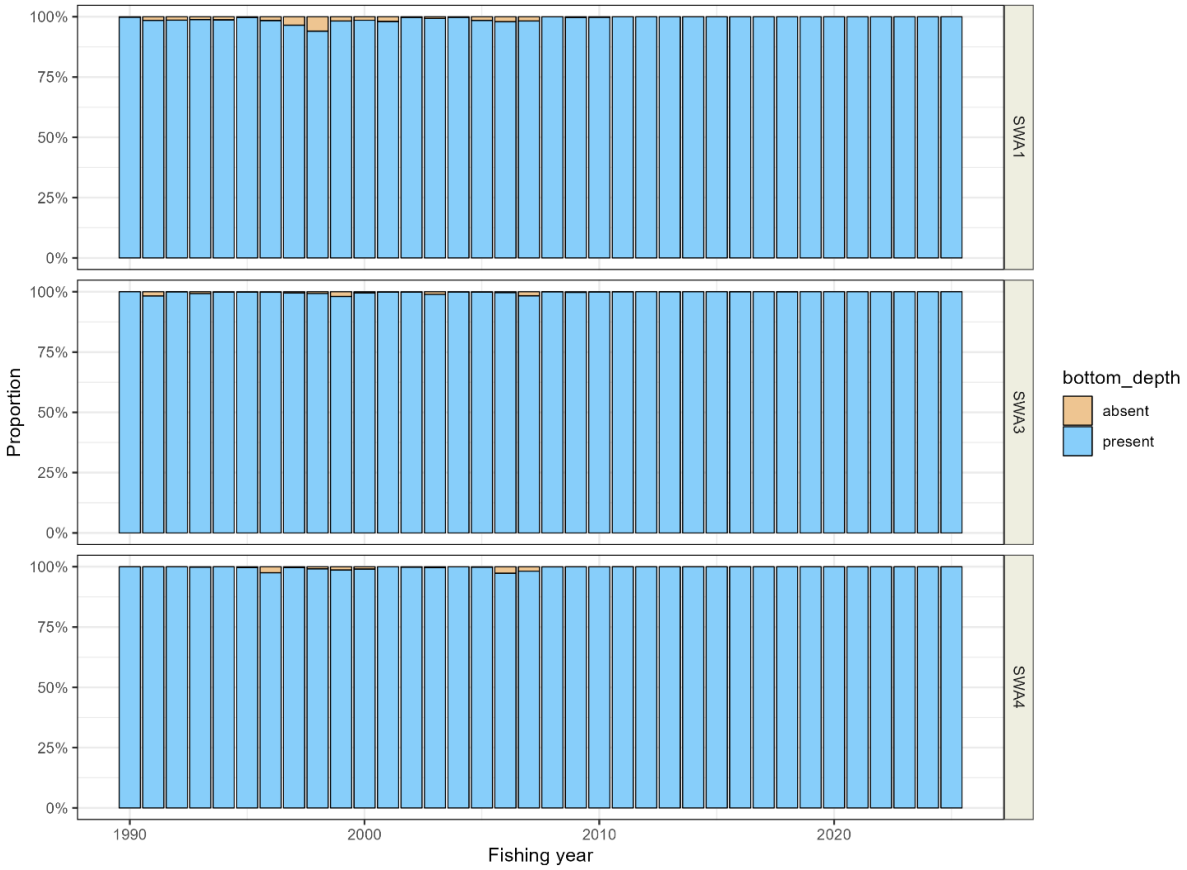


Figure A1.1: Silver warehou SWA 1, 3 and 4, proportion of catch-effort records from BT method with bottom depth information.

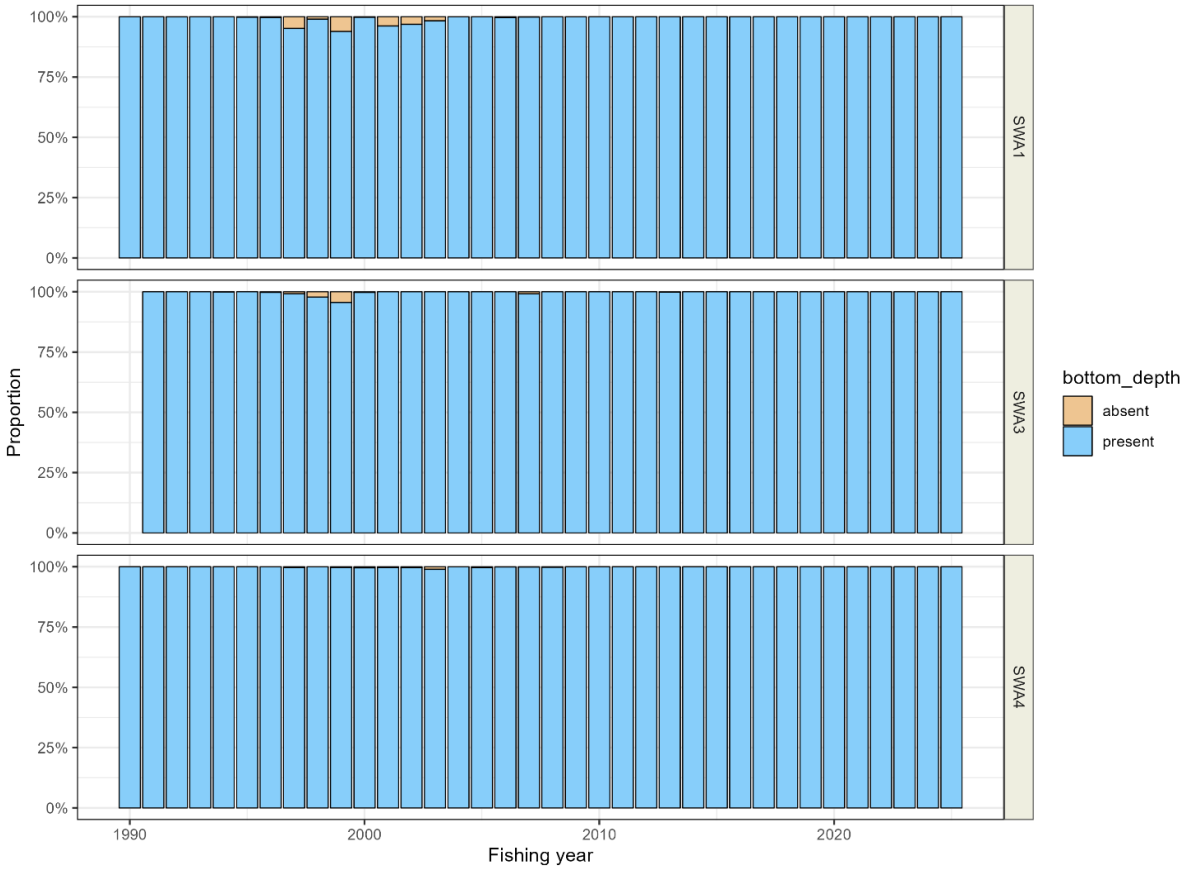


Figure A1.2: Silver warehou SWA 1, 3 and 4, proportion of catch-effort records from MW method with bottom depth information.

Table A1.1: Silver warehou SWA 1, number of permit holders, vessels, tows and hours fished from trips that recorded landings of silver warehou. The percentage of tows for which silver warehou was recorded as the target species, the total catch of silver warehou in the fishing year, the average tonnes per tow and tonnes per hour caught, average duration of tows (hours) and the percentage of tows where more than 10 tonnes was caught in the tow.

Fishing year	Permit holders	Vessels	Tows	Hours fished	% Target	Catch (t)	t/tow	t/hr	Duration (hr)	% >10 t
1989–90	23	66	5 215	19 347	0.48	957	0.18	0.05	3.42	12.94
1990–91	29	73	6 078	25 284	0.13	829	0.14	0.03	4.00	4.07
1991–92	32	70	5 678	23 939	0.23	543	0.10	0.02	4.33	13.38
1992–93	34	77	8 662	30 444	0.25	544	0.06	0.02	3.25	4.65
1993–94	38	102	11 611	40 678	0.37	1646	0.14	0.04	3.17	6.30
1994–95	35	111	13 253	45 767	0.42	1301	0.10	0.03	3.17	3.86
1995–96	46	110	14 323	48 954	0.21	1811	0.13	0.04	3.00	9.08
1996–97	58	125	16 238	56 164	0.30	2719	0.17	0.05	3.00	23.68
1997–98	42	108	16 037	58 641	0.25	3070	0.19	0.05	3.08	13.37
1998–99	46	109	14 630	55 314	0.98	1797	0.12	0.03	3.08	25.20
1999–00	35	90	13 684	49 616	0.22	2210	0.16	0.04	3.00	9.42
2000–01	35	95	15 745	60 841	0.47	2898	0.18	0.05	3.25	28.78
2001–02	39	92	15 560	64 516	0.45	912	0.06	0.01	3.75	10.96
2002–03	37	87	14 660	63 895	0.27	978	0.07	0.02	3.90	15.54
2003–04	35	79	12 612	54 026	0.11	1564	0.12	0.03	3.50	11.88
2004–05	31	71	10 678	44 131	0.96	1333	0.12	0.03	3.42	13.32
2005–06	35	72	10 028	44 885	0.42	960	0.10	0.02	3.75	17.44
2006–07	31	65	10 365	45 908	1.70	2042	0.20	0.04	3.58	35.66
2007–08	51	84	12 387	52 961	1.77	1652	0.13	0.03	3.99	13.93
2008–09	52	88	11 863	50 861	1.28	1339	0.11	0.03	3.92	24.62
2009–10	52	92	13 754	53 450	0.65	705	0.05	0.01	3.50	3.23
2010–11	55	95	13 647	51 791	0.62	900	0.07	0.02	3.50	5.25
2011–12	54	90	12 971	50 254	0.80	993	0.08	0.02	3.50	3.39
2012–13	45	82	14 180	54 245	0.92	672	0.05	0.01	3.50	1.54
2013–14	47	86	14 713	58 191	0.95	764	0.05	0.01	3.67	3.19
2014–15	49	88	14 561	57 800	0.62	755	0.05	0.01	3.67	4.65
2015–16	49	90	13 075	48 722	0.70	1051	0.08	0.02	3.52	8.78
2016–17	51	81	11 684	48 882	0.69	551	0.05	0.01	4.00	4.99
2017–18	47	78	11 383	48 452	0.85	459	0.04	0.01	4.08	0
2018–19	38	65	9 587	38 537	0.22	419	0.04	0.01	3.83	47.81
2019–20	39	65	10 022	40 001	0.11	447	0.04	0.01	3.88	5.80
2020–21	36	64	8 174	34 299	0.22	183	0.02	0.01	4.05	0
2021–22	35	60	7 210	30 500	0.04	296	0.04	0.01	4.05	4.51
2022–23	34	55	8 625	39 932	0.17	229	0.03	0.01	4.40	6.84
2023–24	32	53	6 447	28 103	0.09	107	0.02	<0.01	4.12	0
2024–25	36	57	6 570	29 325	0	79	0.01	<0.01	4.12	0

APPENDIX 2: CPUE ANALYSES

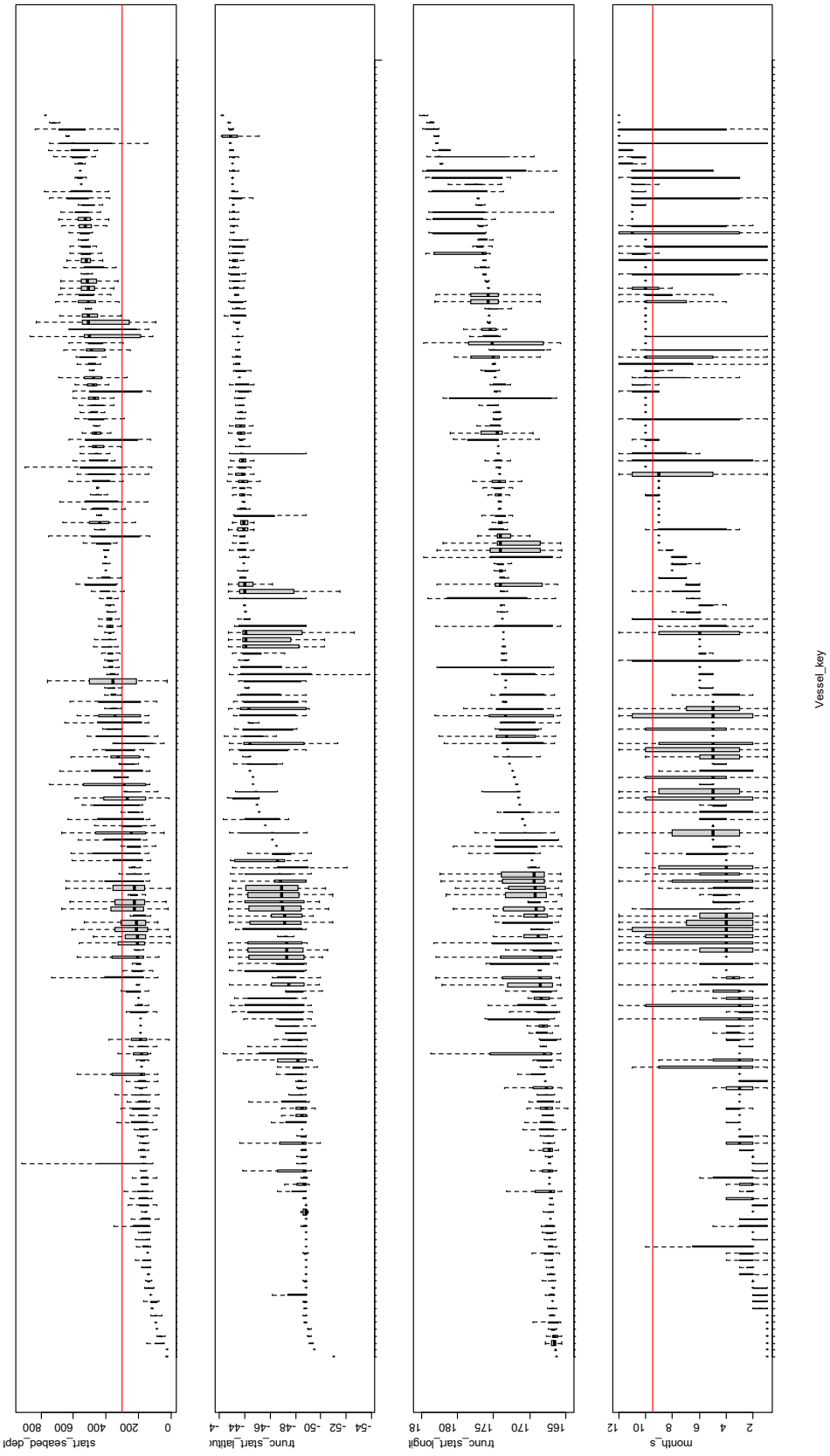


Figure A2.1: Silver warehou SWA 3&4, boxplots of start seabed depth, start latitude, start longitude, and month, by vessel for the silver warehou SWA 3 & 4 fishery data set. Red line on start seabed depth marks 300m. Red line on month marks assumed month of peak spawning.

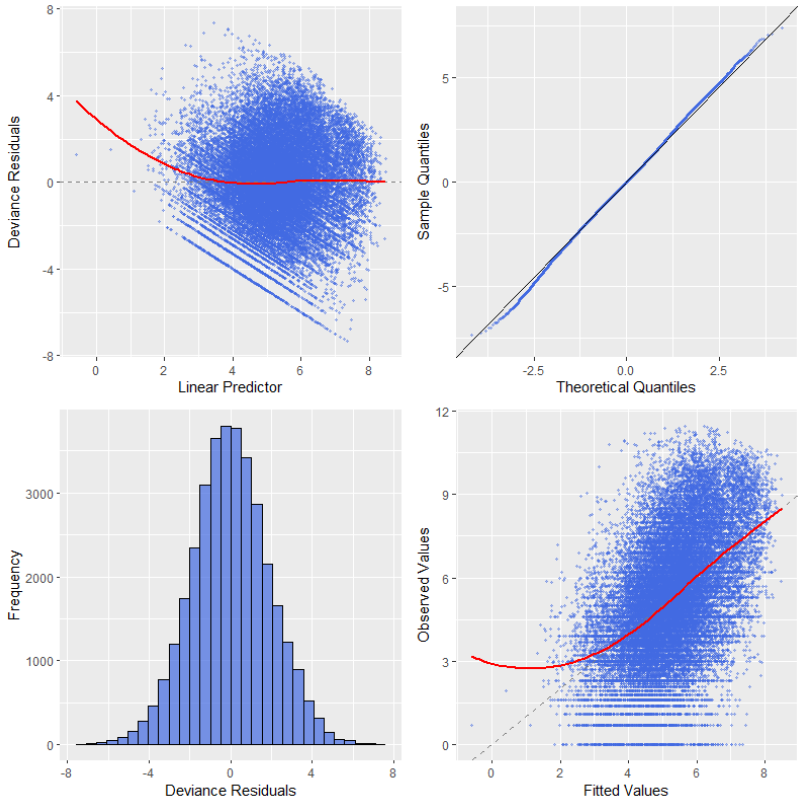


Figure A2.2: Silver warehou SWA 3&4, short CPUE series, GAM residual diagnostics.

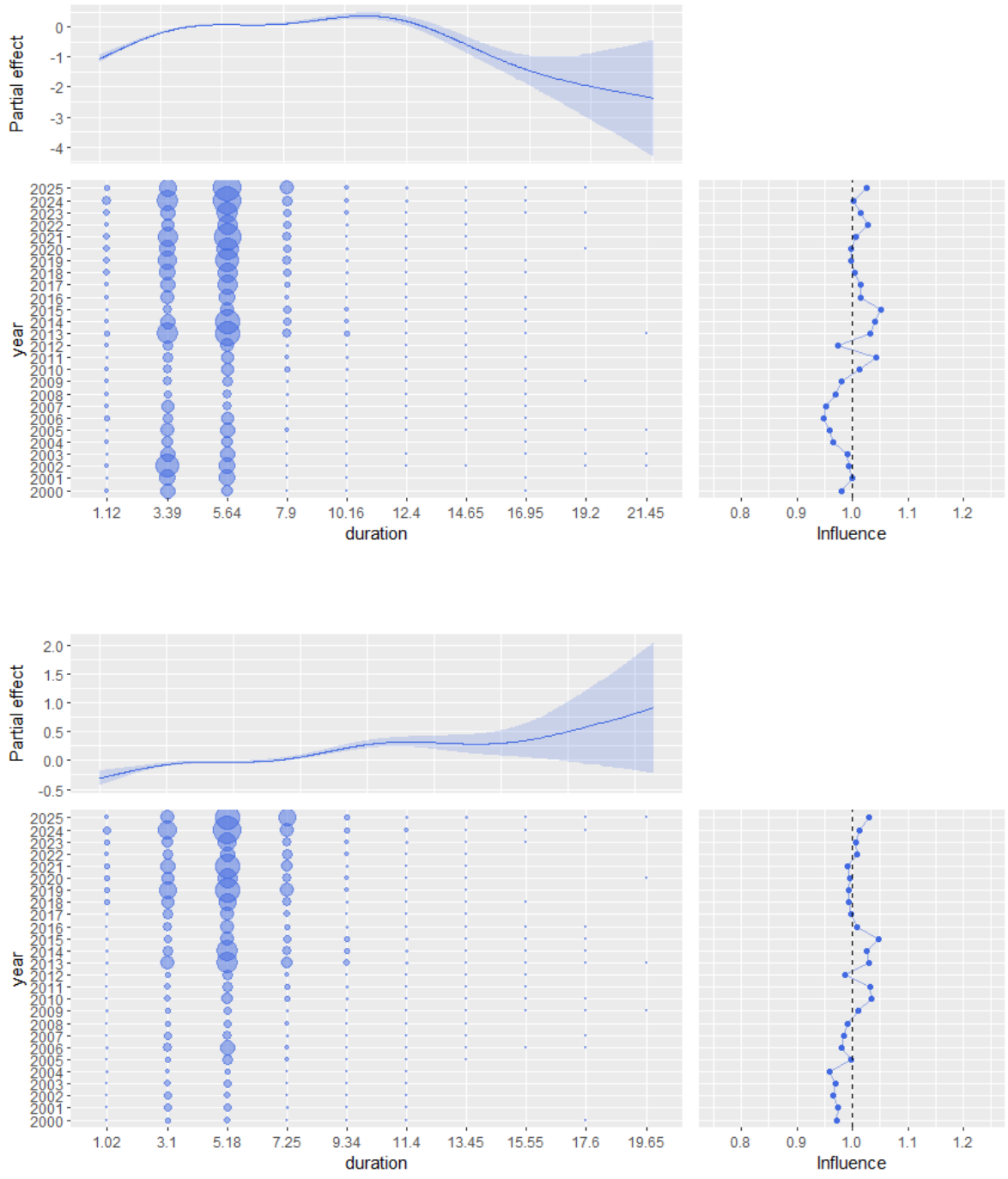


Figure A2.3: Silver warehou SWA 3&4, short series GAM CDI plot for duration. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

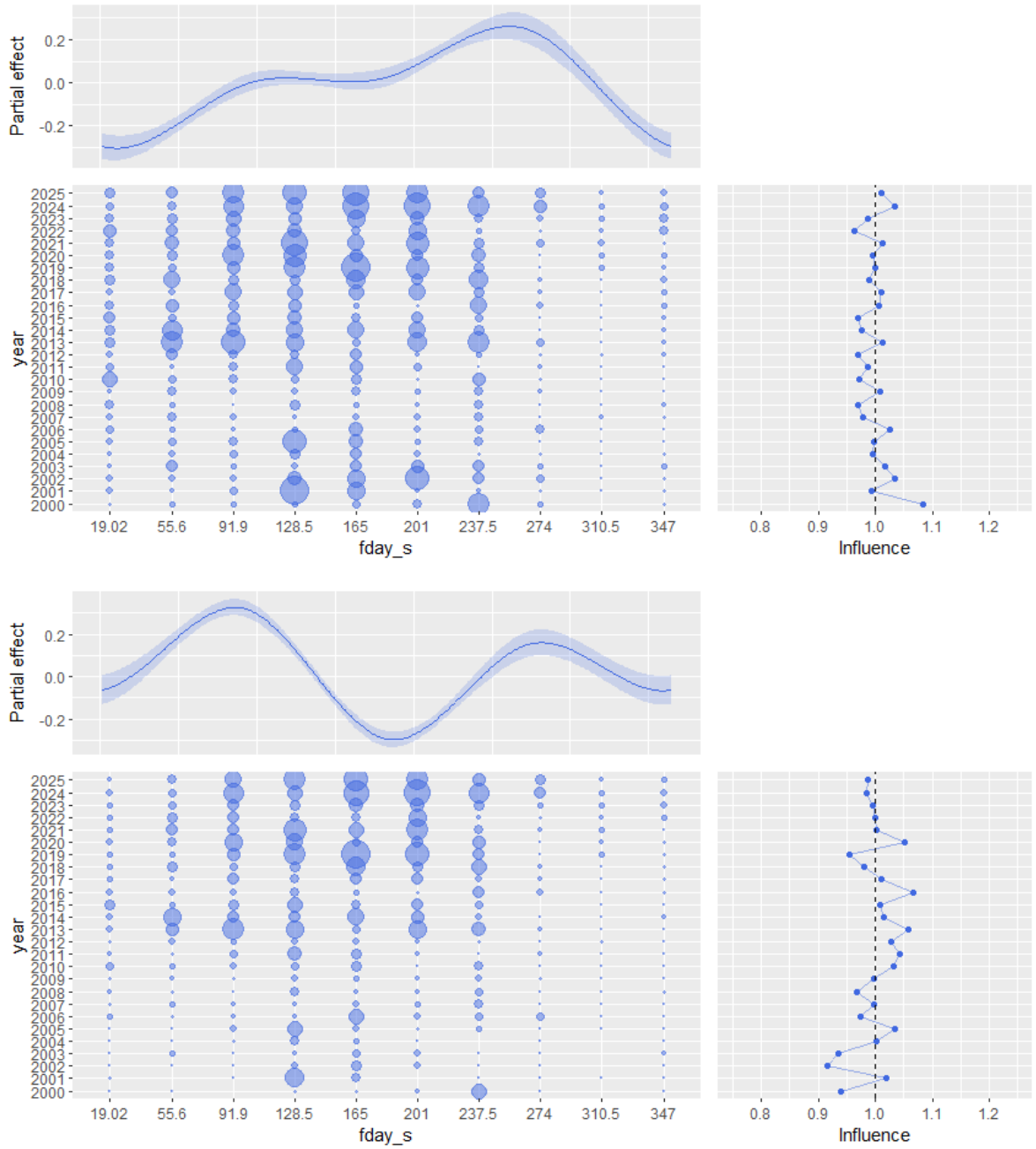


Figure A2.4: Silver warehou SWA 3&4, short series GAM CDI plot for day of the fishing year. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

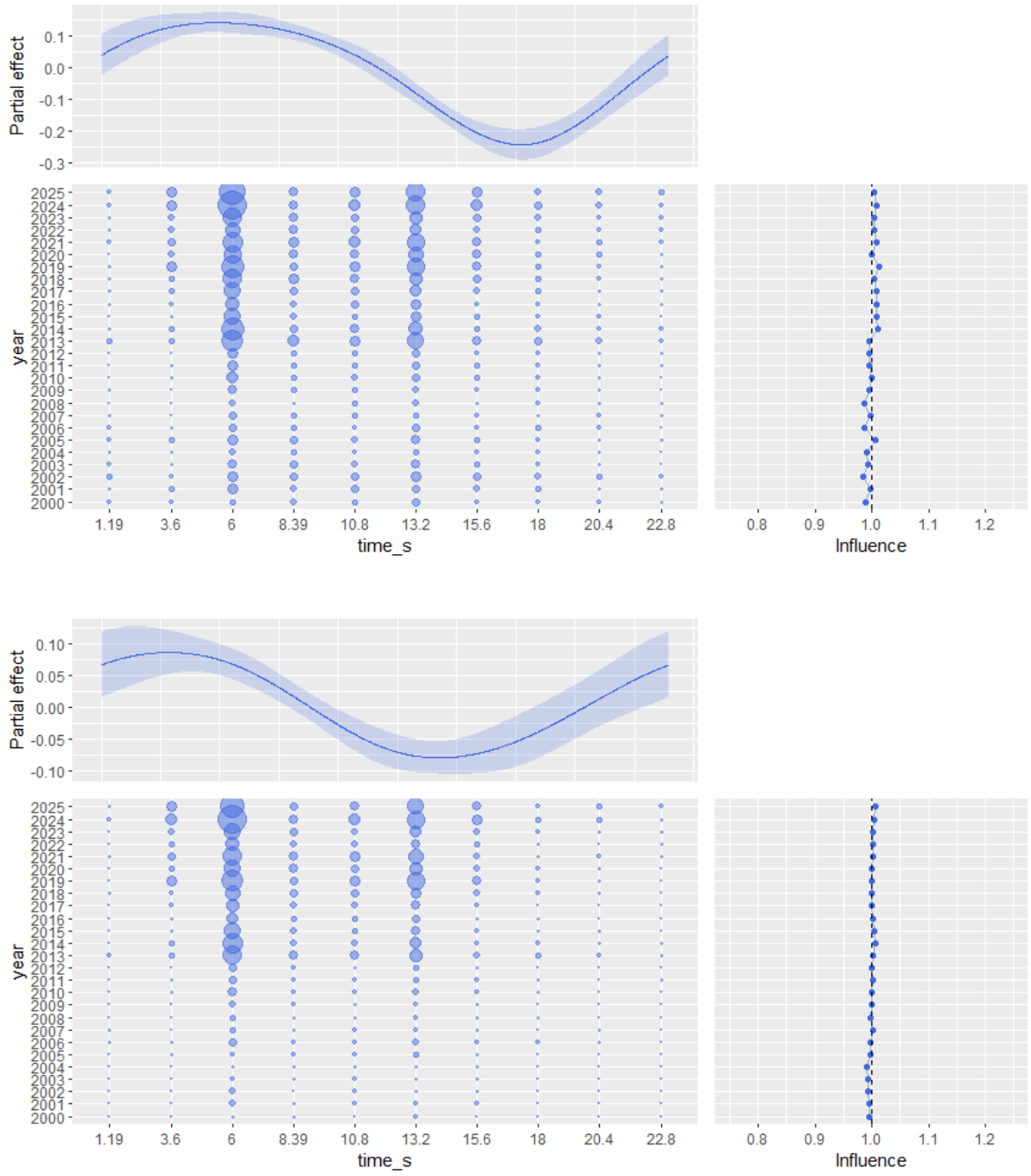


Figure A2.5: Silver warehou SWA 3&4, short series GAM CDI plot for time of day. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

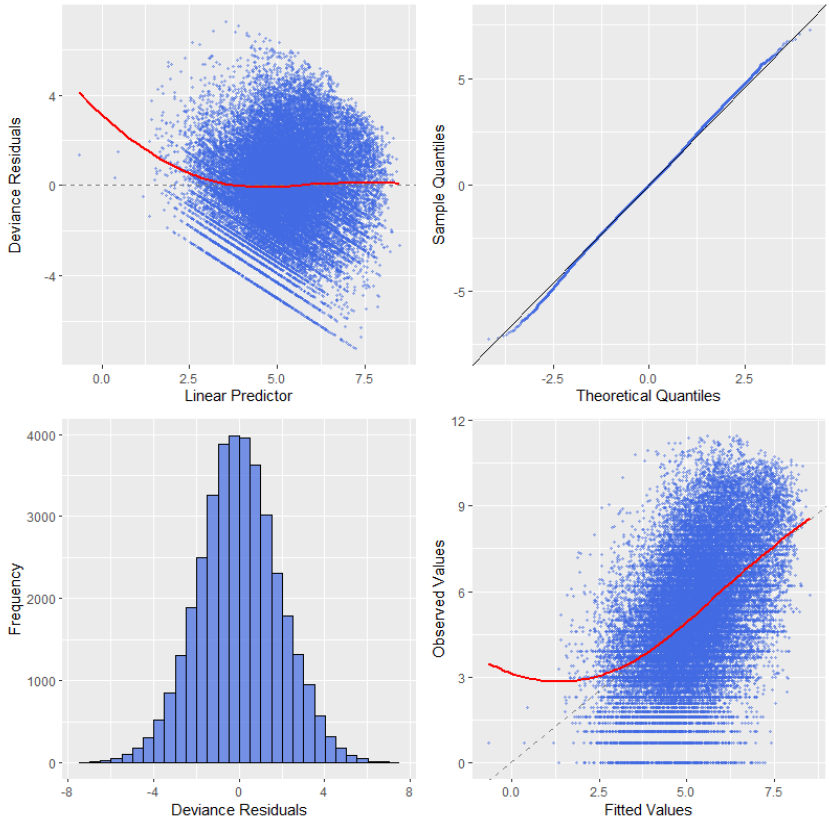


Figure A2.6: Silver warehou SWA 3&4, long CPUE series, GAM residual diagnostics.

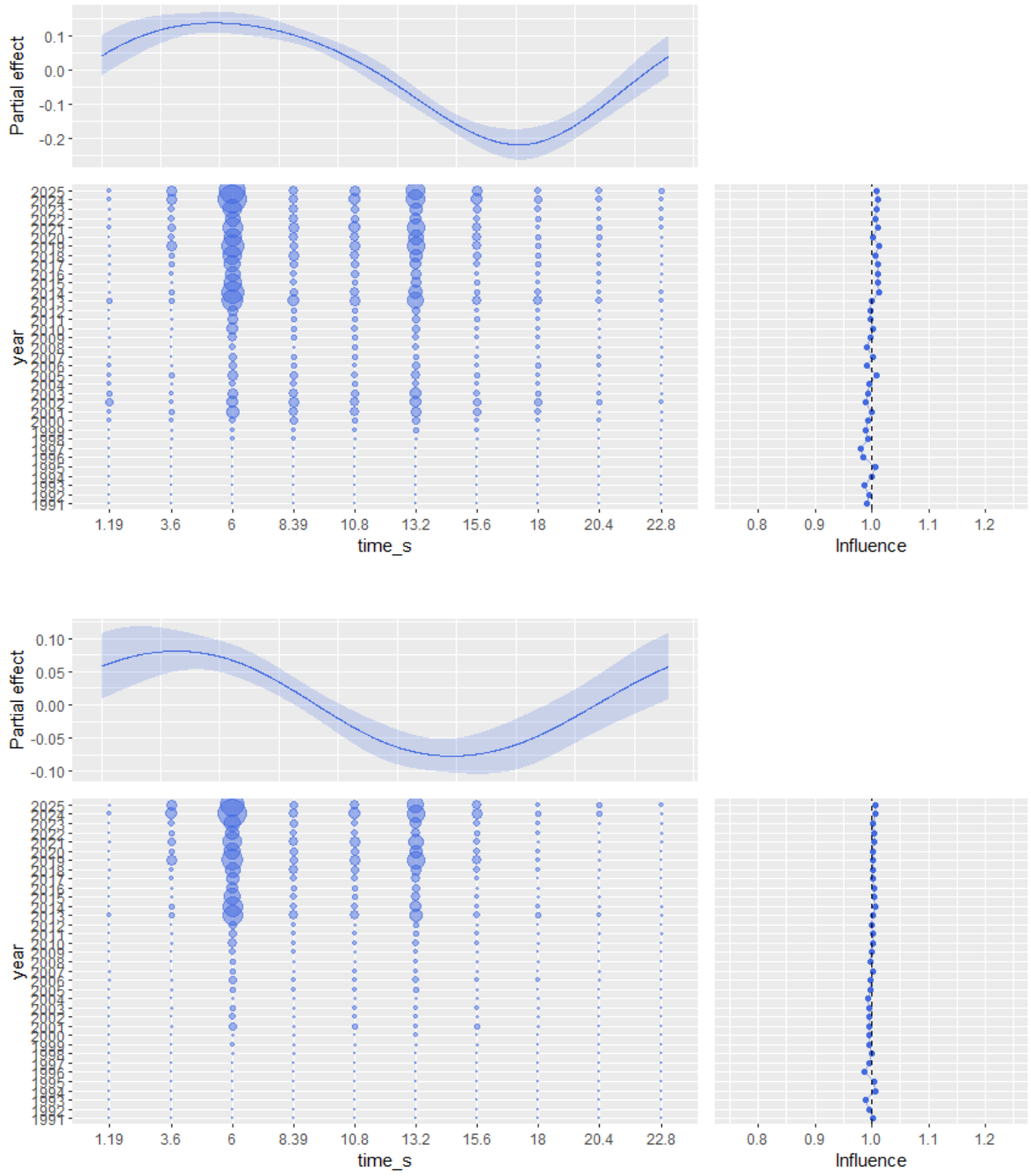


Figure A2.7: Silver warehou SWA 3&4, long series GAM CDI plot for time of day. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

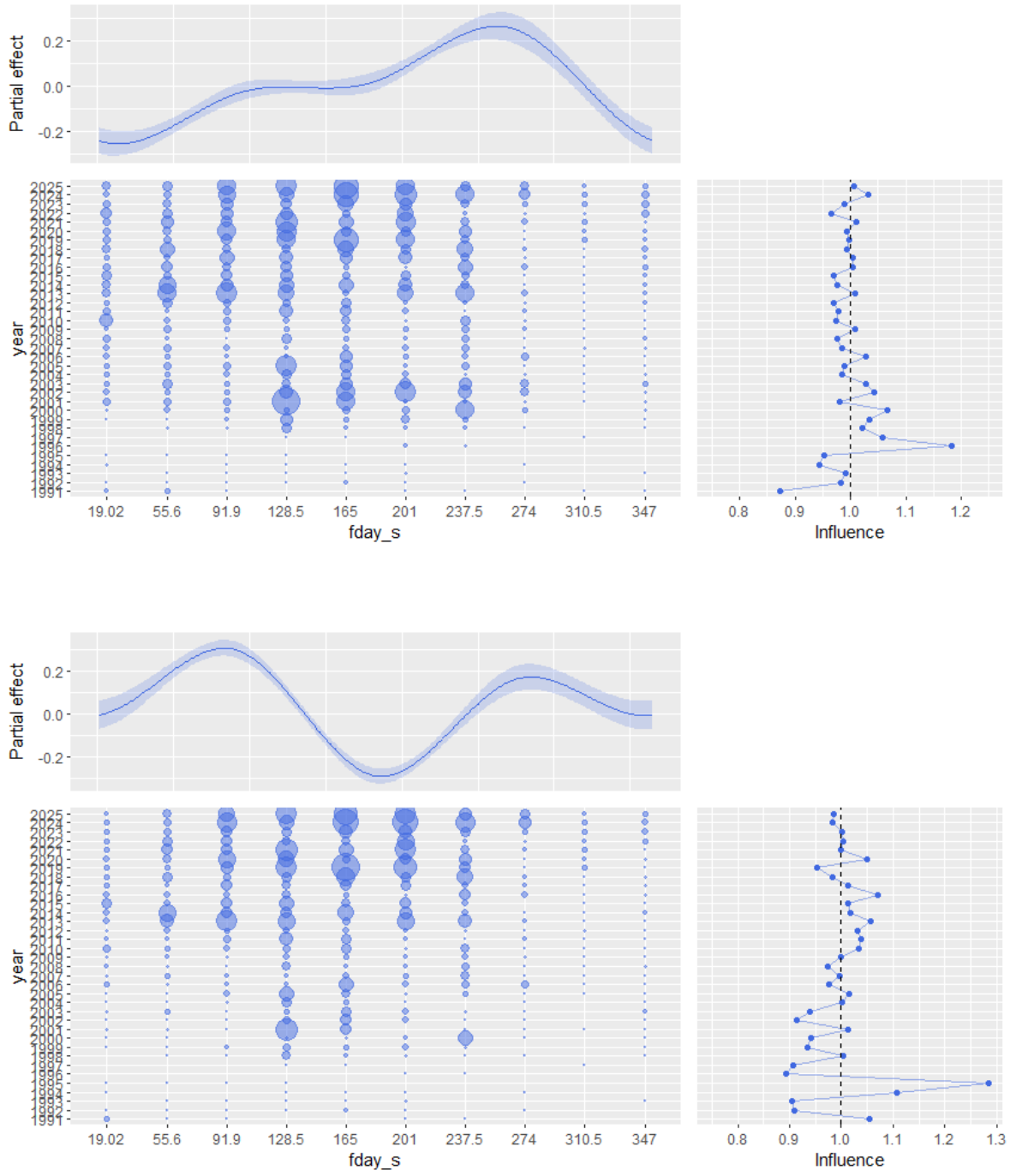


Figure A2.8: Silver warehou SWA 3&4, long series GAM CDI plot for day of the fishing year. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.

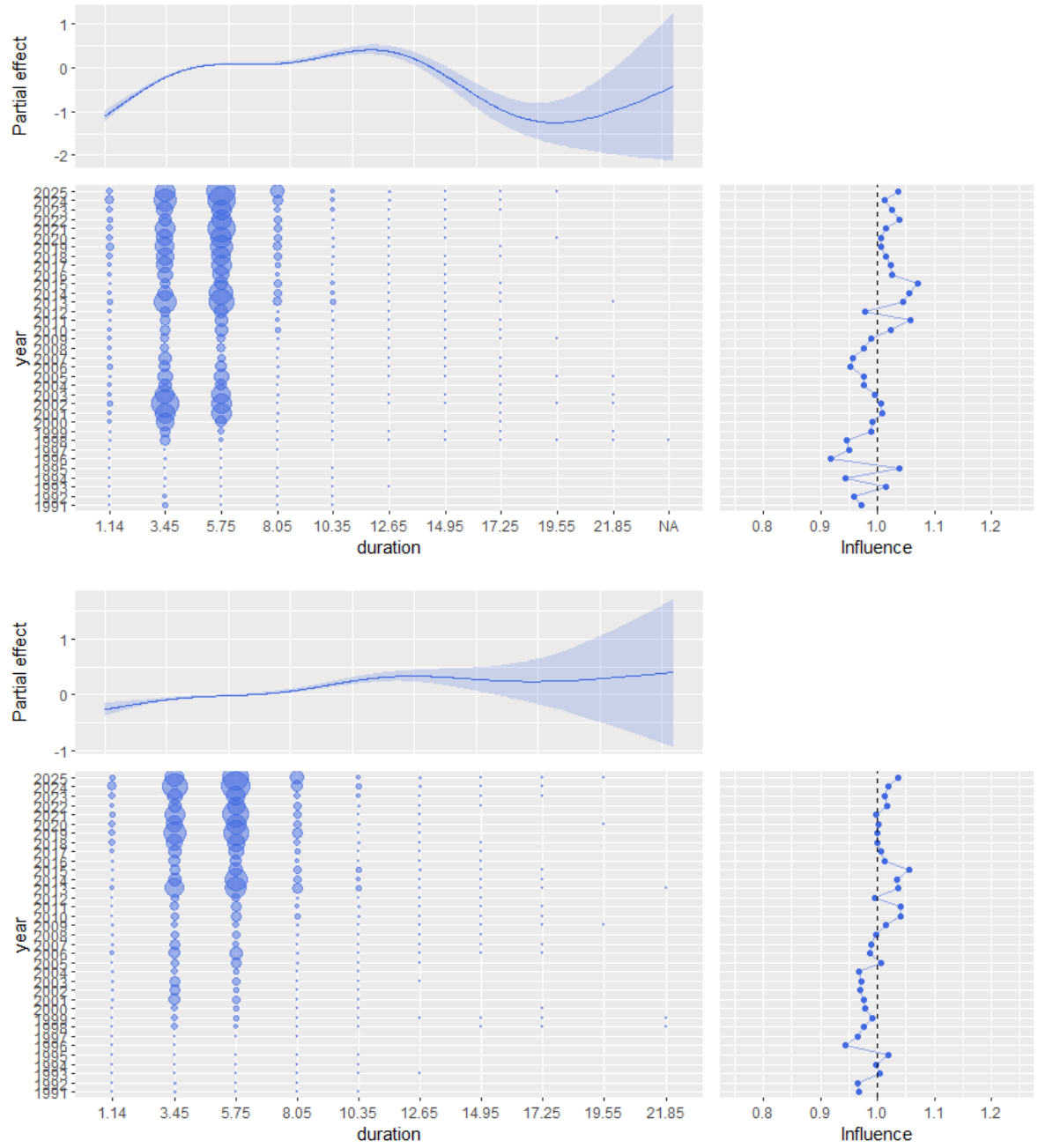


Figure A2.9: Silver warehou SWA 3&4, long series GAM CDI plot for duration. Top panel, binomial model; bottom panel, lognormal model. Within each plot: bottom left panel, bubbles indicate the annual distribution of records by variable category and fishing year; bottom right panel, the annual values of influence; top panel is the predicted effect of the variable on catch rate, with standard error.