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Tini a Tangaroa

Characterisation and CPUE analyses for jack mackerels in the JMA 3 fishery up to 2024

New Zealand Fisheries Assessment Report 2025/50

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ISSN 1179-5352 (online)
ISBN 978-1-991407-43-6 (online)

November 2025



Te Kāwanatanga o Aotearoa
New Zealand Government

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Please cite this report as:

Middleton, D.A.J.; Neubauer, P. (2025). Characterisation and CPUE analyses for jack mackerels in the JMA 3 fishery up to 2024. *New Zealand Fisheries Assessment Report 2025/50*. 431 p.

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PLAIN LANGUAGE SUMMARY

The fishery for jack mackerels in JMA 3, which includes the southern part of New Zealand's EEZ, was characterised using data from 1989 to 2024.

There was little target fishing for jack mackerels in JMA 3 until the 1990s when the area was at the forefront of the "invasion" of Chilean jack mackerel into New Zealand waters. A target fishery subsequently developed, mainly using midwater trawling. Catches declined during the 2000s, but have been stable since 2010.

Because of low observer coverage, a statistical model was developed to estimate the catches of the Chilean jack mackerel and the native greenback jack mackerel in the JMA 3 fisheries (the other native species, yellowtail jack mackerel, is largely absent in JMA 3). Catches estimated using this model demonstrated that the Chilean jack mackerel comprised the majority of the JMA 3 catch until the 2020s.

The species modelling also allowed the development of standardised catch-per-unit-effort series that were intended to provide an indication of trends in abundance, with a focus on the status of the native greenback jack mackerel. However, data on the size and age composition of the catch suggested that greenback jack mackerel in JMA 3 is not an independent stock, but comprises larger and older fish that likely originated in another area.

As a working hypothesis, greenback jack mackerel in JMA 3 were linked to the stock in JMA 7, and CPUE from that area was used to conclude that the stocks in both areas were Likely to be at or above the target.

Chilean jack mackerel are not considered to be a self-sustaining stock in New Zealand waters, but there are some indications of ongoing arrivals from wider Pacific stock, at a lower level than in the 1990s. In particular, most jack mackerels caught around the Chatham Islands are Chilean jack mackerels.

EXECUTIVE SUMMARY

Middleton, D.A.J.¹; Neubauer, P.² (2025). Characterisation and CPUE analyses for jack mackerels in the JMA 3 fishery up to 2024.

New Zealand Fisheries Assessment Report 2025/50. 431 p.

The JMA 3 Quota Management Area (QMA) includes the southern part of the New Zealand EEZ. Unlike the JMA 1 and JMA 7 QMAs, that had established target fisheries, JMA 3 appears to have been established to include the small jack mackerel catches that occurred around southern New Zealand. These catches were initially bycatch in a range of middle depths and inshore trawl fisheries, together with target purse seine catch taken off the Kaikoura coast.

A target midwater trawl fishery for jack mackerels in JMA 3 became established in the late 1990s, primarily in response to the arrival of Chilean jack mackerel (*Trachurus murphyi*) in New Zealand waters. *T. murphyi* was first identified from eastern and southern parts of JMA 3 and subsequently spread west into JMA 7 and north into JMA 1. While it is assumed that some *T. murphyi*, initially present in JMA 3, subsequently emigrated to the other QMAs, sufficient remained that *T. murphyi* was the key species taken in the JMA 3 fisheries until the early 2020s.

Observer sampling of the JMA 3 fishery has been much sparser than in the JMA 7 fishery. As a result, it was necessary to develop species composition modelling to estimate the catch by species. The modelling assumed that yellowtail jack mackerel (*T. novaezelandiae*) was largely absent from JMA 3, at least in the areas of JMA 3 accessible to the midwater fleet, and therefore focussed on separating the catches into *T. murphyi*, and greenback jack mackerel, *T. declivis*.

The species composition modelling used Bayesian generalised linear mixed models. Temporal and spatial variables explained much of the variation in species proportions, with much of the remaining variation attributable to a random effect for the observer trip that collected the data. It is unknown whether this reflects small scale spatial variation in catch composition, or may be related to observers misidentifying the jack mackerel species. However, the consequence is that there is considerable variation in the predicted catches by species. A separate model was developed to characterise the predictive skill of the species composition modelling, and this model was used to assign weights to individual records used in catch per unit effort (CPUE) standardisation.

The CPUE models suggested differing trends in abundance of the two species in JMA 3, with *T. murphyi* abundance increasing rapidly in the 1990s, but then declining rapidly to a low level during the 2000s, with stable abundance since around 2010. Abundance of *T. declivis* also declined in the 2000s, but has trended upwards from the mid 2000s to 2024. However, the scale of the change, and considerable interannual variability, suggested that the CPUE for *T. declivis* was unlikely to represent abundance, at least of an independent JMD 3 stock.

Size data from observer sampling, together with a single year of catch at age sampling in 2013, suggested that *T. declivis* in JMA 3 comprised larger, and older fish, that had originated in another area. For stock assessment purposes, it was assumed that *T. declivis* in JMA 3 (JMD 3) were part of the JMD 7 stock. On the basis of the observer-data based CPUE index for *T. declivis* in JMA 7, the status of the stock in both areas was assessed as Likely to be at or above the target (the geometric mean JMD 7 CPUE for the period 2004–2011). Catches of *T. declivis* in both JMA 3 and JMA 7 were used in assessing relative exploitation rate for the combined stock; this had been below the overfishing threshold since 2011.

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More extensive species composition sampling for jack mackerels in JMA 3, both from target tows and when jack mackerels are taken as bycatch in other midwater trawl fishing, is required to better monitor the JMA 3 fishery going forward.

1. INTRODUCTION

Jack mackerels (JMA) were introduced to the Quota Management System (QMS) on 01 October 1987. The QMS stocks comprise three species, *Trachurus declivis*, *T. novaezelandiae*, *T. murphyi*, two of which (yellowtail jack mackerel, JMN, *T. novaezelandiae*, and greenback jack mackerel, JMD, *T. declivis*) are native species, while the slender, or Chilean, jack mackerel (JMM; *T. murphyi*) is considered to be a more recent arrival in New Zealand, first identified in 1987, and may not spawn locally (Taylor 2002). The species are not reported separately in the QMS data.

In an early description of the jack mackerel fishery in New Zealand, Robertson (1978) recognised two main fisheries: the west coast fishery operated by Japanese bottom trawlers, and the purse seine fishery in the Bay of Plenty. These fisheries likely provided the basis for the establishment of the JMA 7 and JMA 1 Quota Management Areas (QMAs) respectively, with the remainder of the EEZ (except Fisheries Management Area 10, around the Kermadecs) being designated as the JMA 3 Quota Management Area (Figure 1).

While the JMA 3 area lacked established jack mackerel target fisheries in the late 1970s and early 1980s, it was in this area that *T. murphyi* were first detected (Kawahara et al. 1988). Having found a few ‘unusually large’ jack mackerel amongst *T. declivis* caught in ‘southern New Zealand waters’, jack mackerel specimens were collected during the joint Japan/New Zealand trawl survey conducted using the RV *Shinkai Maru* in 1986. During the survey, specimens of *T. murphyi* were caught on the Snares Shelf, the Mernoo and Vryan Banks on the Chatham Rise, and around the Chatham Islands.

The JMA 3 and JMA 7 fisheries are primarily deepwater trawl fisheries, and jack mackerels are considered a Tier 1 species in the National Fisheries Plan for Deepwater and Middle-depth Fisheries (Ministry of Fisheries 2013, Fisheries New Zealand 2019). Reported catches from JMA 3 began at the end of the 1960s, exceeded 5000 t in three years in the 1970s, but were below the initial 2700 t catch limit in the late 1980s (Figure 2). Catches were substantially higher during the 1990s, and approached 20 000 t in 1996. The catch dropped substantially from 2000 to 2001, and was especially low in 2004 and 2005. Subsequent catches gradually increased and have been around 5000 t per annum since the late 2010s.

To date, there has been no stock assessment for JMA 3 (Fisheries New Zealand 2024). From 1 October 2016, the TAC for JMA 3 was reduced from 18 000 t to 9000 t (its current level; Table 1) on the basis that there was evidence of a sustained period of decreased abundance of *T. murphyi*, and that the higher TAC—that had been increased in the early 1990s following the arrival of *T. murphyi*—could no longer be considered appropriate.³

Recreational and customary allowances of 20 t were also set for JMA 3 in the 2017 fishing year. The latest harvest estimates for recreational fishers (Heinemann & Gray 2024) reported no catch of jack mackerels in FMAs 3 and 5 (FMAs 4 and 6 were not surveyed).

Table 1: Total Allowable Catch (TAC), Total Allowable Commercial Catch (TACC), and allowances (all tonnes) for JMA 3, as at 1 October 2025.

Stock	TAC	TACC	Allowances		
			Customary	Recreational	Other mortality
JMA 3	9000	8780	20	20	180

³Minister’s decision letter on fisheries sustainability measures for 1 October 2016; <https://www.mpi.govt.nz/consultations/review-of-fisheries-sustainability-measures-for-1-october-2016/>

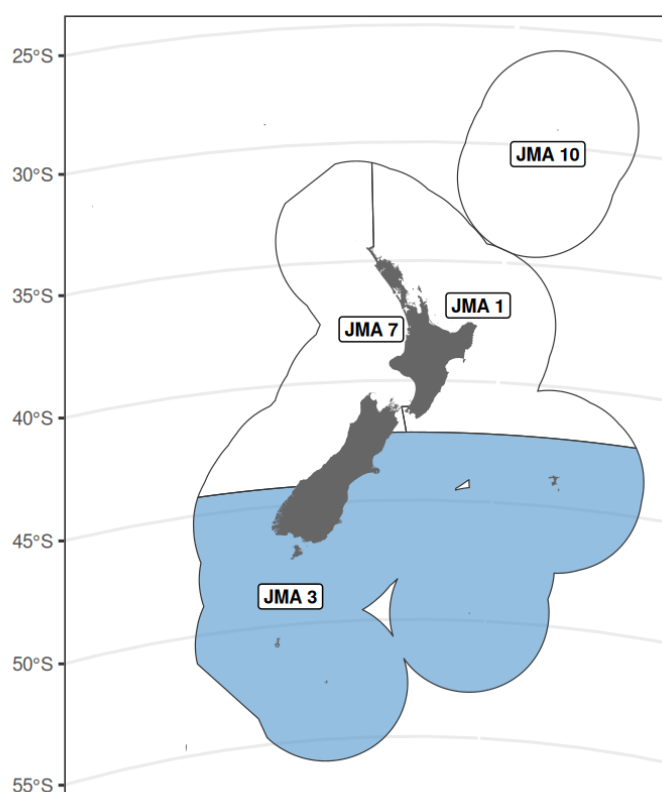


Figure 1: Quota Management Areas for jack mackerels with JMA 3 highlighted.

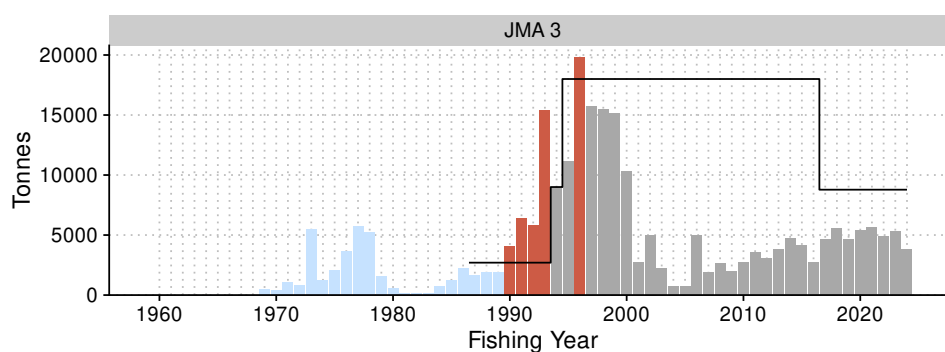


Figure 2: Total Allowable Commercial Catch (TACC; black line) and Monthly Harvest Return/Quota Management Report annual totals (bars) for JMA 3 from 1990 to 2024. Years where the TACC was exceeded are highlighted in red. Catches prior to 1990 are shown in blue using the information compiled in the Fisheries Assessment Plenary Report (Fisheries New Zealand 2024). Tabulated data are provided in Table B.1.

1.1 Jack mackerel species in JMA 3

Jones (1990) indicated that all three species of jack mackerels occurred around southern New Zealand and on the Chatham Rise (Figure 3), with the two native species occurring around the North Island. However, Jones (1990) did comment that, in the Taranaki Bight, *T. novaezelandiae* tended to be associated with warmer water. Kawahara et al. (1988) were clearer that, while *T. novaezelandiae* and *T. declivis* were common around northern New Zealand, only *T. declivis* extended southwards as far as Stewart Island.

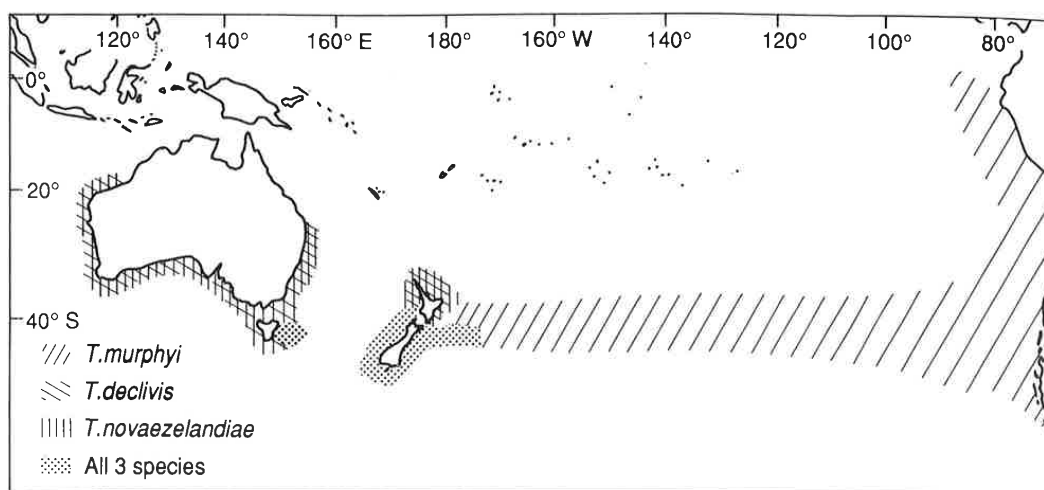


Figure 3: Indicative distributions of jack mackerel species found in New Zealand, from Jones (1990, fig. 3)

Maps of research bottom trawl data indicated that *T. novaezelandiae* was sparsely distributed on the east and west coasts of the South Island, was absent from the Chatham Rise, but was occasionally encountered in the vicinity of Foveaux Strait (Anderson et al. 1998). *T. declivis* was encountered more frequently in research trawls on the east and west coasts of the South Island, was sparse on the Chatham Rise, but was found reasonably frequently across the Stewart-Snares Shelf. *T. murphyi* was encountered in research trawls off the southern east and west coasts of the North Island, and around the South Island, being encountered more frequently than *T. declivis* on the Chatham Rise and on the Stewart-Snares Shelf in research trawls up to May 1997.

Estimates of species composition in JMA 3 from 1986 to 2005 were summarised by Taylor & Julian (2008). These were primarily based on observer sampling, but some limited sampling of JMA 3 landings was carried out in Nelson. The proportion of *T. novaezelandiae* in the catch was usually low, often zero or just a few percent of the catch, but was reported as 22% in 1987 (Taylor & Julian 2008, table 3). Estimates of the proportions of *T. declivis* and *T. murphyi* in the catch varied substantially from year to year. Other than in 1987 and 2003, *T. murphyi* was the dominant species, estimated to comprise at least 65%, and up to 100%, of the JMA 3 catch.

The most recent description of the JMA 3 fishery was provided by Horn et al. (2014) who estimated species composition using observer sampling data, and also estimated catch at age for the 2013 fishing year. At that time, it was estimated that *T. murphyi* made up 57% of the JMA 3 catch, with negligible *T. novaezelandiae* present. Based on a 'clear north-south split' in the distribution of the trawl fishery, estimates for 2013 were made using northern and southern strata with the boundary off the Otago Peninsula (at 45.8°S). In the northern stratum, *T. declivis* was estimated to make up 52% of the catch, while the southern area was dominated by *T. murphyi* (estimated to comprise 78% of the catch). Horn et al. (2014) did not recalculate the historical species composition estimates using these strata.

The estimates of species composition in JMA 3 reported by Taylor & Julian (2008) and Horn et al. (2014) are illustrated in Figure 4.

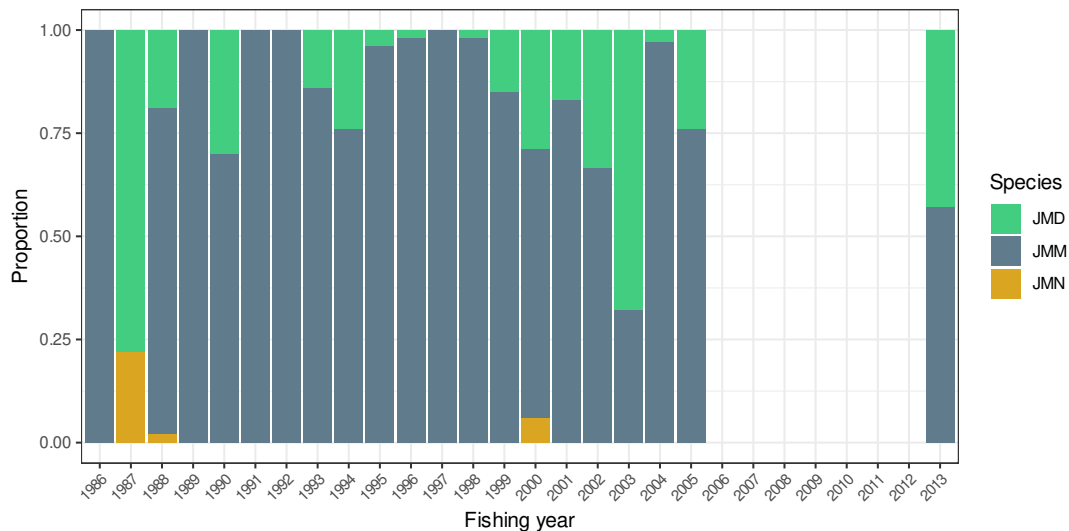


Figure 4: Estimated proportions of *Trachurus declivis* (JMD), *T. novaezelandiae* (JMN) and *T. murphyi* (JMM) in the JMA 3 trawl fishery, as reported by Taylor & Julian (2008) and Horn et al. (2014).

1.2 Stock structure

Jones (1990) noted that a biochemical study (protein electrophoresis to detect allozyme variation using liver samples) suggested that the *T. declivis* population in New Zealand waters was distinct from that off western Australia, and probably distinct from those off southeastern Australia. He suggested that separate stocks of any of the jack mackerel species within New Zealand were unlikely, because ‘of the widespread pelagic distribution of the adults, eggs, and larvae.’

Growth in both *T. novaezelandiae* and *T. declivis* was estimated to be faster in the Bay of Plenty than off the west coast, although few samples of *T. declivis* from the Bay of Plenty were available (Horn 1993).

Horn et al. (2014) found that males dominated the catch of *T. declivis* in JMA 3, whereas roughly equal sex ratios tended to be found in JMA 7. Furthermore, *T. declivis* less than 9 years of age were rare in JMA 3 in 2013, while catches in JMA 7 always included—and were often dominated by—fish 5 years old or younger. As a result, they suggested that the adult *T. declivis* in JMA 3 may not be a distinct stock.

Taylor (2002) concluded that, in 2002, the New Zealand population of *T. murphyi* consisted mostly of individuals that had invaded New Zealand waters, but with a small proportion that was the result of local spawning. However, Horn & Maolagáin (2021) suggested that there was no evidence (before 2017–2018) of either substantial new immigration or recruitment through spawning success.

1.3 Stock assessment history

Horn et al. (2014) aged *T. declivis* from JMA 3 at up to 24 years, with fish between 10 and 19 years most abundant in the catch in 2013, and few fish under 9 years. The catch of *T. murphyi* was dominated by fish between 14 and 18 years. A Chapman-Robson estimate of total mortality rate for *T. declivis* was $Z = 0.35\text{y}^{-1}$ when the age at full recruitment was assumed to be 15 years. However, it was noted that, due to the possibility that *T. declivis* in JMA 3 may not be a distinct stock, this may not be a good estimate; no assessment was undertaken using this estimate.

In recent years, stock assessment research for the deepwater jack mackerel fisheries has focused on JMA 7. Attempts to develop fully quantitative assessments were challenged by the need to separate the three species, and both methodological and data quality issues arose. The adequacy of observer sampling of trawl catches was addressed by Middleton (2022); after examining data from supplemental

observer sampling, it was concluded that observer sampling should give an acceptable indication of species composition even if sampling was not spread throughout the full processing period of the tow.

A further concern has been the accuracy of species identifications in the observer data. Misidentification of the species in some observer samples is particularly apparent in age at length data. A model-based approach to evaluating the probability that an observer's identification of the jack mackerel species was correct was developed by Neubauer & Middleton (in prep.). However, Middleton et al. (2024) found that excluding data from tows or trips where misidentification had occurred had relatively little impact on catch-per-unit-effort (CPUE) series generated using observed tows, where the quantity of the individual jack mackerel species could be estimated using sampling data.

The Deepwater Working Group, and a subsequent Fisheries Assessment Plenary meeting, accepted CPUE indices generated using observer data as indices of abundance for *T. declivis* and *T. novaezelandiae* in JMA 7. Conceptual proxies for B_{MSY} were also defined, based on the CPUE series, allowing a partial quantitative assessment of the status of these species to be reported for JMA 7.

This report characterises the JMA 3 fisheries and develops CPUE series for *T. declivis* and *T. murphyi* in JMA 3, with the assumption that *T. novaezelandiae* is largely absent in that area. A partial quantitative assessment for *T. declivis* in JMA 3 was carried out, under the assumption that this is part of the JMA 7 stock.

2. METHODS

Extracts (report logs 13159, 16925) of statutory commercial catch, effort, and landings data were provided by Fisheries New Zealand and processed using standardised grooming routines (Appendix A).

All years in this report refer to the standard New Zealand fishing year which runs from 1 October to 30 September. Fishing years are labelled using the later calendar year; thus, for example, 1990 refers to the fishing year 1 October 1989 to 30 September 1990.

For a full list of acronyms used in this report, please refer to Appendix E.

2.1 Terminology

In this report we use the term **catches** to refer to the catch of legally retainable fish. Catches include any legally retainable fish that are optionally returned to the sea (for example, schedule 6 returns) but exclude those fish that *must* be returned to the sea, such as fish below the minimum legal size (MLS). Catches include declared accidental losses of fish but do not include fish that escape capture, for example by escaping through the mesh of a trawl.

For species managed under the Quota Management System (QMS) we use the term **removals** to refer to the known mortality of fish; i.e., the legally retainable catches without those fish that are optionally returned to the sea and considered likely to survive. Any mortality suffered by these returned fish is not included in removals. However, in the case of non-QMS species we include returned fish as part of the removals.

2.2 Data sources

There are three types of statutory commercial data relevant to assessing catches and removals:

- Monthly Harvest Returns (MHRs) and their forerunner, Quota Management Reports (QMRs), which we refer to as the **MHR/QMR** data;
- landings and disposals, referred to as **landings** data; and
- the **estimated catches** recorded by fishers for individual fishing events.

MHR/QMR data are the key information used in the balancing of commercial catch against the Total Allowable Commercial Catch (TACC); however, they provide information at a relatively coarse resolution of client, stock, and month. QMRs provided a record of the total monthly catch of each QMS fishstock for each quota holder, by month from December 1986 to September 2001. MHRs replaced QMRs from October 2001 and record data on harvest of both QMS and non-QMS species.

The finest-scale catch information is provided by estimated catches, which are reported per species per fishing event. However, estimated catch data are not necessarily comprehensive or accurate; this is because not all species caught are required to be reported for each event, and the quantities reported are estimated rather than weighed.

Landings and disposals provide data on the catches of all stocks, generally at the fishing trip resolution, with quantities verified (where practicable; e.g., when landed) by weighing. Under the Electronic Reporting regime introduced by the Fisheries (Reporting) Regulations 2017, these data provide a comprehensive record of catches per trip, with the fate of those catches indicated by a destination code (Table 2). However, the set of available destinations has become more comprehensive as reporting regulations have evolved and the possibility that the landings data were less complete in the past must be considered.

In some cases, landings from a trip are first recorded to an interim destination. Because these fish should subsequently be reported to a final destination, the data for the initial, non-final landings are dropped from the landings dataset used in this report, together with any landings data for categories of fish that are not legally retainable.

The **catches** and **removals** used in the remainder of this report comprise the landings for final, legally retainable destinations (Table 2).

2.3 Allocation of catches to fishing events

As noted above, the landings data that define the catches and removals for a stock are generally reported at the resolution of the fishing trip. In some fisheries, trips are lengthy (exceeding a month) and carry out fishing over a wide area; as a result, catches are most usefully *allocated* to individual fishing events. Two allocation approaches are available: *trip-based allocation* and *annual scaling*. In this report, trip-based allocation was used for all stocks and methods.

The trip-based approach allocates the catches of JMA from a trip to the fishing event records from the trip using the hierarchical method of Starr (2007). If jack mackerels were included in the estimated catch for at least one of the fishing event records on the trip, then catches were allocated in proportion to the estimated catch for each record (**Est. catch** allocation). If no estimated catch of jack mackerels were recorded on the trip, but a single fishing method was used on the trip, then catches were allocated in proportion to the number of fishing events per record (**Effort no.** allocation). If neither of the previous approaches applied for a trip then catches were allocated equally across fishing effort records (**Equal** allocation).

2.4 Conversion factors

Catches and removals in this report are reported as greenweight. However, actual weighing of the catch may take place after processing, in which case the greenweight is derived by applying a conversion factor to the measured processed weight. The conversion factors used in the statutory commercial reporting are specified by Fisheries New Zealand, by species and processed state.

The regulated conversion factors may be updated at times; occasionally this is because the nature of processing a particular species or state has changed, but usually it is because sufficient data have been collected to provide a more reliable estimate of the appropriate conversion factor. In this report, we adjust historical landings data to the current conversion factor for the species and processed state:

$$gwt_{adj} = gwt_{rep} \frac{CF_{cur}}{CF_{rep}} \quad (1)$$

where gwt_{adj} is the adjusted greenweight, gwt_{rep} is the greenweight originally reported, CF_{cur} is the current conversion factor, and CF_{rep} is the conversion factor used when the data were reported.

Table 2: Destination codes used in reporting of landings and disposals, with introduction date for codes that were not defined in the original Fisheries (Reporting) Regulations 1990. The inclusion of the landing/disposal in subsequent MHR returns is indicated in circulars issued under the Fisheries (Reporting) Regulations 2017. Only categories that are legally retainable, and considered final, are included in the catches and removals for a stock. LFR = Licensed Fish Receiver.

Code	Description	Date		Final	Retainable	Included in		
		Introduced	Revoked			MHR	Catches	Removals
A	Accidental losses			Y	Y	Y	Y	Y
B	Retained for use as bait			Y	Y	Y	Y	Y
E	Catch eaten on board			Y	Y	Y	Y	Y
EOY	End of year landings	2017-10-01		Y	Y	Y	Y	Y
H	Losses from holding receptacles		2018-06-30	Y	Y	Y	Y	Y
HL	Losses from holding receptacles on land	2018-07-01		Y	Y	Y	Y	Y
HW	Losses from holding receptacles in the water	2018-07-01		Y	Y	Y	Y	Y
J	Observer or Fishery Officer authorised returns	2013-10-01		Y	Y	Y	Y	Y
L	Landings to an LFR			Y	Y	Y	Y	Y
LFL	Fish landed after being held live on land	2019-01-10		Y	Y	Y	Y	Y
LP	Final landing of fish from holding receptacles at sea	2018-07-01	2019-01-09	Y	Y	Y	Y	Y
LR	Final landing of retained fish	2017-10-01		Y	Y	Y	Y	Y
M	Sixth schedule returns (spiny dogfish)	2004-10-01		Y	Y	Y	Y	Y
O	Catch transported outside the EEZ			Y	Y	Y	Y	Y
PF	Predated fish	2018-07-01		Y	Y	Y	Y	Y
QL	Landings to an LFR after storing in a holding receptacle on land	2018-07-01		Y	Y	Y	Y	Y
S	Catch taken by a Fishery Officer or observer			Y	Y	Y	Y	Y
T	Transhipments		2018-06-30	Y	Y	Y	Y	Y
TL	Transhipments, reported as landed by the catching vessel	2018-07-01		Y	Y	Y	Y	Y
U	Used as bait			Y	Y	Y	Y	Y
W	Wharf sales			Y	Y	Y	Y	Y
Z	Returns to the sea (certain sharks, dead or near-dead)	2014-10-01		Y	Y	Y	Y	Y
BS	Biotoxin samples	2019-11-26		Y	Y	N	Y	Y
CS	Customary catch	2017-10-01	2019-11-25	Y	Y	N	Y	Y
D	Non-QMS returns			Y	Y	N	Y	Y
F	Landings as recreational entitlement	2002-07-11		Y	Y	N	Y	Y
I	Returns for safety of protected species	2022-11-01		Y	Y	N	Y	Y
V	Observer samples	2017-10-01		Y	Y	N	Y	Y
X	Permitted returns	2006-10-01		Y	Y	N	Y	N
C	Disposal to the Crown		2001-09-30	Y	Y		Y	Y
G	Returns above legal size	2018-07-01		Y	N	N	N	N
K	Lobster required returns (not sub-MLS)	2018-07-01		Y	N	N	N	N
Y	Sub-MLS returns	2017-10-01		Y	N	N	N	N
LF	Live fish held on land	2019-01-10		N	Y	N	N	N
N	Removals from holding receptacles at sea	2018-07-01		N	Y	N	N	N
P	Placed into a holding receptacle at sea			N	Y	N	N	N
Q	Placed into a holding receptacle on land		2018-06-30	N	Y	N	N	N
R	Landings retained on board			N	Y	N	N	N
TT	Transhipments, reported as landed by the receiving vessel	2017-10-01		N	Y	N	N	N

2.5 Characterisation dataset

A fishery characterisation dataset was prepared by identifying all trips with landings or estimated catches from JMA 3 and extracting the associated catch and effort data for fishing events within the JMA 3 Quota Management Area (Figure 1). Fishing events were selected based on start position (where available) or statistical area. The earlier QMS-era catch and effort data were reported at the resolution of statistical areas, and some statistical areas cannot be uniquely assigned to a single fishstock (Figure 5).

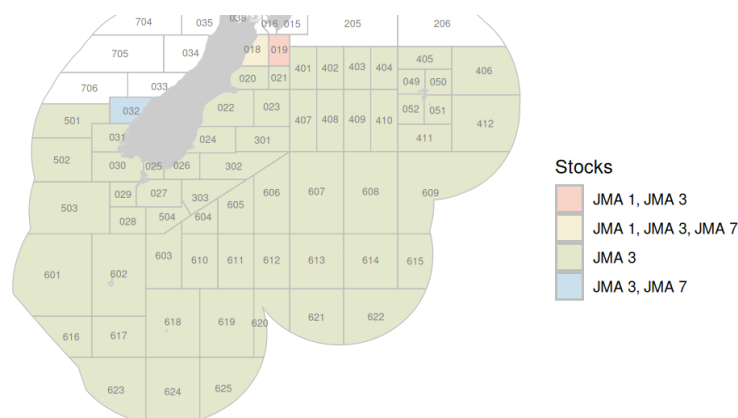


Figure 5: Statistical Areas that intersect the JMA 3 Quota Management Area.

2.5.1 Processed catch

Processed catches, from trips that landed JMA 3, were included in the characterisation dataset if they could be assigned to a stock. Assignment of processed catches to a stock used the following approaches, in order of preference:

- if a trip landed catches to a single JMA stock, then all processed catch of jack mackerels from the trip was assigned to that stock. This was termed *trip* based assignment;
- if all effort on the day on which the catch was processed occurred within a single JMA QMA, then all processed catch of jack mackerels on that day was assigned to that stock. This was termed *day* based assignment; or
- the processed catch was assigned to the stock where the previous estimated catch of jack mackerels on the trip took place. This was termed *previous* catch assignment.

2.6 CPUE methods

Fishing events for catch-per-unit-effort (CPUE) modelling were selected by a combination of some or all of:

- reporting form;
- fishing method;
- target species;
- area; and
- time period.

All fishing events matching the series definition were extracted, whether or not JMA were caught. Datasets for CPUE modelling were prepared at differing resolutions:

fishing event level where records represented individual fishing events such as trawls or longline sets;

daily (pseudo-CELR) resolution where finer scale records were aggregated to vessel-day resolution to provide data that mimic the resolution provided by the Catch, Effort and Landing Return (CELR), following the approach suggested by Langley (2014); or

trip level where each record was for a complete fishing trip with aggregated statistics summarising the fishing effort from the trip.

For the fishing event and daily resolution data, catches were allocated to fishing events following the approach of Starr (2007) as summarised above. For the fishing event resolution data, the catch allocation process was applied after restricting estimated catches to the top five species (`allockg_top5`; matching the resolution of the TCEPR form), the top eight species (`allockg_top8`; matching the resolution of the TCER, NCELR, LCER, and LTCER forms), or without restricting estimated catches (`allockg`, or `scaledkg` in cases where annual rather than trip level scaling was applied).

For the daily resolution data, catches were allocated after first restricting the estimated catches to include only the top five species estimated caught on the day, to match the resolution of the CELR data (`allockg`). For the daily resolution data, processed catch totals were also included in the dataset (`prockg`); these included the summed greenweight of any processed catch records for the date of the fishing activity.

Trip resolution CPUE datasets included the aggregate, trip-level catches directly, without any allocation to fishing events (`landkg`) and sums, mean, and/or modal values of the effort variables for the trip.

2.7 Observed species proportions

Species proportions were calculated for each tow sampled by Fisheries New Zealand observers, as follows:

- The total catch of jack mackerels in the tow was calculated by summing entries in the COD table `x_fishing_event_catch`. Catches recorded under codes JMA, JMD, JMM, and JMN were included. Any species-specific totals were treated as if they were records of aggregate jack mackerels.
- The proportion of each species by weight was estimated by applying the length-weight relationships for each species (Fisheries New Zealand 2024) to the fish in the length-frequency sample for the tow, summing by species, and calculating the species proportions (by weight) in the length-frequency sample.
- Estimates of catch by species in sampled tows were derived by multiplying the total jack mackerel catch by the species proportions by weight in the length-frequency sample.

2.8 Identifying spatial clusters of sampled tows

Density based clustering (dbscan; Hahsler et al. 2019) of the start locations of tows with length-frequency samples of jack mackerel was used to identify spatial clusters in the sampling. These clusters were used for presenting summaries of the sampling data.

The dbscan algorithm uses the concept of the ε -neighbourhood (epsilon neighbourhood) of a data point to identify the set of points within a specified radius, ε , around a data point p . Two parameters are required:

- ε , the size (radius) of the ε -neighbourhood (here measured in metres); and
- *minPts*, the minimum number of points required in the ε -neighbourhood for a point to qualify as a core point.

Points are then classified as:

- **core points**, if the number of points, $N_\epsilon(p)$, in their ϵ -neighbourhood is greater than or equal to the minimum threshold, $minPts$;
- **border points**, if they are in the neighbourhood of a core point but do not meet the definition of a core point; or
- **noise points** otherwise.

Points are assigned to a cluster if they qualify as core or border points; noise points are not assigned to a cluster.

The parameters used for the dbscan algorithm were selected after inspecting the resulting spatial clustering for a range of parameter choices. For reporting purposes, the concave hull that encloses the tow locations assigned to a cluster was plotted, using a concavity parameter of 0.8 to limit the detail of the polygon border.

2.9 Predicting species composition for unobserved events

In order to derive a CPUE index for each jack mackerel species, the species composition of catches needs to be known. As the catch composition is only available from observer data, and observer coverage was relatively sparse in JMA 3 (see below), we attempted to use the observer data to develop a species distribution model that could predict the most likely catch composition for unobserved fishing events.

Modelling focussed on JMA 3 only, and on the binary question of the relative contribution of JMM and JMD in observed fishing events (assuming, as discussed below, that any JMN reported in samples from JMA 3 are the result of misidentification, and therefore not important in the species mix). Our overall strategy was as follows:

1. Fit a range of species distribution models;
2. Use stratified cross-validation to test predictive ability—choosing the best model;
3. Estimate data-point weights—predicting the predictive ability of the model;
4. Predict the species catch for each tow, attaching the prediction weight; and
5. Fit the CPUE model with weighted observations.

Competing species distribution models were formulated as Bayesian generalised linear mixed models with a Beta-binomial response that treated the species-specific catch (i.e., JMM or JMD catch) as an integer number (in kilograms), with the binomial N (trials) as the sum of all JMA catches. Integrating over the Beta-distribution leads to an over-dispersed logistic regression that accommodates additional variability beyond that catered for by the covariates in the linear predictor. The latter differed between models in terms of i) the treatment of space in the model, using either splines or categorical spatial proxies, ii) the treatment of year effects, and iii) the use of additional variables (month, depth, target) beyond just two-dimensional space and year (Table 3). All models included a trip-level random effect to account for small-scale spatio-temporal variation and/or potential observer skill/misidentification. All models were fitted in brms (Bürkner 2017), retaining 2000 draws from eight MCMC chains.

Observer data with length samples for JMA (and hence species proportions) were subset to midwater trawl only, leaving 1900 observed events in JMA 3 across BAR, SQU and JMA targets (Figure 6). We removed sparse data prior to 1993 as these data were unlikely to be representative of the fishery. Sampled species proportions were assumed to be representative of the sampled tow.

The categorical spatial strata (`start_obs_fma`) were modified observer FMAs that accommodated the spatial patterns evident in the midwater trawl fishery (see Figure 18, below), specifically:

- the boundary between FMA 3 (SEC) and FMA 4 (SOE) was moved to 179°W (instead of 176°W) so any points in SOE that had longitude < 179° were recoded to SEC; and
- the boundary between FMA 3 (SEC) and FMA 5 (SOU) was moved to 45°S so any points in SEC that had latitude < -45° were recoded to SOU.

Table 3: Candidate models with their names and linear predictor, as used in brms. The term 1| denotes a random effect, ‘:’ denotes an interaction term, t2 is a tensor spline, k is the number of knots considered for the spline, bs is the type of spline (tp: thin plate; re: random effect), and d is the dimension.

Model name	brms linear predictor
FULL	$t2(\text{latitude}, \text{longitude}, \text{fyear}, \text{bs}=\text{c}(\text{"tp"}, \text{"re"}), k=25, d=\text{c}(2,1)) + (1 \text{month}) + (1 \text{target-species}) + (1 \text{trip})$
SPLINEonly	$\sim t2(\text{latitude}, \text{longitude}, \text{fyear}, \text{bs}=\text{c}(\text{"tp"}, \text{"re"}), k=25, d=\text{c}(2,1)) + (1 \text{trip})$
noSTspline	$\sim t2(\text{latitude}, \text{longitude}, \text{bs}=\text{c}(\text{"tp"}), k=25, d=\text{c}(2)) + (1 \text{fyear}) + (1 \text{month}) + (1 \text{target-species}) + (1 \text{trip})$
FMA-splineY	$\sim (1 \text{start_obs_fma}) + t2(\text{fyear}, \text{start_obs_fma}, \text{bs}=\text{c}(\text{"tp"}, \text{"re"}), k=25) + (1 \text{month}) + (1 \text{target-species}) + (1 \text{trip})$
FMA-linearY	$\sim (1 \text{start_obs_fma}) + (1 \text{fyear-num} \text{start_obs_fma}) + (1 \text{month}) + (1 \text{target-species}) + (1 \text{trip})$
FMAY	$\sim (1 \text{start_obs_fma}) + (1 \text{start_obs_fma}:\text{fyear}) + (1 \text{fyear}) + (1 \text{month}) + (1 \text{target-species}) + (1 \text{trip})$
FMAYonly	$\sim (1 \text{start_obs_fma}) + (1 \text{start_obs_fma}:\text{fyear}) + (1 \text{fyear}) + (1 \text{trip})$
FMA	$\sim (1 \text{start_obs_fma}) + (1 \text{fyear}) + (1 \text{month}) + (1 \text{target-species}) + (1 \text{trip})$
FMAnoY	$\sim (1 \text{start_obs_fma}) + (1 \text{month}) + (1 \text{target-species}) + (1 \text{trip})$

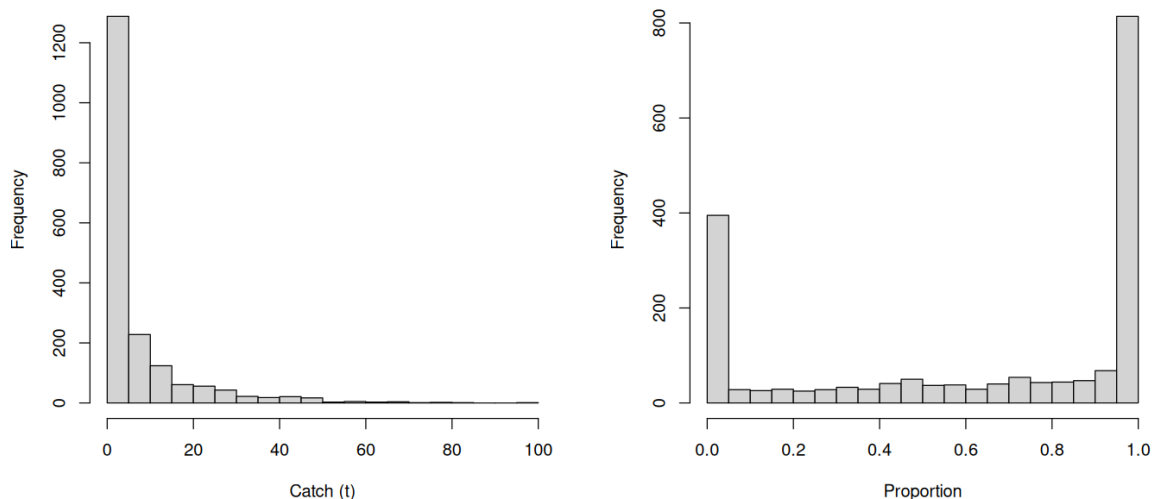


Figure 6: Illustration of the catch for JMM in terms of catch weight (left) and proportion (right) across modelled fishing events.

2.9.1 Cross-validation

We used spatially and temporally stratified cross-validation (CV) to test the predictive power of each model, and to identify the most appropriate model for the task. Stratification was applied across degree latitude-longitude-year combinations. We used a 10-fold CV, with latitude-longitude-year strata allocated to CV folds by occurrence (i.e., each CV fold removed a number of degree lat-long-year combinations). Trip was held constant (integrating over the trip-effect) to reflect the approach used to provide predictions for the CPUE dataset (this assumes that the trip effect reflects fine-scale spatial variation, not observer misidentification). Models were ranked by predictive ability according to the expected log predictive density (ELPD) and its difference (including standard error) between models.

2.10 Predictive ability weighting

To test the ability of the model to predict the catch composition of individual events, we examined the distribution of ELPD values by event, with a view to build a model that discerns when and/or where in space, time or otherwise our best model provides good predictions, and where predictions might be poor (biased or highly uncertain). We sought to answer two questions:

1. when are predictions “bad”?, and
2. if predictions are “OK”, when are they better?

For these tasks, we employed a mixture-of-Gaussians model, where the logit of the ELPD was the response, and each Gaussian distribution represents either good (represented by parameters μ_{good} and σ_{good}) or poor predictions (μ_{poor} , σ_{poor}). The probability of an event being predicted poorly was then modelled as a function of explanatory variables, such that:

$$\text{logit}(p[\mu_{poor}]) \sim (1|fyear) + (1|start_obs_fma) + (1|start_obs_fma : fyear) + lat + lon + (1|target_species) + (1|trip). \quad (2)$$

For the second question we modelled the distribution for “good” predictions, again as a function of predictors to understand where the model’s strengths and weaknesses are for the set of reasonably predicted events:

$$\mu_{good} \sim (1|fyear) + (1|start_obs_fma) + (1|start_obs_fma : fyear) + lat + lon + (1|target_species). \quad (3)$$

No such predictor was formulated for poorly predicted observations; these ultimately translate into a low weight.

The mixture model was fitted in brms with vaguely informative priors and forcing the identifiability of the mixture by using ordered intercepts for the Gaussians (i.e., $\mu_{good} > \mu_{poor}$; the distribution for poorly predicted observations was forced to have a lower mean logit(ELPD) than that for good observations), using four MCMC chains for inference.

The prediction weight for observations in the CPUE dataset was derived by taking the inverse logit of the predicted logit of the EPD from the mixture model for each observation.

3. FISHERY CHARACTERISATION

Except in 1999, where catches exceed the QMR totals, there has been a generally good correspondence between catches and MHR/QMR totals (Figure 7). Landings directly to a Licensed Fish Receiver have comprised the majority of the JMA 3 landings since the early 1990s, but a small proportion of catch was transhipped during the 1990s (Figure 7).

Over the period from 1995 to 2024, the majority of jack mackerel landings from JMA 3 have been of dressed fish (Figure 8), although some fish were landed in unprocessed (green) state during the 1990s (and in 2023–2024), and landings of headed and gutted fish were notable in 1993 and 1994. A small amount of the catch was mealed in the 1990s. No significant changes in the conversion factors for jack mackerels have occurred (Figure 9). There was a good correspondence between total catches and catches that could be allocated to fishing events (Figure 10).

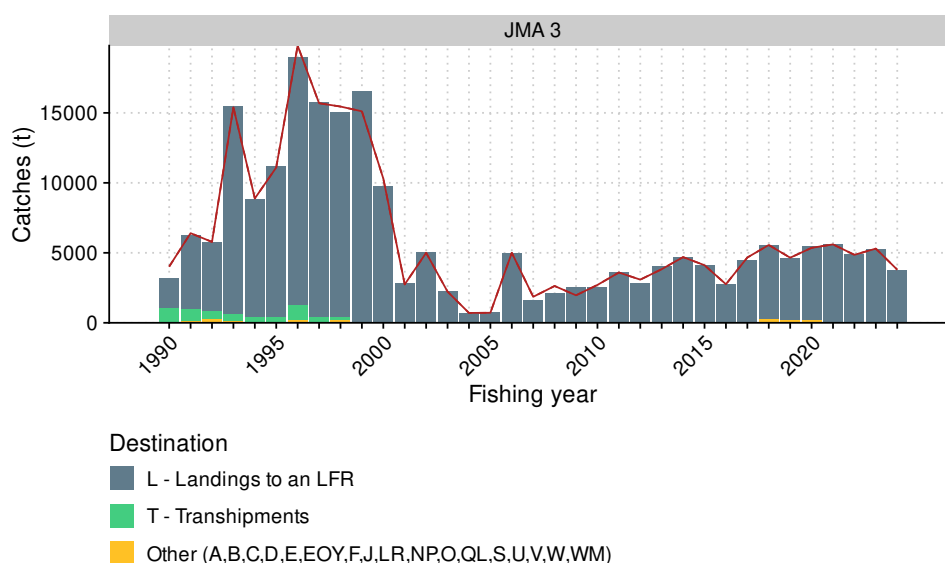


Figure 7: Catches of jack mackerels by destination (bars), compared with Monthly Harvest Return / Quota Management Report (MHR/QMR) annual totals (line), for Quota Management Area JMA 3. Destination codes are defined in Table 2 and tabulated catches are given in Appendix B.

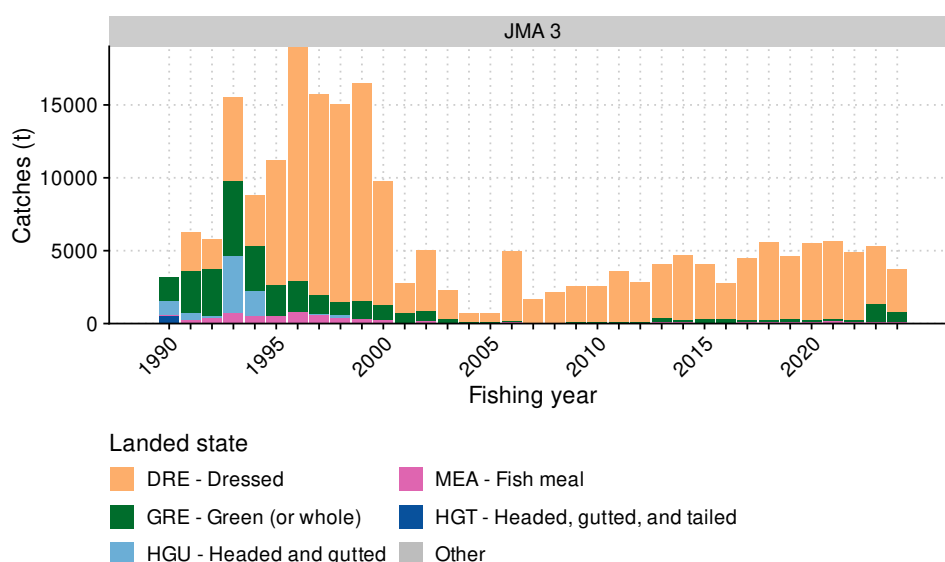


Figure 8: Product state of jack mackerels landings from Quota Management Area JMA 3. Catches are tabulated in Appendix B.

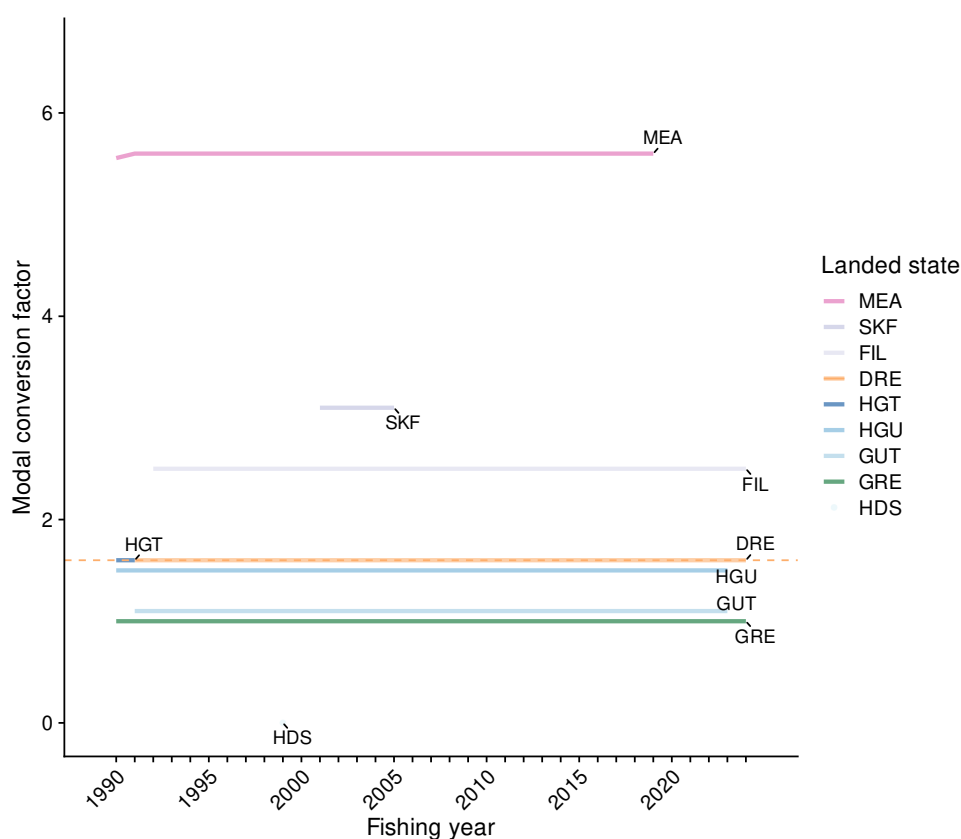


Figure 9: The modal annual conversion factor reported for the product states used in JMA 3 catches. The current statutory conversion factor is indicated by a dashed line for states where a species-specific value is defined. Tabulated results are provided in Table B.5, and landed state codes are defined in the glossary Table E.1.

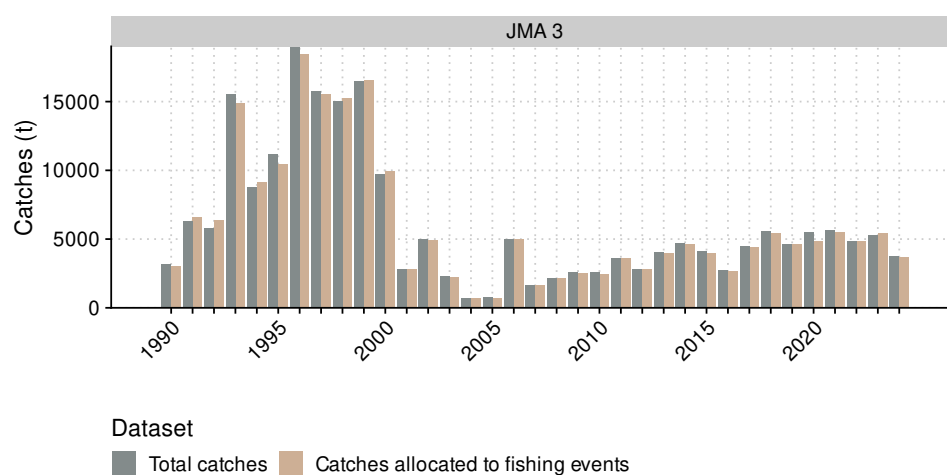


Figure 10: Total catches (t) of jack mackerels from JMA 3 in comparison with catches allocated to fishing events in the characterisation dataset.

Landings of JMA 3 were almost exclusively from trips that also recorded estimated catches; these estimates were scaled to landings by the allocation procedure (Figure 11a). Most landings were also recorded in daily processed catch data. Event-level estimated catches averaged 90.2% of landings, with an average of 91.1% of landings recorded in the daily processing data (Figure 11a,b).

During the 2000s, jack mackerel were typically recorded in around a fifth of the fishing events associated with trips that landed JMA 3 (Figure 11c), although this proportion dropped in the mid 2000s before increasing gradually to 2020. The proportion of days that had jack mackerel catches recorded also dropped from the mid 1990s to mid 2000s, but steadily increased from 2005 to 2024 (Figure 11d).

Electronic Reporting has been the dominant reporting method in the fishery since 2018 (Figure 12); prior to this most catch and effort was recorded via the Trawl, Catch, Effort and Processing Return (TCEPR) form. Most of the catch has been from midwater trawling (Figure 13), with a small, but ongoing, catch by bottom trawling. Purse seine catches reduced through the 1990s and have been insignificant since 2005.

In the midwater trawl fishery the jack mackerel catch arises from a mix of target fishing, and bycatch in tows targeting barracouta (Figure 14); bycatch in squid target midwater trawling was significant in the 1990s. The bottom trawl catch has arisen from a mix of target fishing, for both inshore and middle depths species, with little jack mackerel target bottom trawling since the early 2000s. The purse seine catch in the 1990s and early 2000s was mostly targeted fishing for jack mackerels, with some bycatch from kahawai target sets. Most of the catch by other methods was reported from squid jigging effort in 1998; while the 1998 quantity seems unusually high (Figure 14), it represents only a small proportion of the overall catch (Figure 14) and was not investigated further.

For target trawling, jack mackerel was usually the first ranked species in the reported estimated catch and typically had an average rank of 2–3 when taken as bycatch of barracouta or squid midwater trawl effort (Figure 15).

There are no indications that the transition to Electronic Reporting resulted in a change in the resolution of effort reporting for midwater trawling in JMA 3 (Figure 16). Bottom trawl reporting was more variable, reflecting a mix of inshore and deepwater fleet effort. Purse seine reporting clearly had an aberrant number of sets recorded for some events in 1994.

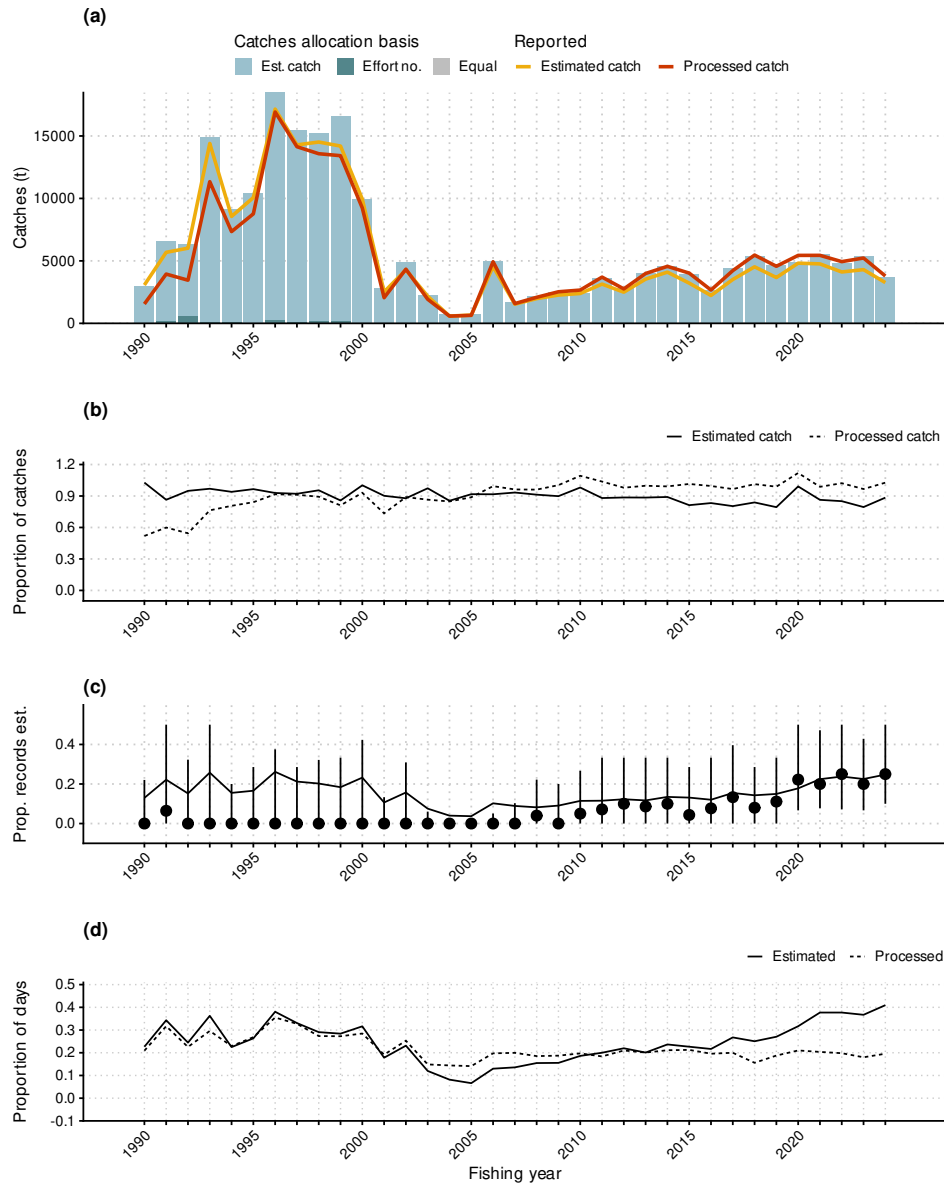


Figure 11: (a) bars: jack mackerels catches allocated to fishing events in the JMA 3 QMA with allocation method indicated by fill colour (see Section 2.3); lines: total estimated and processed catch of JMA; (b) the proportion of JMA 3 catches included in estimated and processed catch data; (c) the proportion of fishing event records with an estimated catch of JMA, with the line showing the overall proportion and the distributions illustrating the median and inter-quartile range by trip; (d) the proportion of vessel-days fished with a reported catch of JMA.

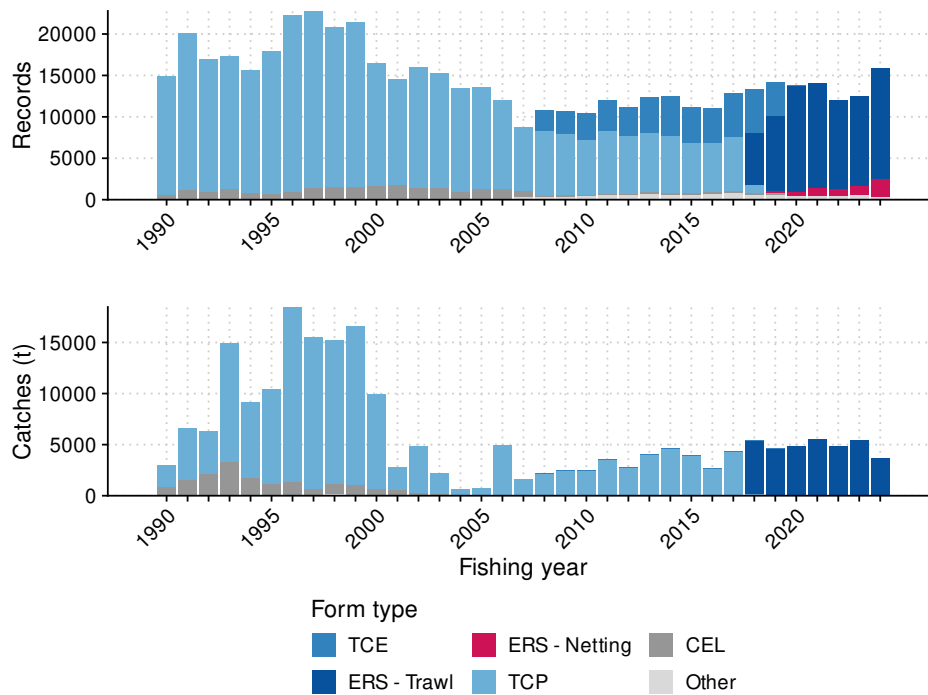


Figure 12: Reporting forms used on trips catching jack mackerels within the JMA 3 Quota Management Area, in terms of fishing event records and catches. Tabulated results are available in Appendix B. Form types grouped as Other include: ERS - Lining, ERS - Other Lining, ERS - Potting, ERS - Seining, HTC, LCE, LTC, NCE, SJC. A list of the main form type codes is included in the glossary Table E.2.

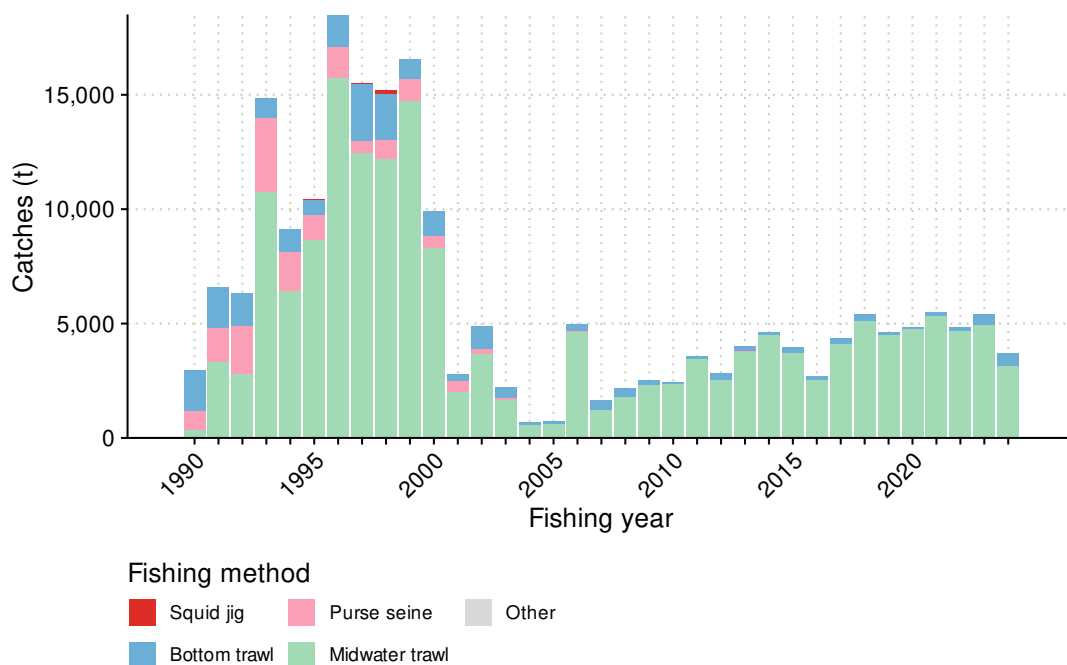


Figure 13: Catches of jack mackerels by fishing method, for events within the JMA 3 Quota Management Area. Methods grouped as Other include: BLL, BPT, BS, CP, D, DL, DN, DS, FP, HL, PL, POT, PRB, PRM, RLP, SN, T, TL. Tabulated results are provided in Appendix B, and a list of the main fishing method codes is included in the glossary Table E.3.

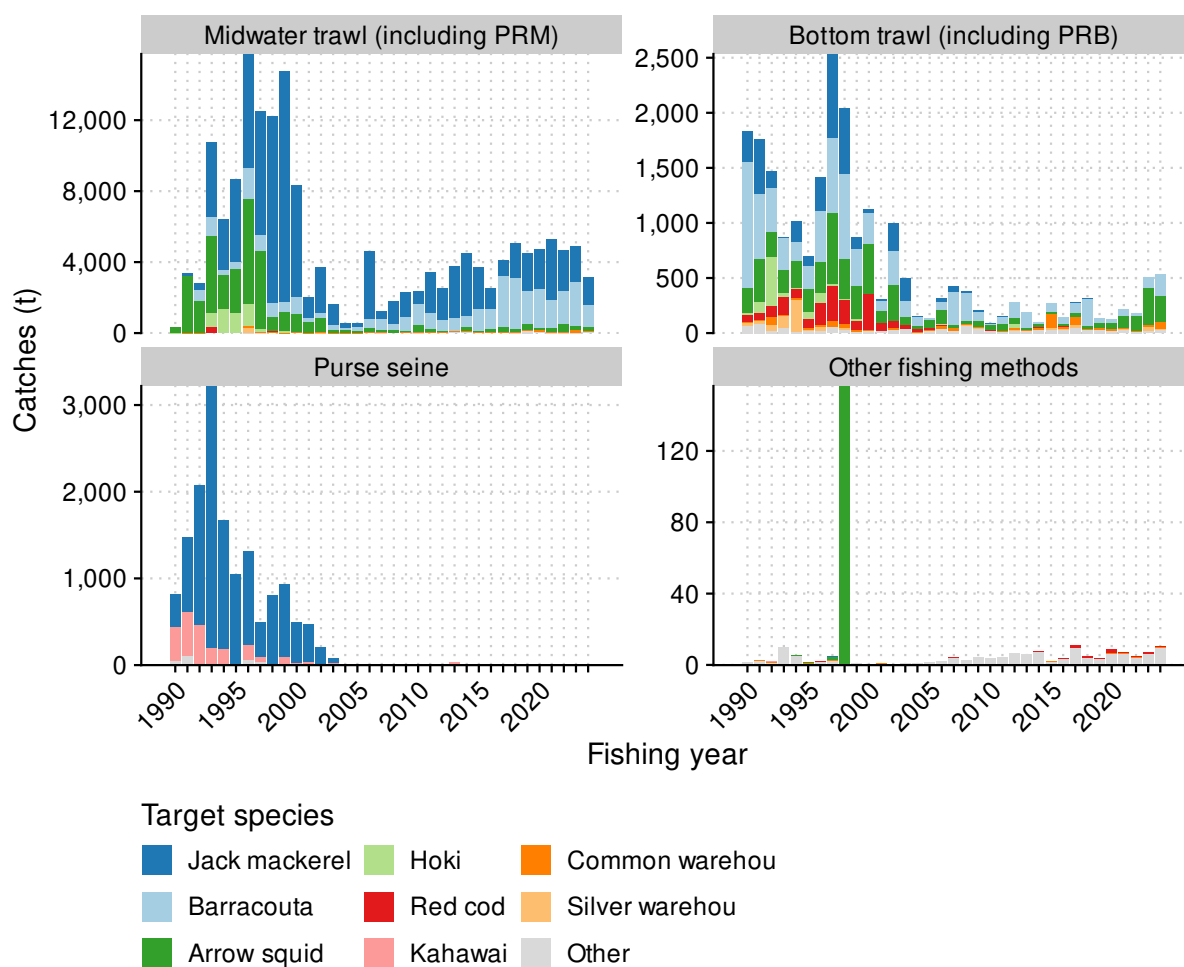


Figure 14: Catches of jack mackerels by fishing method and declared target species, for events within the JMA 3 Quota Management Area. Precision bottom trawl (PRB) catches are included with conventional bottom trawl (BT) catches, and precision midwater trawl (PRM) catches are included with conventional midwater trawl (MW) catches. Fishing methods grouped as Other include: BLL, BPT, BS, CP, D, DL, DN, DS, FP, HL, PL, POT, RLP, SJ, SN, T, TL. Species grouped as Other include target species with less than 3% of the jack mackerels catch within the JMA 3 Quota Management Area in a fishing year.

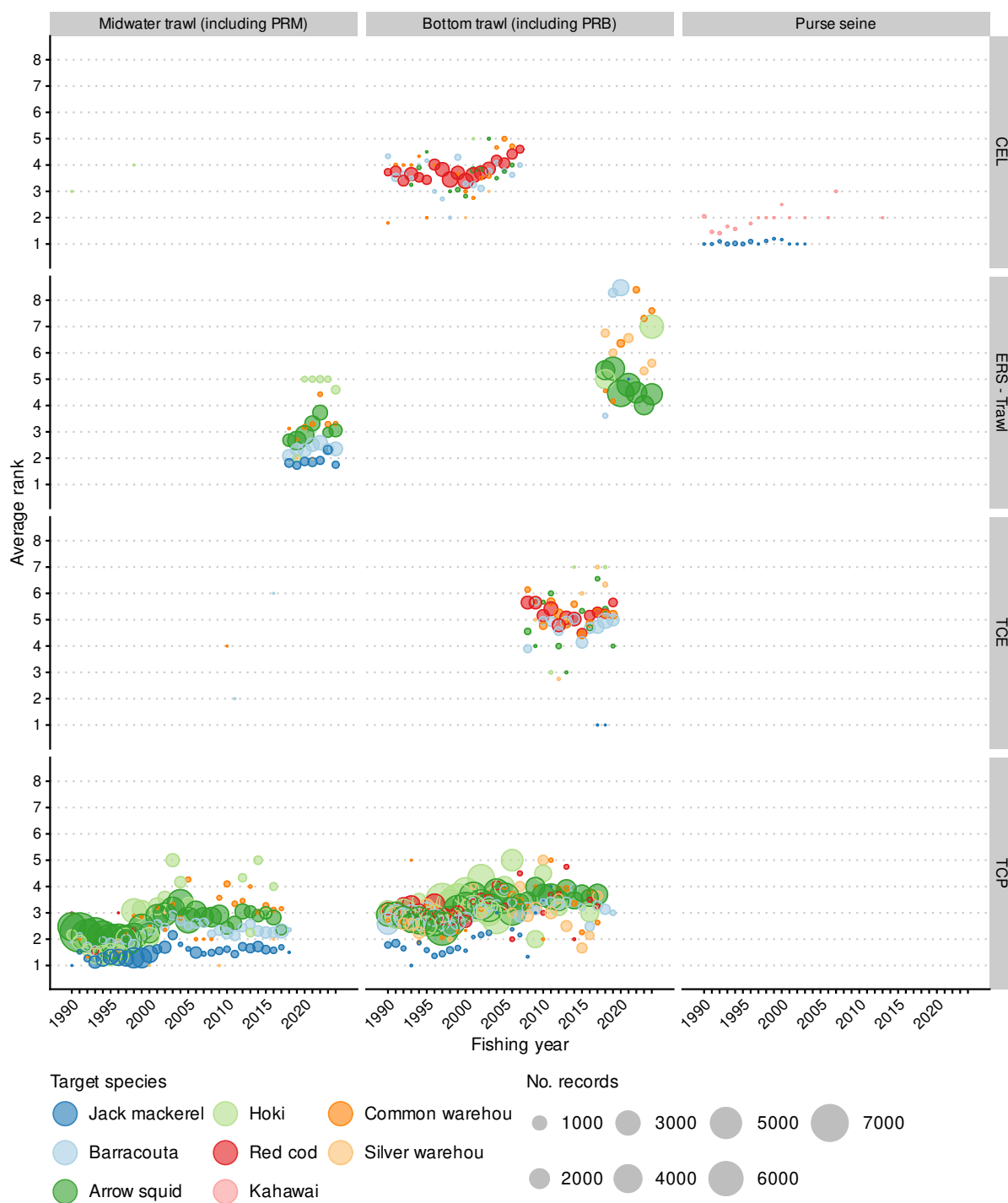


Figure 15: Average rank of jack mackerels in the estimated catch, by fishing method, form type and declared target species, for events with estimated catches within the JMA 3 Quota Management Area. The area of the circles scales with the number of records.

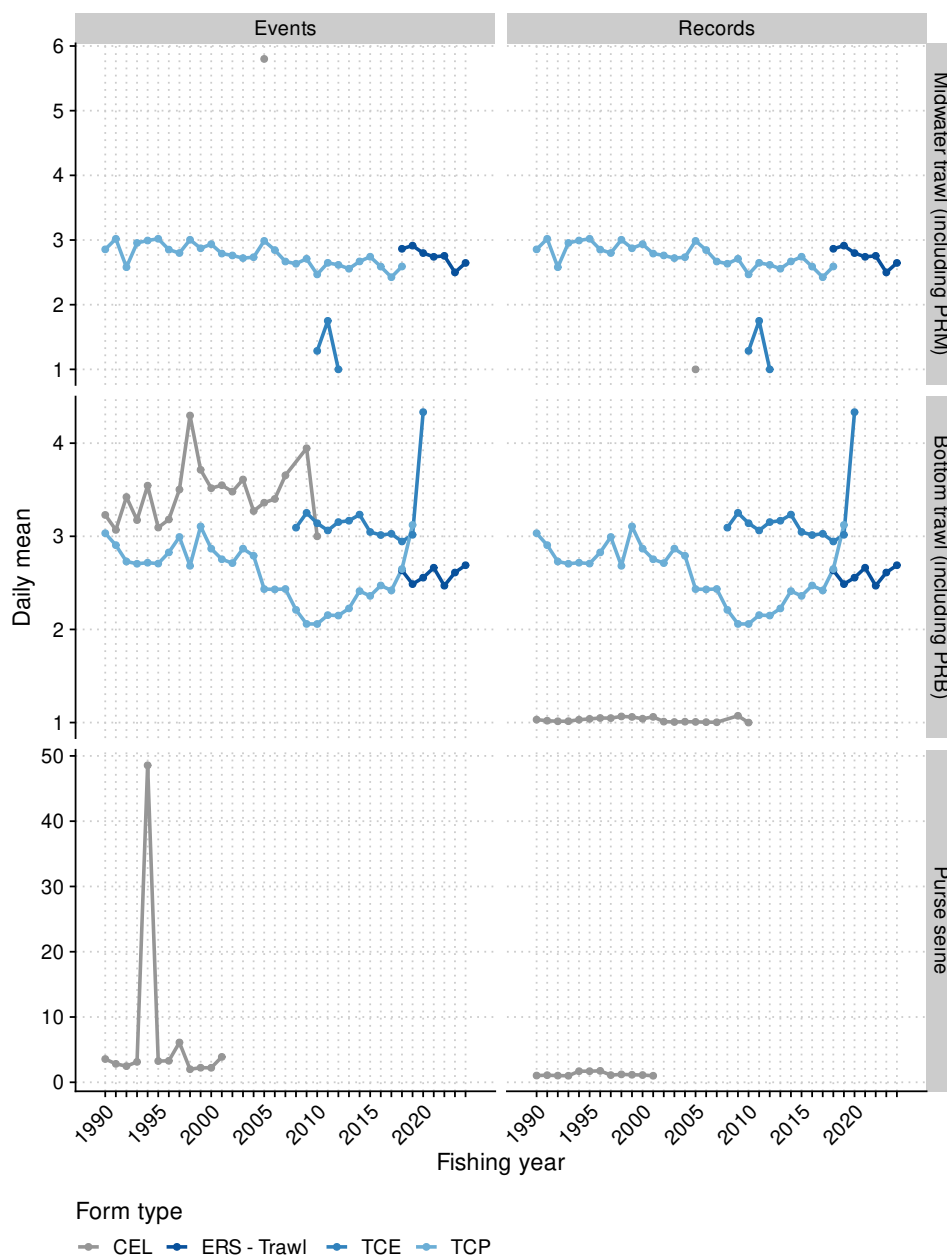


Figure 16: The mean number of fishing events and data records per vessel-day, by fishing method and reporting form, for effort within the JMA 3 QMA on trips landing catch from JMA 3. Data are included for years where a form was used on at least five vessel-days.

3.1 The midwater trawl (including PRM) fishery

All midwater trawl catch and effort in JMA 3 has been recorded with fine scale (tow-level latitude and longitude) spatial information since 1990 (Figure 17). Three main regions of jack mackerel catch by the midwater trawl fishery are evident: (i) the Stewart-Snares shelf (extending to the Auckland Islands, Statistical Area 602, in the earlier periods), (ii) the east coast off the Banks Peninsula, and the western Chatham Rise, especially the Mernoo Bank, and (iii) around the Chatham Islands (Figure 18). Jack mackerel and barracouta were targeted in all three regions, while squid target effort was primarily in the southern region and, more recently, on the Mernoo Bank (Figure 19). The overall fishery extents have increased during the last three decades (Figure 20).

In the southernmost region, the jack mackerel catch has been greatest, and most consistent, in Statistical Area 028 at the southern extent of the Stewart-Snares shelf (Figure 21). Catches from that area peaked in 1999, declined in the early 2000s, but have been more consistent since 2010. In the most southerly areas (such as Statistical Area 602 around the Auckland Islands), catches of jack mackerels were only recorded for a couple of years in the mid 1990s.

Catches off the east coast of the South Island and western Chatham Rise (primarily in Statistical Areas 021 and 022) have shown considerable inter-annual variation, but have been generally more consistent over time than those in the southern region. The largest catches around the Chatham Islands (in Statistical Areas 049, 050 and 052) have been higher since 2015 (Figure 21).

The main midwater trawl fisheries, targeting jack mackerel, barracouta, and squid, show a similar seasonal pattern in their jack mackerel catches that primarily occur from December through to May (Figure 22). This is consistent with the seasonal operating patterns of the deepwater fleet (Middleton et al. 2024).

The majority of the midwater trawl effort on trips catching JMA 3 was carried out near the sea floor (Figure 23). Target jack mackerel effort was focussed in depths of 100 m to 200 m (Figure 24). Barracouta and squid target effort had a similar depth range, with jack mackerels caught throughout the depth range of the barracouta fishery, but more frequently in the shallower parts of the squid fishery. Most hoki target effort was deeper, from 400 m to 700 m; jack mackerels were caught throughout the depth range of the hoki fishery but the catch-weighted distribution illustrates that jack mackerel catches tended to be greater in the shallower parts of the hoki fishery.

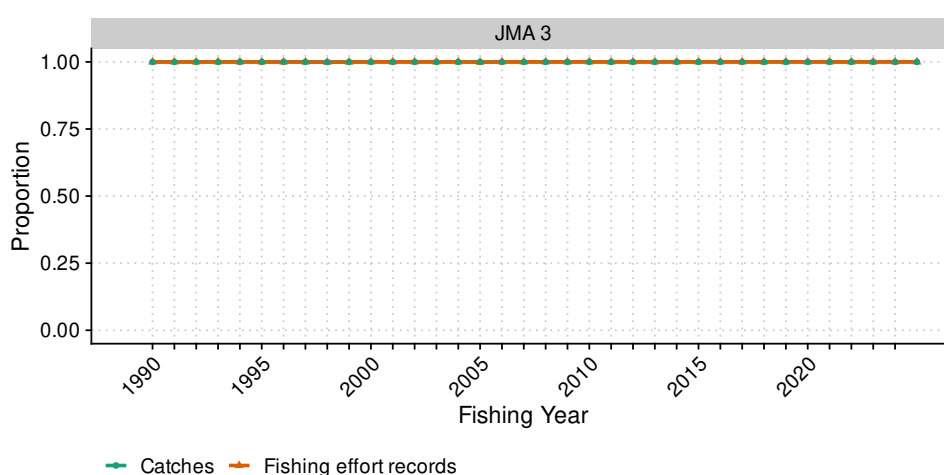


Figure 17: The proportion of records and catches reported with a latitude/longitude for the JMA 3 midwater trawl (including PRM) fishery.

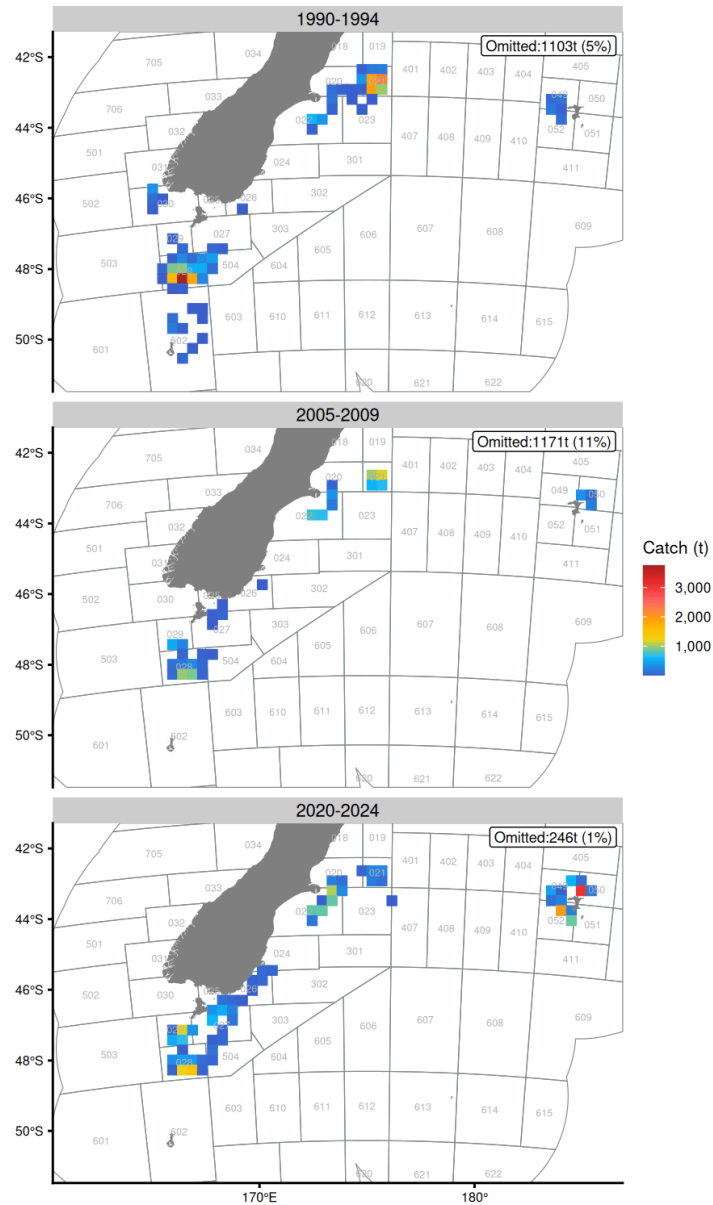


Figure 18: Catches (t) for the JMA 3 midwater trawl (including PRM) fishery, for 5-year periods within the era during which at least 80% of catch was reported with spatial information. These plots use a 32 km grid and include records where catches were allocated in proportion to estimated catch. Cells with data from less than three vessels or permit holders are omitted; the quantity of catch affected is indicated on each panel.

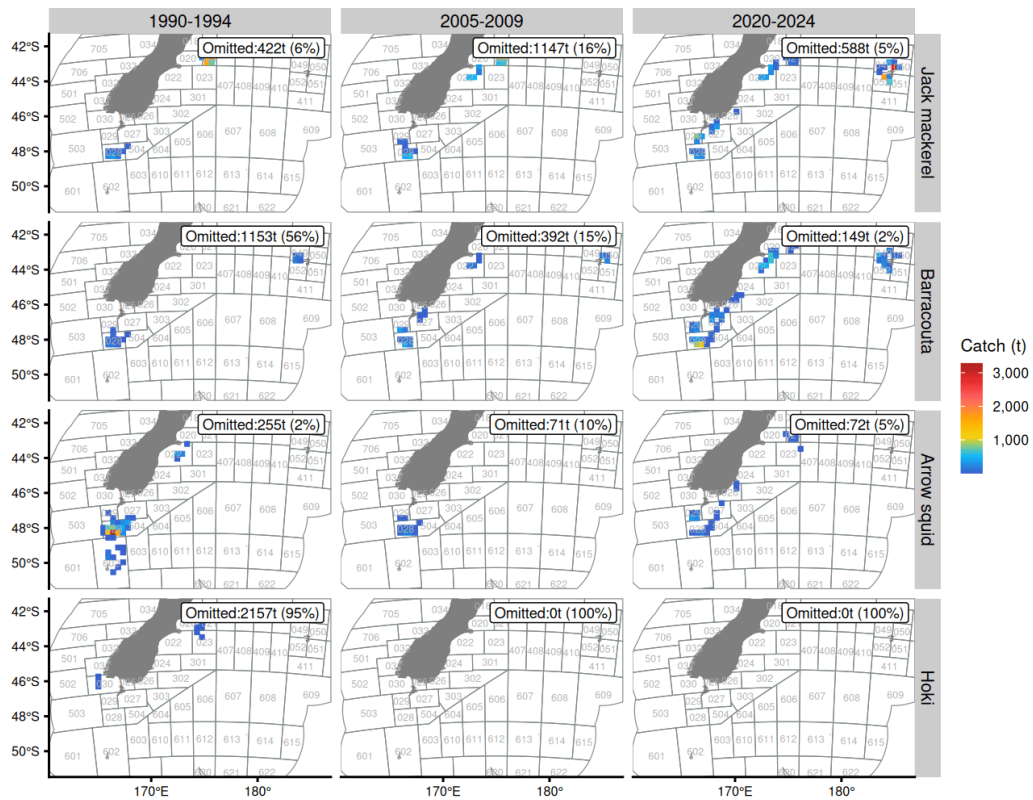


Figure 19: Catches of jack mackerels from the midwater trawl (including PRM) fishery by key target species. These plots use a 32 km grid and include records where landings were allocated in proportion to estimated catch. Cells with data from less than three vessels or permit holders are omitted; the quantity of catch affected is indicated on each panel.

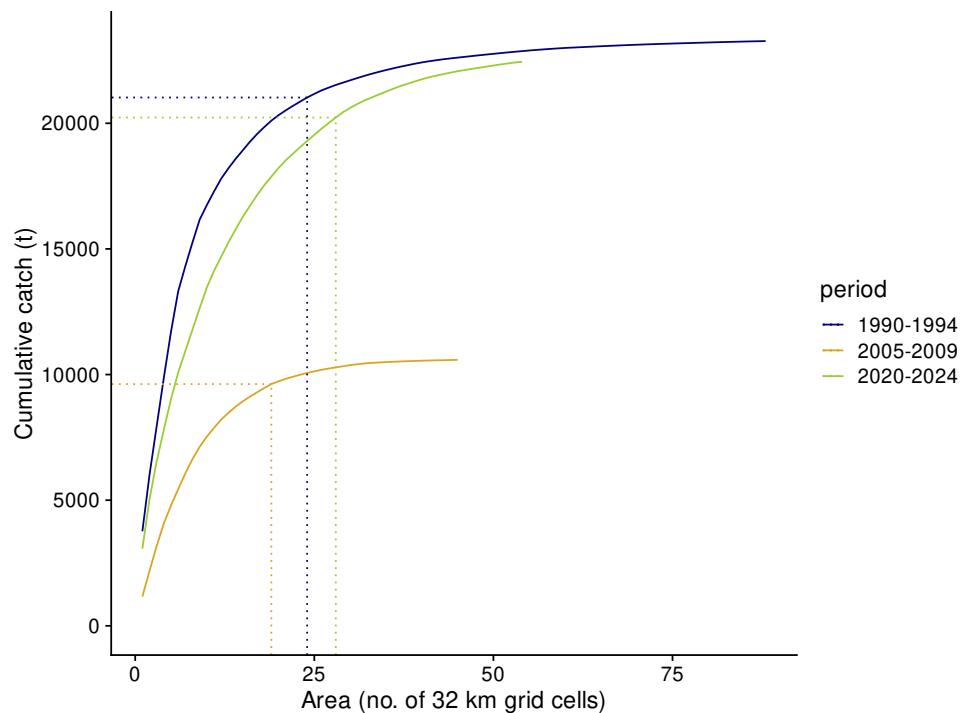


Figure 20: Cumulative JMA 3 catch by area (grid cells) for the midwater trawl (including PRM) fishery, aggregated for the first, middle, and last 5-year period of reporting. Dotted lines indicate the 90th percentile for the first, middle, and last 5-year period of reporting.

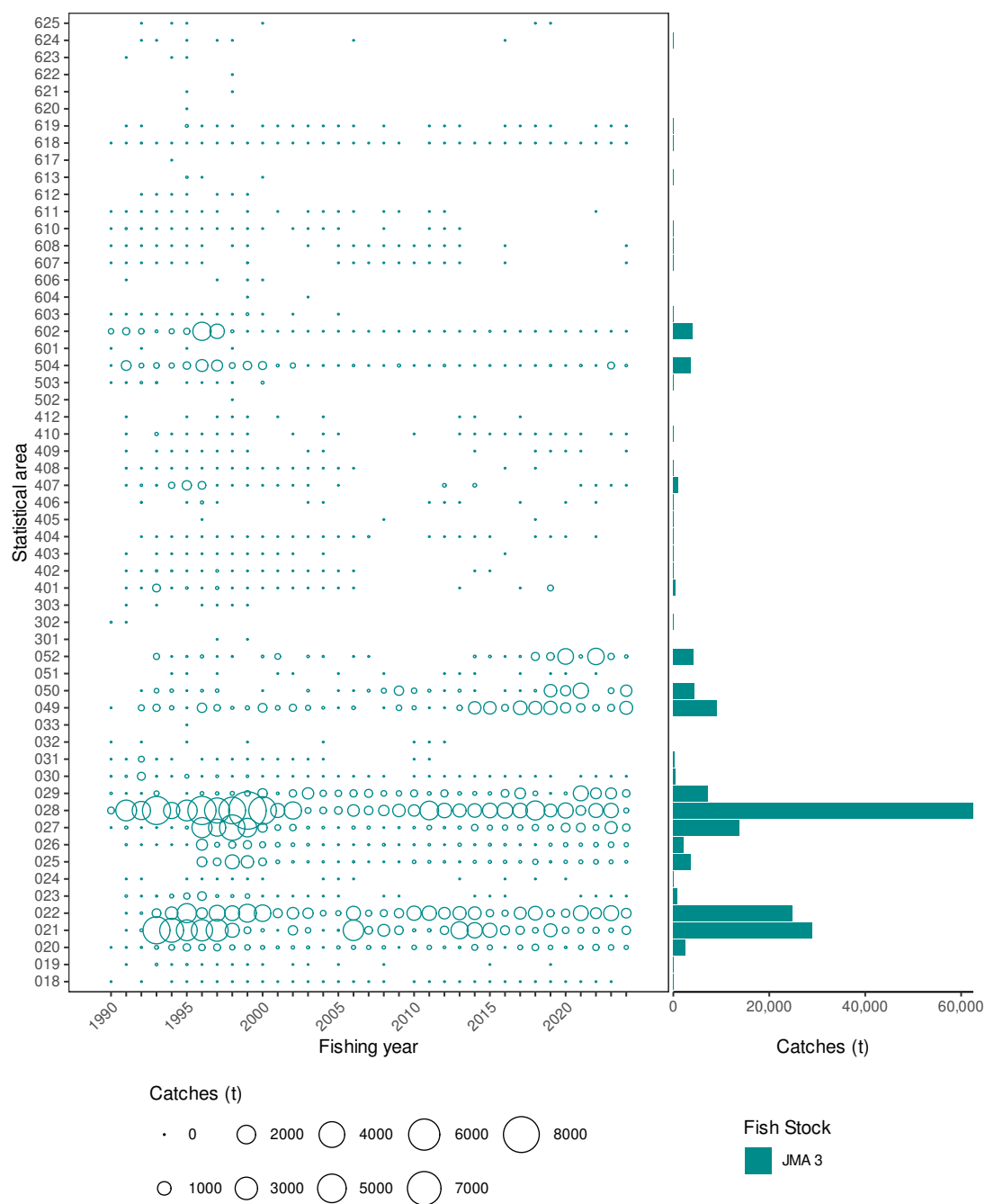


Figure 21: Annual JMA 3 catches (t) by statistical area for the midwater trawl (including PRM) fishery. The circle size scales with the catches by statistical area. The bar plot (right) shows the total catches of JMA 3 for each statistical area.

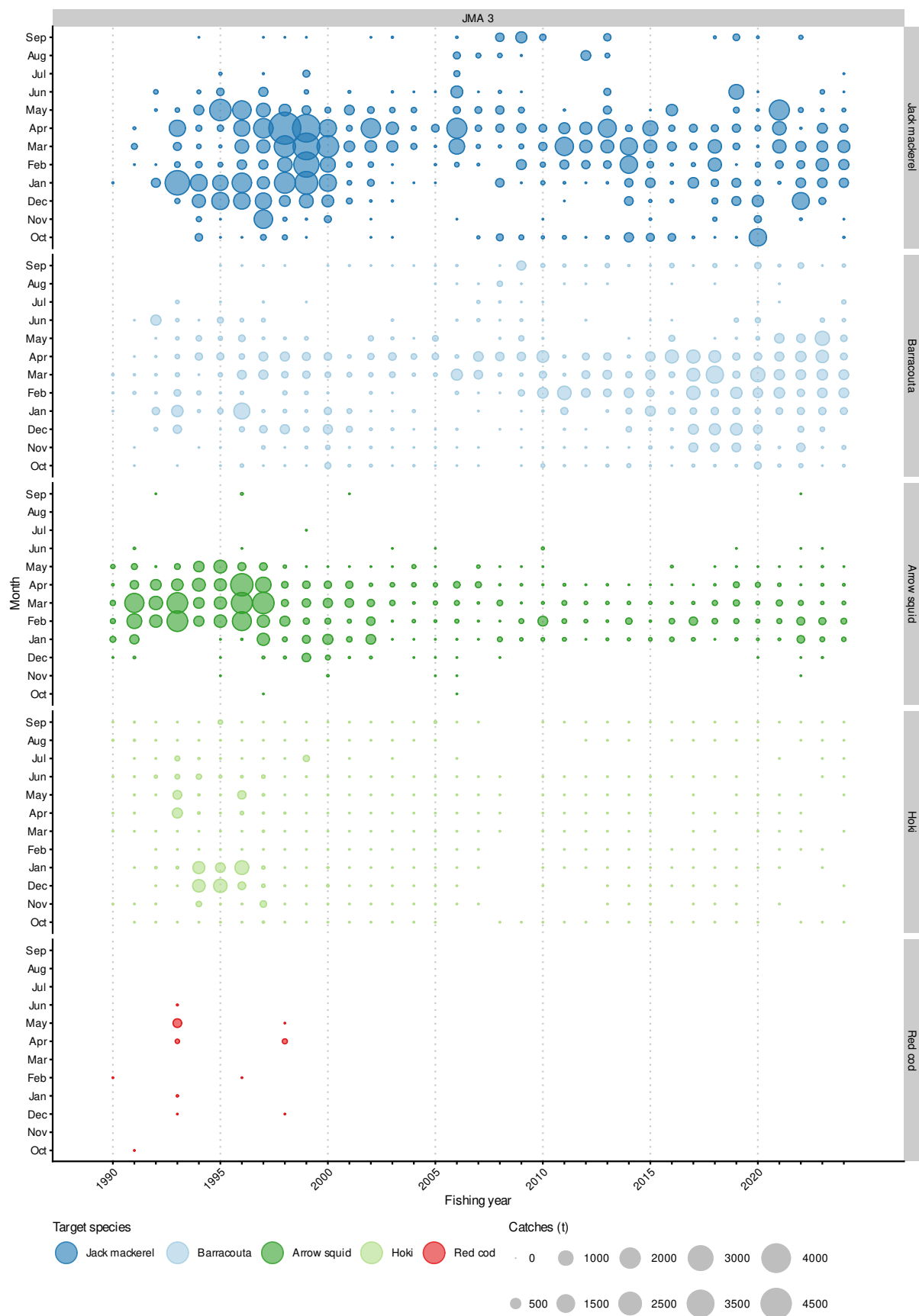


Figure 22: Seasonal distribution of JMA 3 catches by month and fishing year for the midwater trawl (including PRM) target fisheries. The area of the circle scales with the monthly catches.

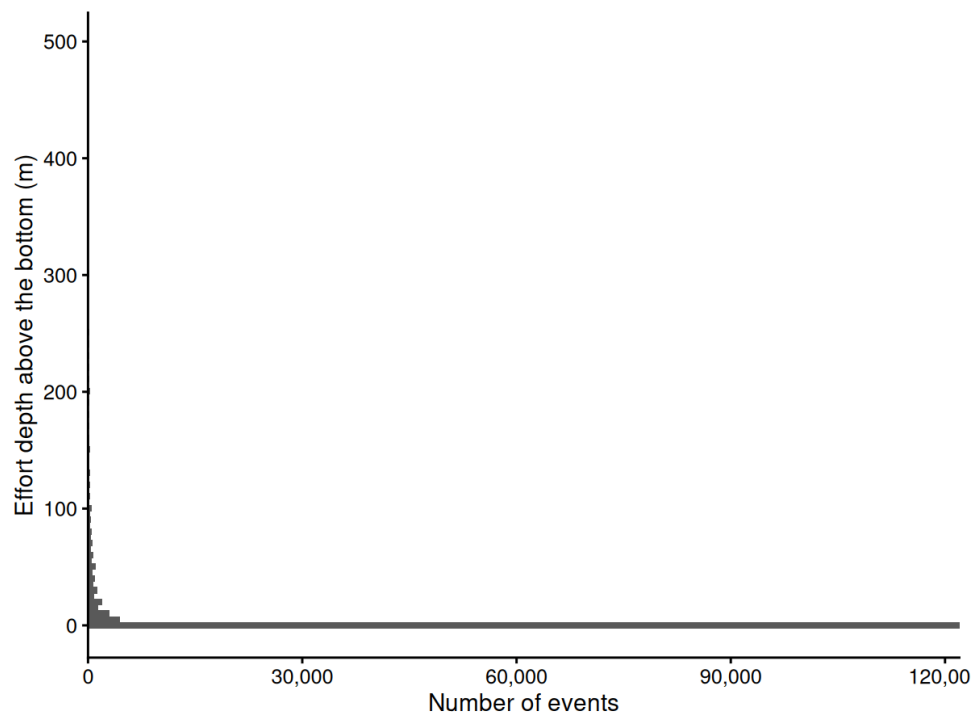


Figure 23: Distribution of the distance of fishing effort from the bottom for trips landing JMA 3 from the midwater trawl (including PRM) fishery.

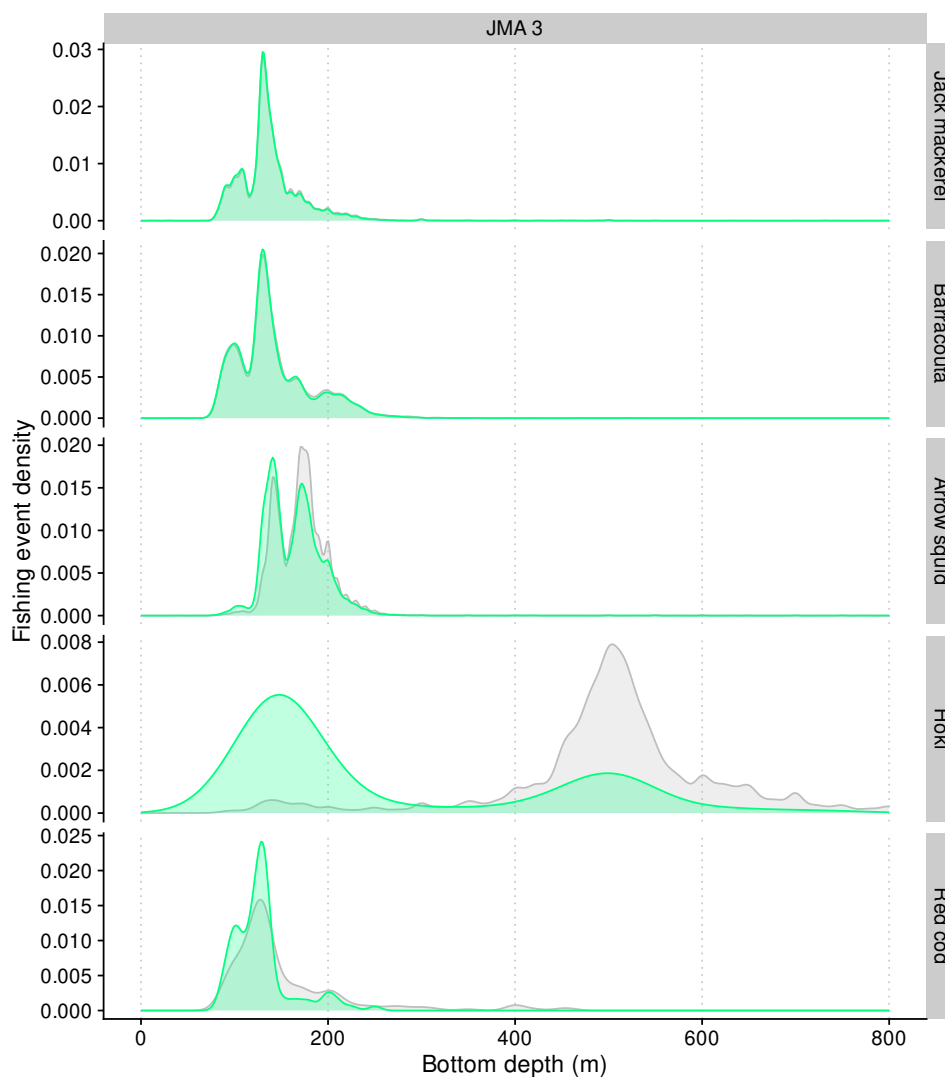


Figure 24: distribution by target species for trips landing JMA 3 from the midwater trawl (including PRM) fishery. Target species are included if they are represented in at least 30 events. Grey fill = total effort, green fill = positive effort (i.e., estimated catch > 0).

3.2 The bottom trawl (including PRB) fishery

In most years, over 80% of bottom trawl effort on trips landing JMA 3 was recorded with spatial information (Figure 25); with comprehensive spatial catch and effort available from 2008 after the introduction of the TCER form. Bottom trawl catches occurred over a similar geographic range to those in the midwater trawl fishery, but showed greater continuity off the east coast of the South Island (Figure 26). Bottom trawl catches around the Chatham Islands have reduced in the later period.

Bottom trawl catches off the east coast of the South Island were evident from jack mackerel, barracouta, squid, and hoki target tows, but the bottom trawl catch around the Chatham Islands was largely from barracouta target effort (Figure 27). The spatial extent of the bottom trawl catch of jack mackerels has decreased over time (Figure 28). Recent catches of jack mackerels by bottom trawl have predominantly been taken in Statistical Areas 027, 028, and 029 (Figure 29).

There is little seasonality evident in the catches of jack mackerel by bottom trawl, other than for squid target effort (Figure 30). Target jack mackerel bottom trawling effort had a somewhat broader depth range than that of the midwater fishery, operating from 100 m to 350 m (Figure 31). Barracouta target bottom trawl effort was somewhat shallower, and squid effort slightly deeper, with jack mackerels caught throughout the depth range of these fisheries.

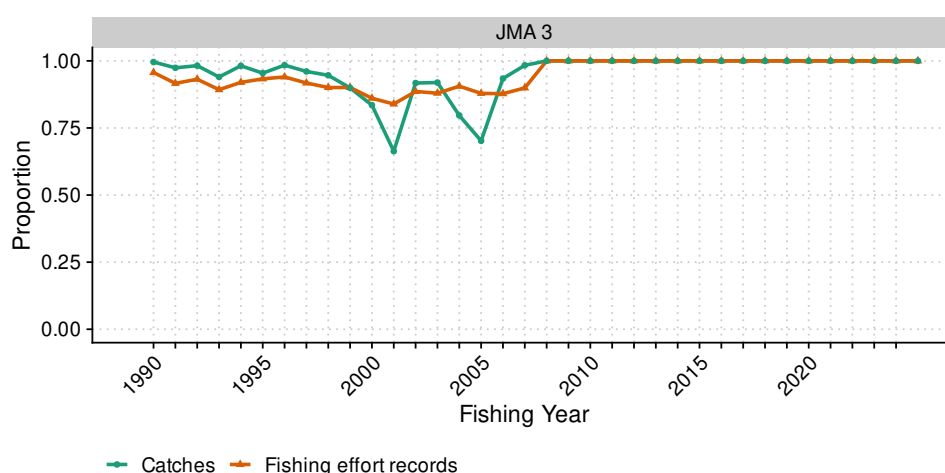


Figure 25: The proportion of records and catches reported with a latitude/longitude for the JMA 3 bottom trawl (including PRB) fishery.

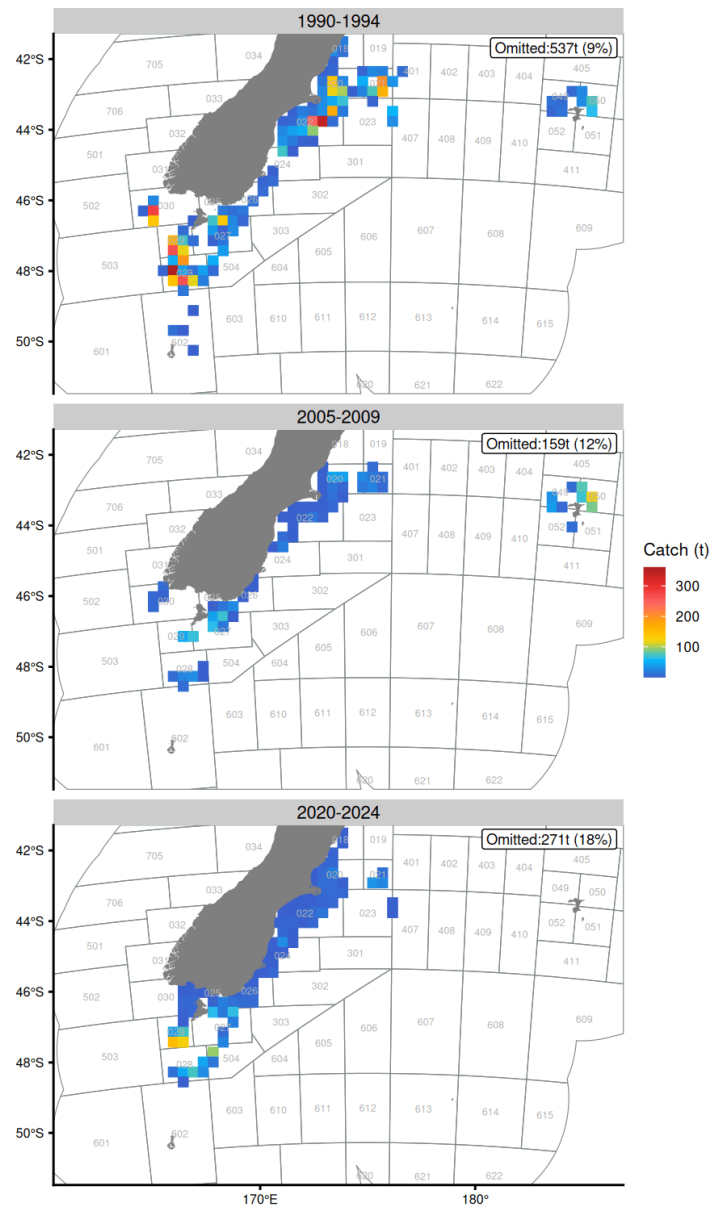


Figure 26: Catches (t) for the JMA 3 bottom trawl (including PRB) fishery, for 5-year periods within the era during which at least 80% of catch was reported with spatial information. These plots use a 32 km grid and include records where catches were allocated in proportion to estimated catch. Cells with data from less than three vessels or permit holders are omitted; the quantity of catch affected is indicated on each panel.

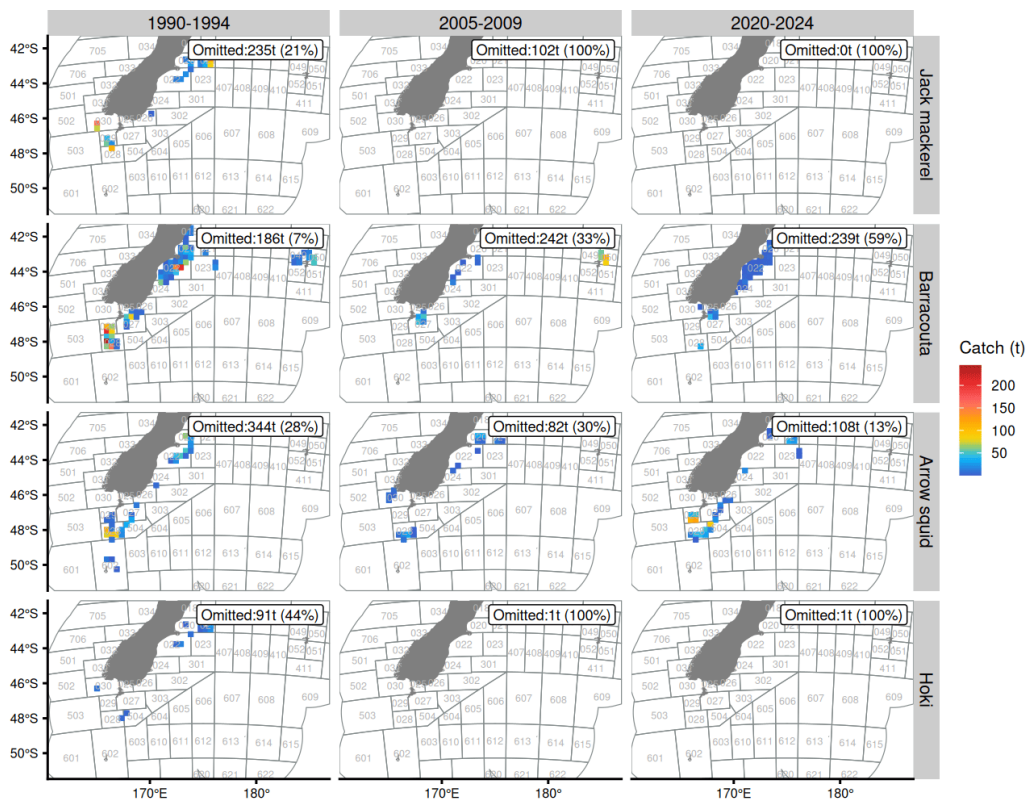


Figure 27: Catches of jack mackerels from the bottom trawl (including PRB) fishery by key target species. These plots use a 32 km grid and include records where landings were allocated in proportion to estimated catch. Cells with data from less than three vessels or permit holders are omitted; the quantity of catch affected is indicated on each panel.

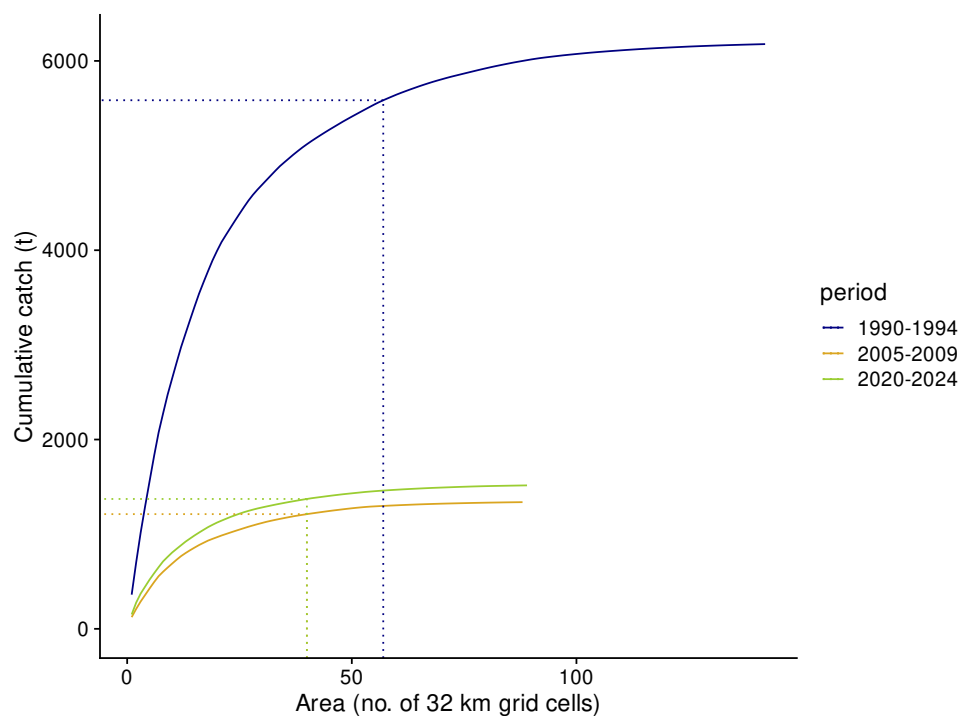


Figure 28: Cumulative JMA 3 catch by area (grid cells) for the bottom trawl (including PRB) fishery, aggregated for the first, middle, and last 5-year period of reporting. Dotted lines indicate the 90th percentile for the first, middle, and last 5-year period of reporting.

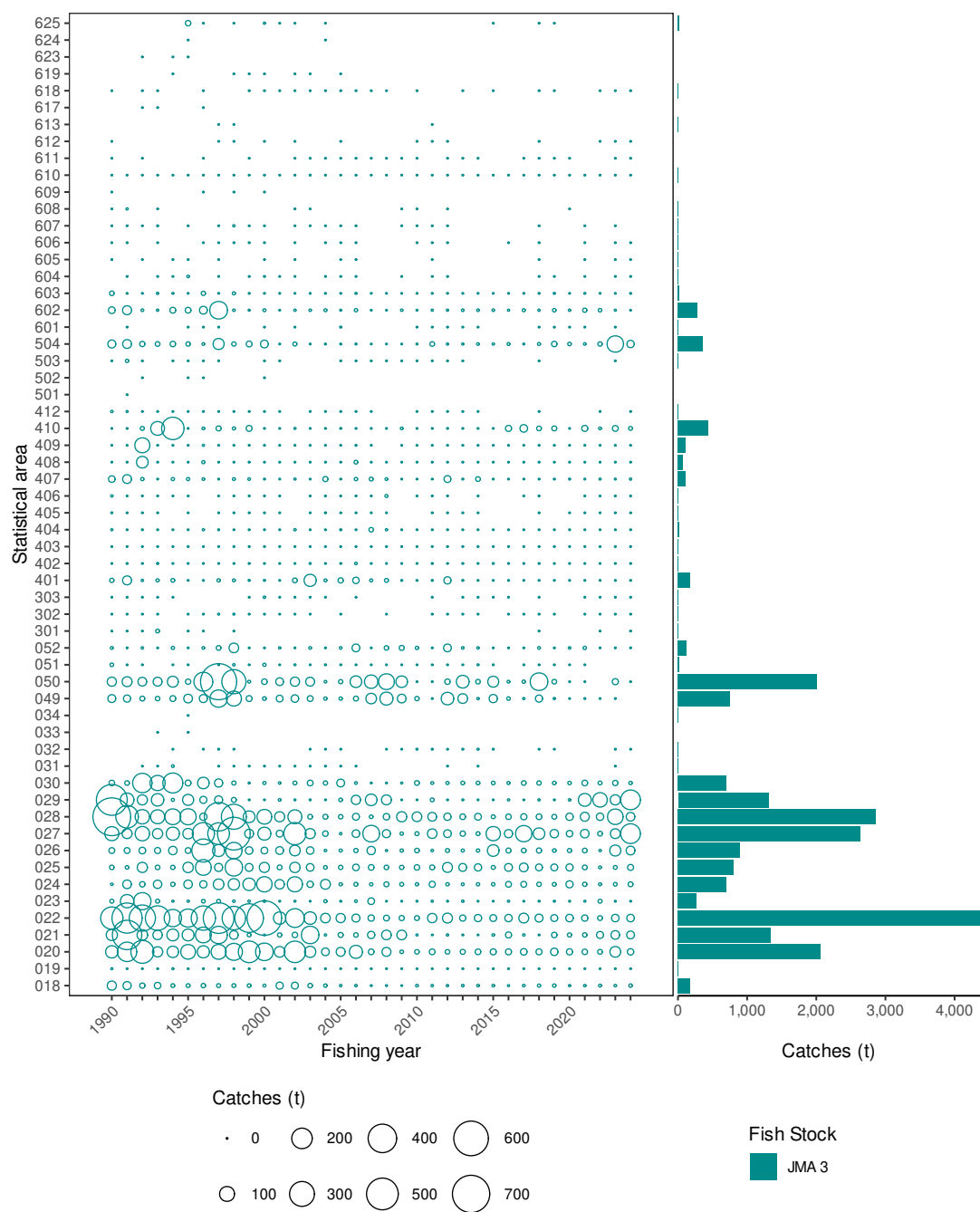


Figure 29: Annual JMA 3 catches (t) by statistical area for the bottom trawl (including PRB) fishery. The circle size scales with the catches by statistical area. The bar plot (right) shows the total catches of JMA 3 for each statistical area.

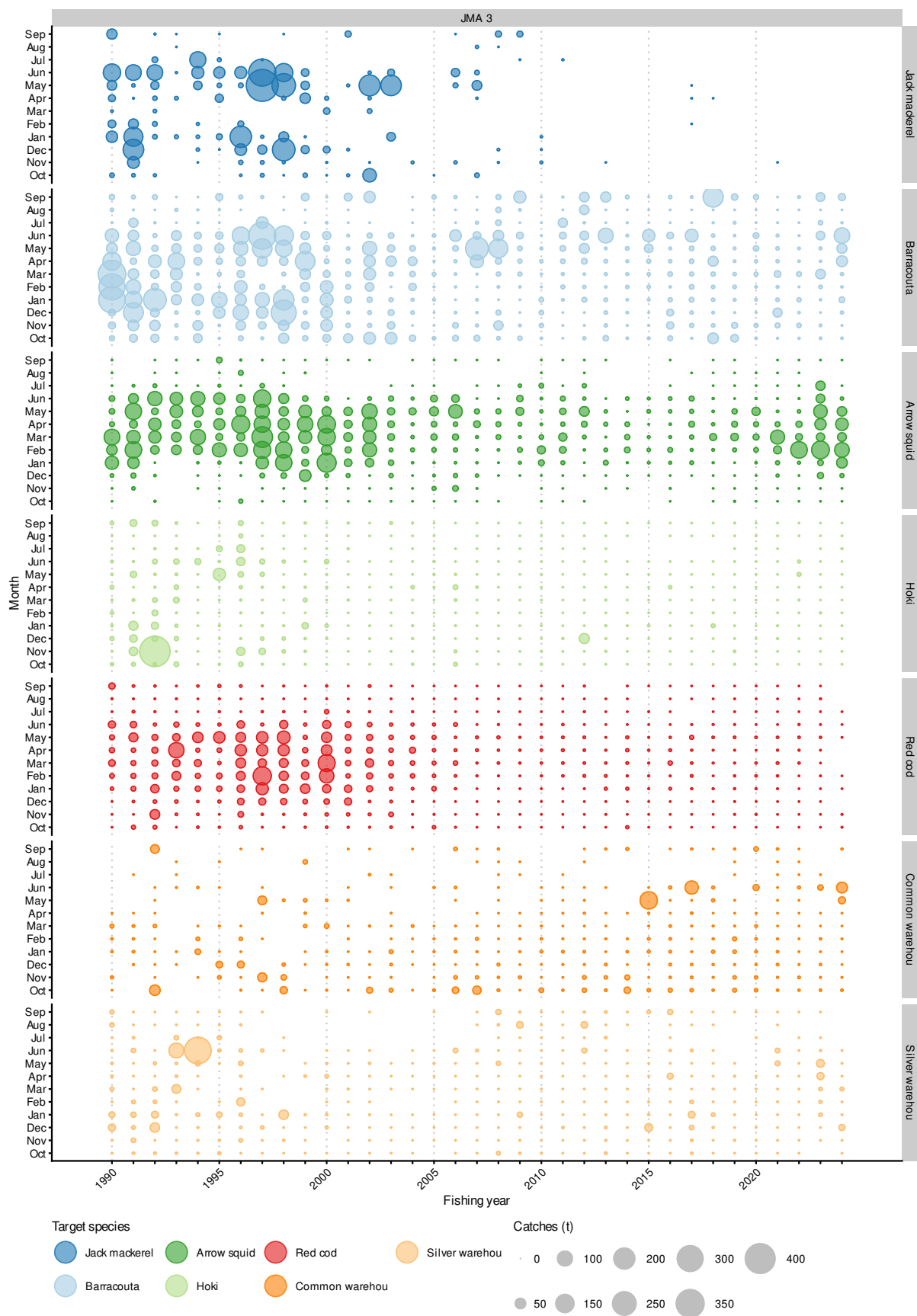


Figure 30: Seasonal distribution of JMA 3 catches by month and fishing year for the bottom trawl (including PRB) target fisheries. The area of the circle scales with the monthly catches.

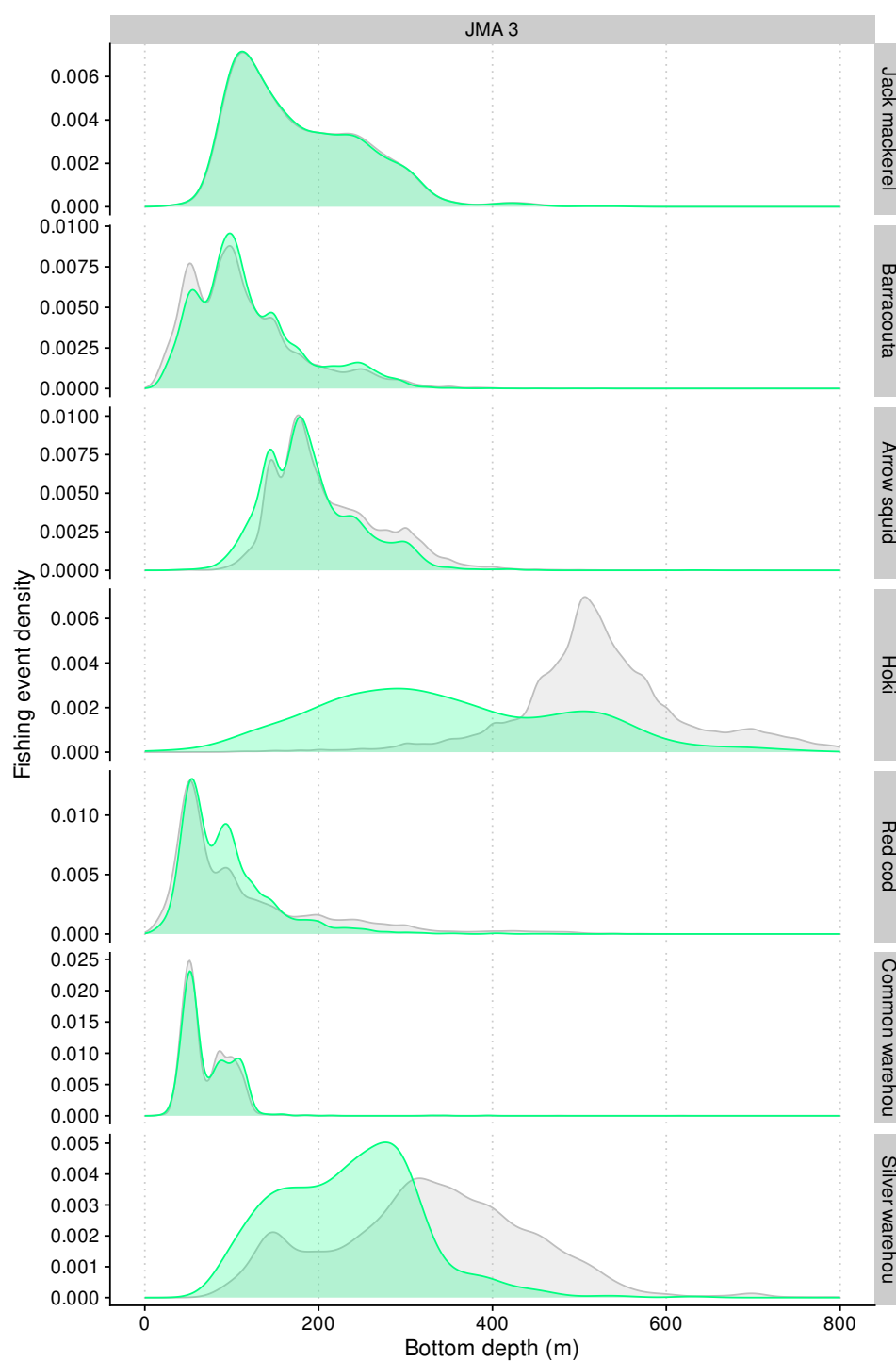


Figure 31: distribution by target species for trips landing JMA 3 from the bottom trawl (including PRB) fishery. Target species are included if they are represented in at least 30 events. Grey fill = total effort, green fill = positive effort (i.e., estimated catch > 0).

3.3 The purse seine fishery

Purse seine fishing has been reported from a range of Statistical Areas, but the majority of the purse seine catch was taken from Statistical Area 018, off Kaikoura (Figure 32).

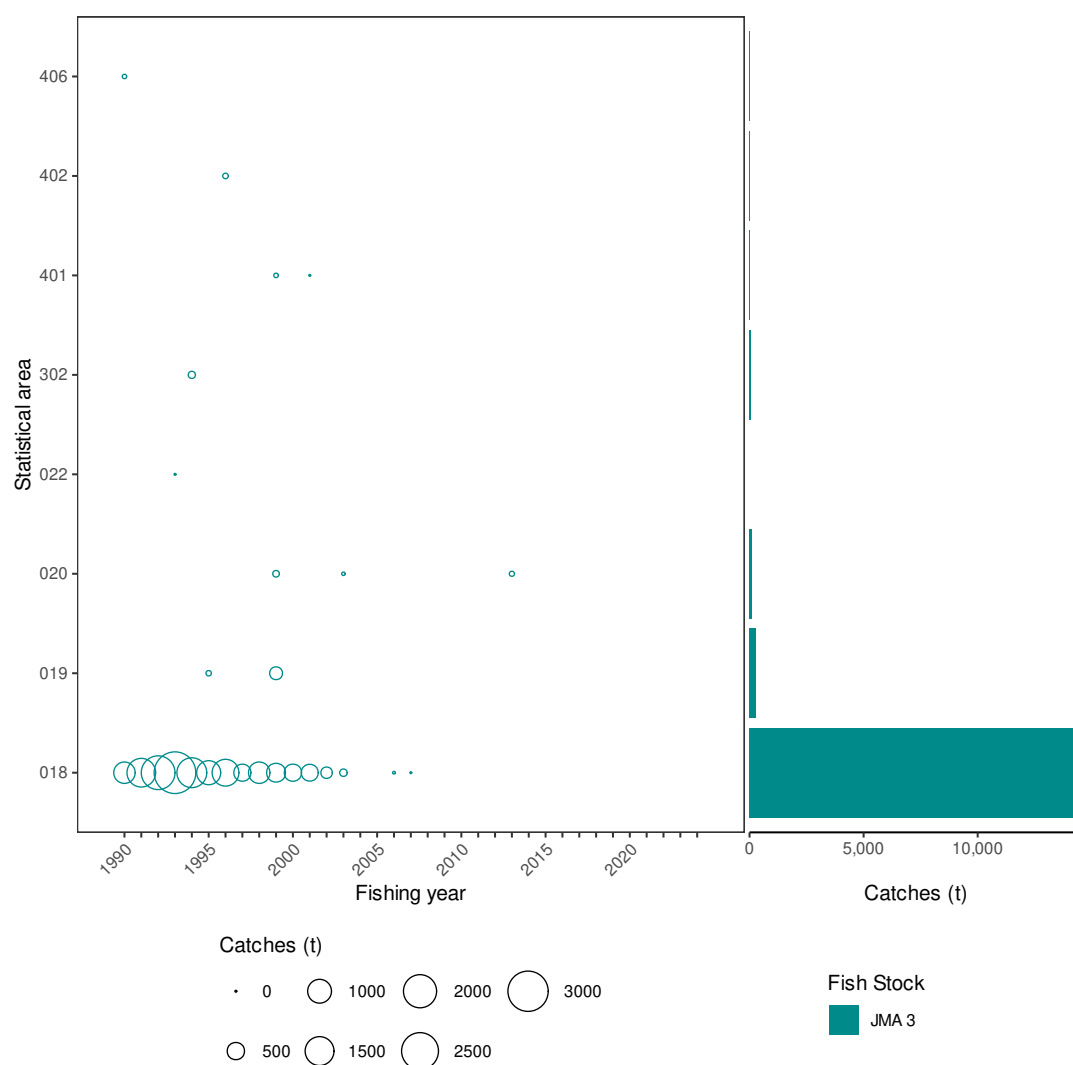


Figure 32: Annual JMA 3 catches (t) by statistical area for the purse seine fishery. The circle size scales with the catches by statistical area. The bar plot (right) shows the total catches of JMA 3 for each statistical area.

4. OBSERVER SAMPLING

Because the QMS data from the jack mackerel fisheries report all catches against the JMA species-group code, additional data are required to separate catches into the three jack mackerel species. In JMA 3, these data are provided by Fisheries New Zealand observers (although some shore based sampling was conducted in Nelson historically; see Taylor & Julian 2008).

During the processing of jack mackerel catches, observers take random samples of the jack mackerel catch and record the species and the length of the fish in the sample (the Fisheries New Zealand Observer Programme confirmed that JMA 3 sampling protocols match those used in JMA 7; these are available as appendices given by Middleton 2022).

Observer data are labelled with the observer Fisheries Management Area (FMA) in which they were collected; there are five such FMAs within the JMA 3 Quota Management Area (Figure 33). A summary of the observer length-frequency sampling for jack mackerels in JMA 3 to 2024 (Table 4) shows that sampling has predominantly been from the midwater trawl fishery; however, sample sizes were an order of magnitude smaller than those available from the JMA 7 fishery (Middleton et al. 2024, table 4).

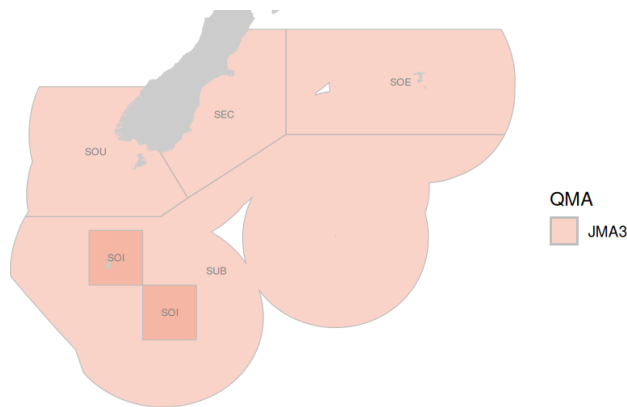


Figure 33: Observer Fisheries Management Areas in relation to the Quota Management Areas (QMA) for jack mackerels.

Table 4: Length-frequency samples of jack mackerels by area and method, sampled by the Observer Programme from fishing years 1987 to 2024. Observer Fisheries Management Area (FMA) codes and method codes are defined in the glossary.

QMA	Observer FMA	Method	Sampled events	Number of fish
JMA3	SEC	BT	35	1 149
JMA3	SEC	MW	766	48 271
JMA3	SEC	SN	1	35
JMA3	SOE	BT	39	2 181
JMA3	SOE	MW	282	17 352
JMA3	SOI	BT	7	300
JMA3	SOI	BT	7	300
JMA3	SOI	MW	53	2 505
JMA3	SOI	MW	53	2 505
JMA3	SOU	BT	191	5 159
JMA3	SOU	MW	1 000	60 227

During the 1990s, and up to 2002, observers recorded data from an average of 810 tows per annum with jack mackerel catches (590 midwater and 220 bottom trawl), and obtained species-specific length-frequency samples from 6% of recorded events with most of these samples coming from midwater trawls (Figure 34). From 2003 to 2011 the reduced fishery saw observed tows drop to an average of 350 tows per annum, with very little length-frequency sampling.

The numbers of observed tows increased from the early 2010s, with data recorded from an average of 1600 tows per annum between 2012 and 2024 (1050 midwater and 540 bottom trawl). Species-specific length-frequency samples were mainly obtained from the midwater fishery, with sampling of an average of 10% of observed tows. This contrasts with the level of sampling in the JMA 7 fishery, where 30% of observed tows that caught jack mackerels from 2012 to 2022 had length-frequency samples taken (Middleton et al. 2024). Observers were more likely to take a jack mackerel length-frequency sample when jack mackerels were the target species of the tow (Figure 35).

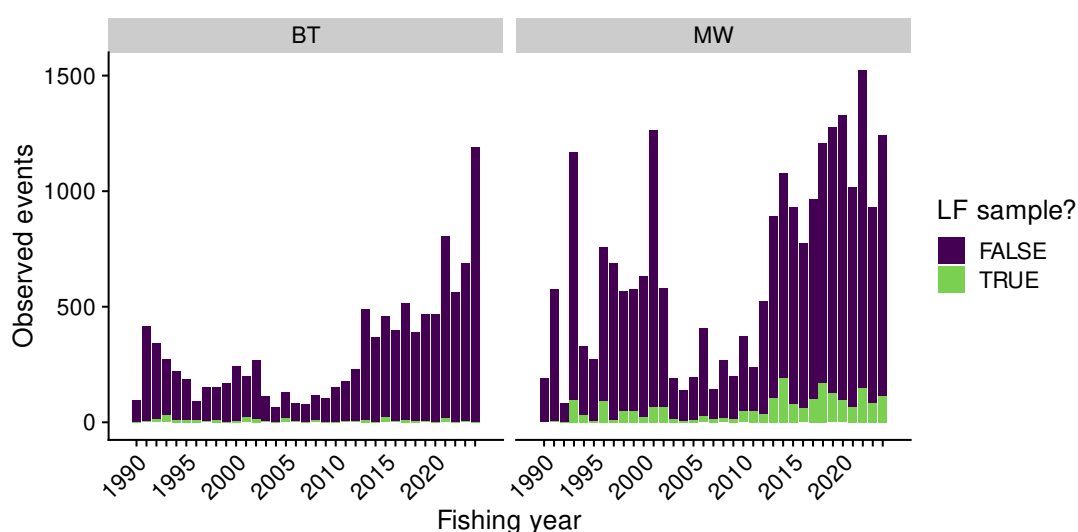


Figure 34: Observed trawl fishing events in JMA 3 where JMA was caught, with and without length-frequency sampling, by fishing year and method.

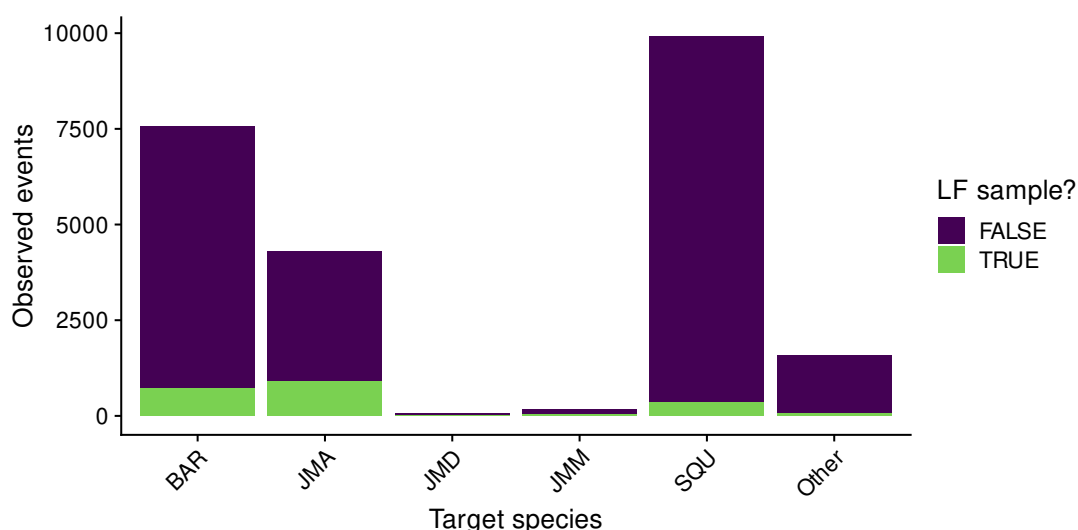


Figure 35: Observed midwater trawl fishing events in JMA 3 where JMA was caught, with and without length-frequency sampling, by observer assessed target species.

4.1 Sampling representativeness

The representativeness of observer length-frequency sampling of the midwater trawl fishery is illustrated for month in Figures 36 and 37, for latitude in Figures 38 and 39, and for longitude in Figures 40 and 41.

Seasonal representativeness of the sampling was patchy in the 1990s and 2000s. This improved after 2013, although sampling was consistently low in August and September. Latitudinal representativeness of the sampling was better than seasonal representativeness for most of the time series, but longitudinal representativeness tended to be inconsistent until after 2013. Even in this more recent period, sampling of the easternmost areas of the fishery (i.e., around the Chatham Islands) has typically been limited.

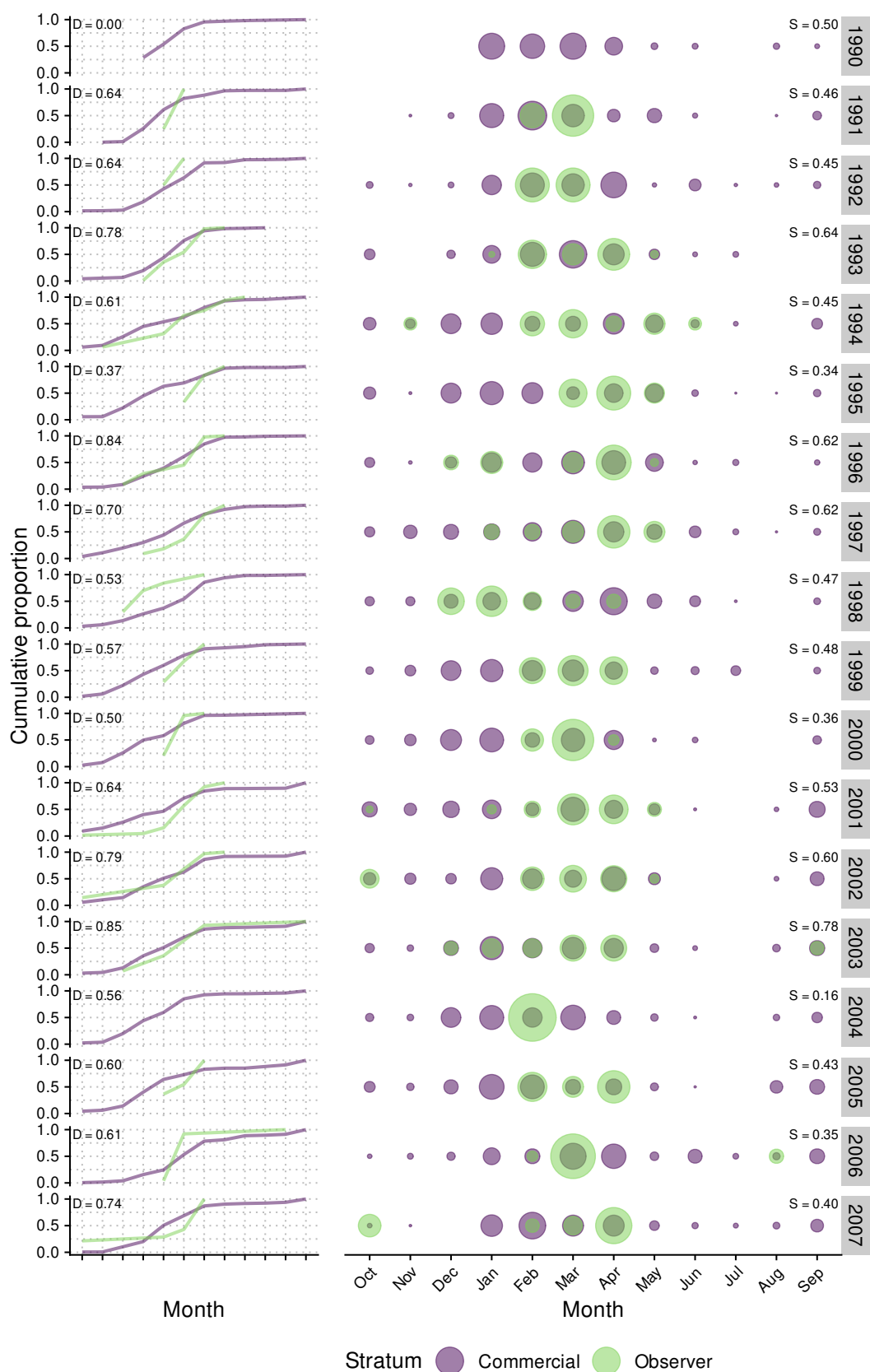


Figure 36: Representativeness of observer sampling coverage of midwater trawl fishing events that caught jack mackerels in 1990 to 2007 by fishing year and month. Observer data are for observed events with length sampling. Circle area is proportional to the proportion of events in a month, with proportions summing to one within each fishing year. D: Kolmogorov-Smirnov maximum absolute difference; S: Manhattan block distance.

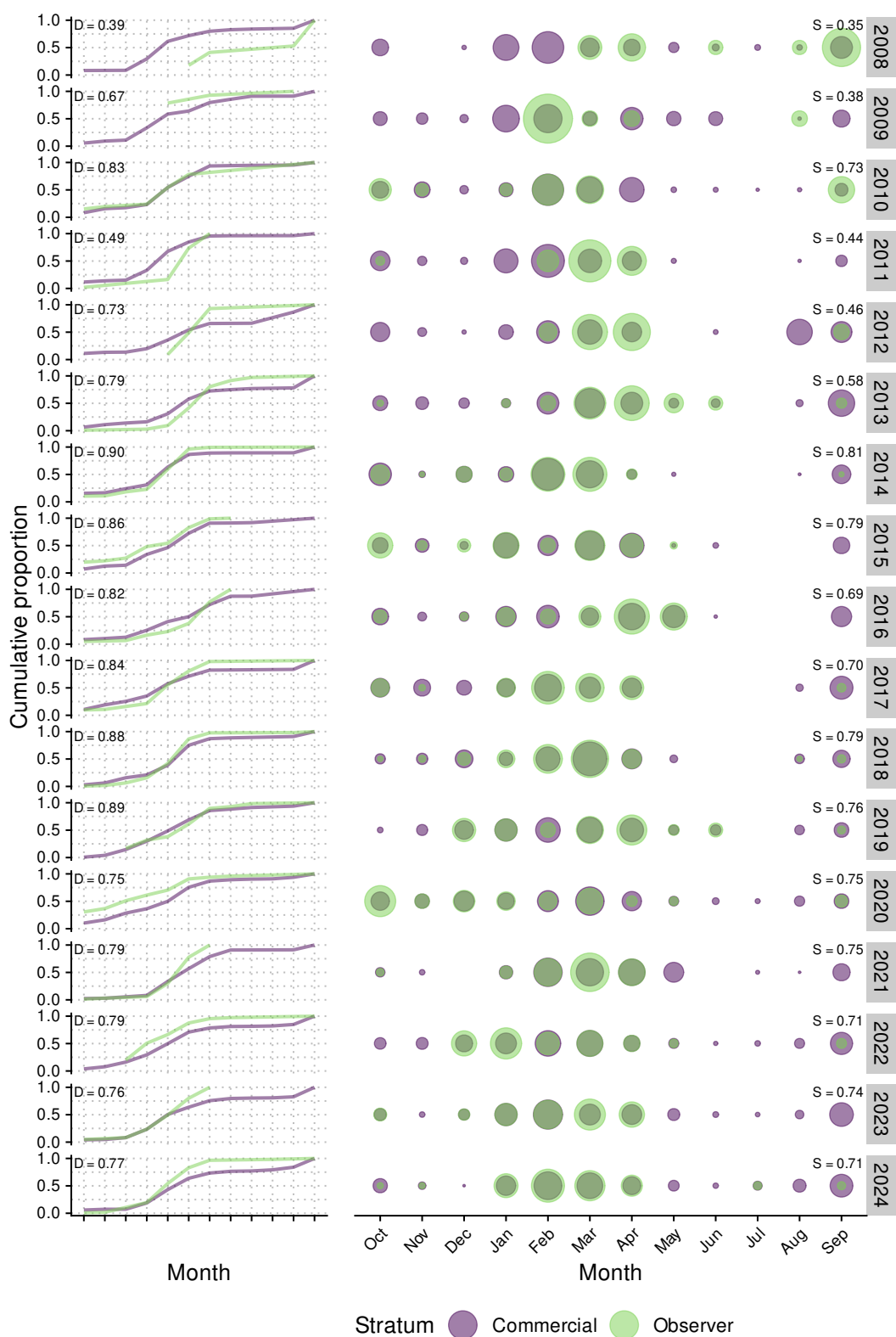


Figure 37: Representativeness of observer sampling coverage of midwater trawl fishing events that caught jack mackerels in 2008 to 2024 by fishing year and month. Observer data are for observed events with length sampling. Circle area is proportional to the proportion of events in a month, with proportions summing to one within each fishing year. D: Kolmogorov-Smirnov maximum absolute difference; S: Manhattan block distance.

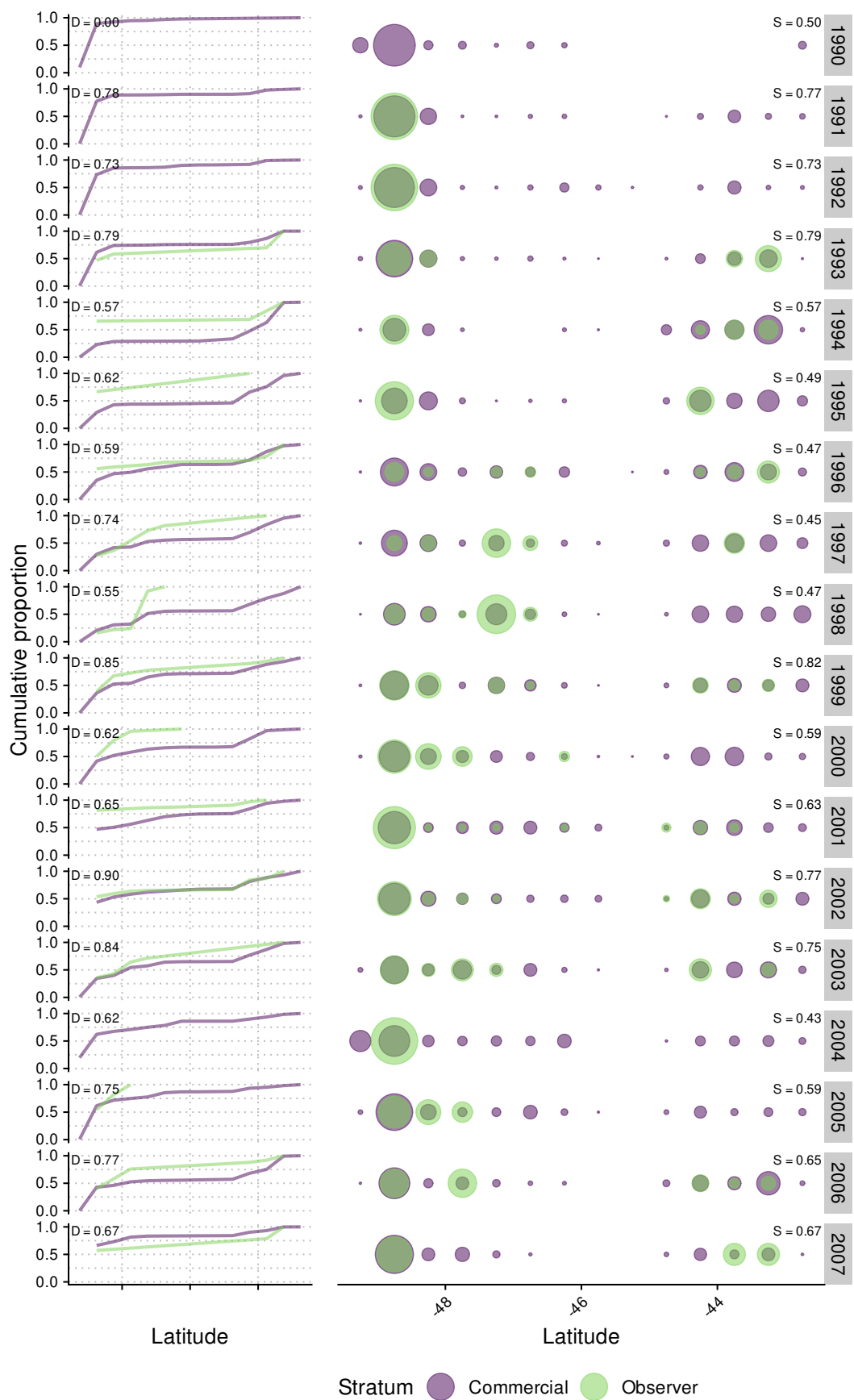


Figure 38: Representativeness of observer sampling coverage of midwater trawl fishing events that caught jack mackerels in 1990 to 2007 by fishing year and latitude. Observer data are for observed events with length sampling. Circle area is proportional to the proportion of events in a latitude bin, with proportions summing to one within each fishing year.

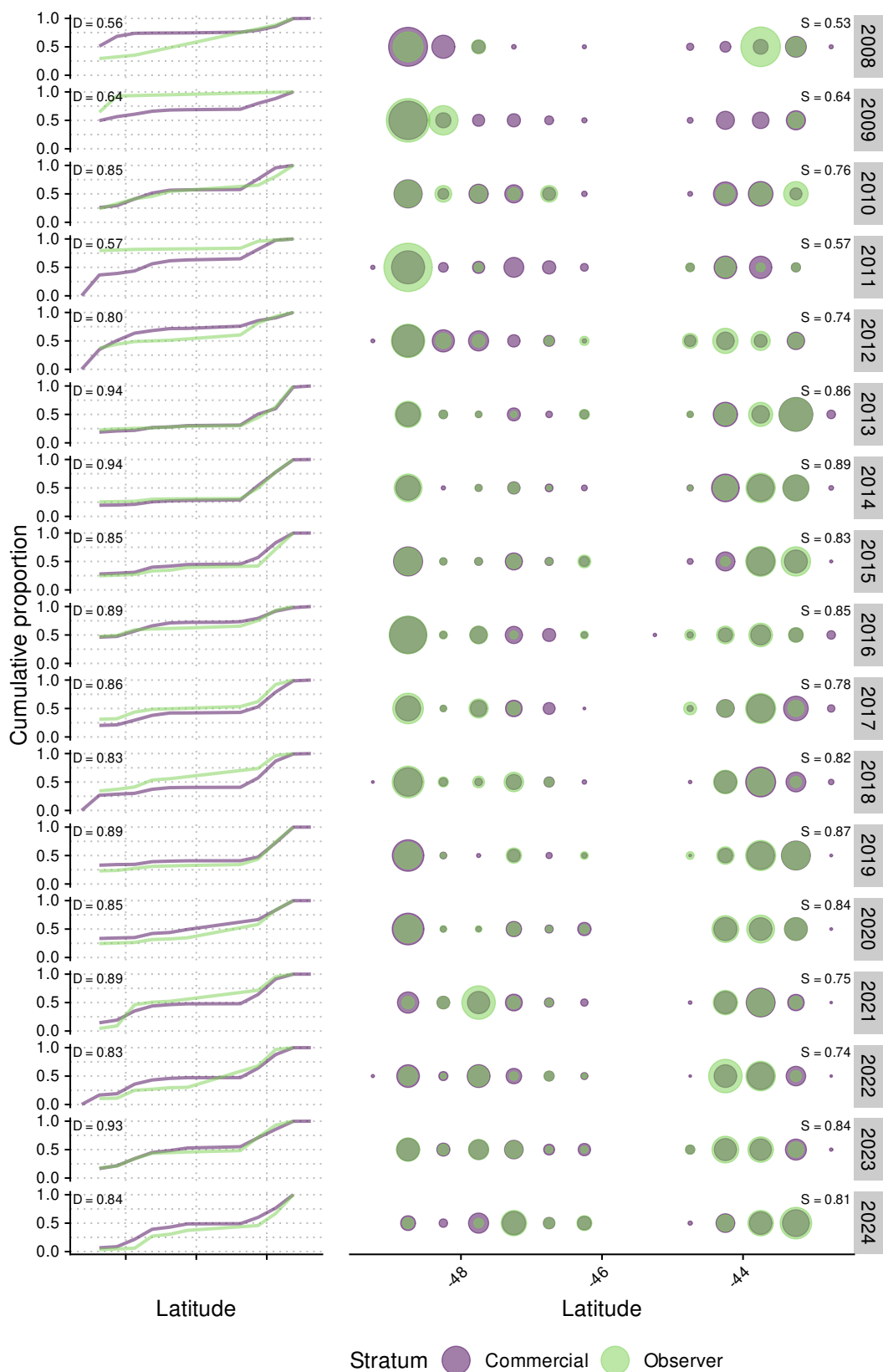


Figure 39: Representativeness of observer sampling coverage of midwater trawl fishing events that caught jack mackerels in 2008 to 2024 by fishing year and latitude. Observer data are for observed events with length sampling. Circle area is proportional to the proportion of events in a latitude bin, with proportions summing to one within each fishing year.

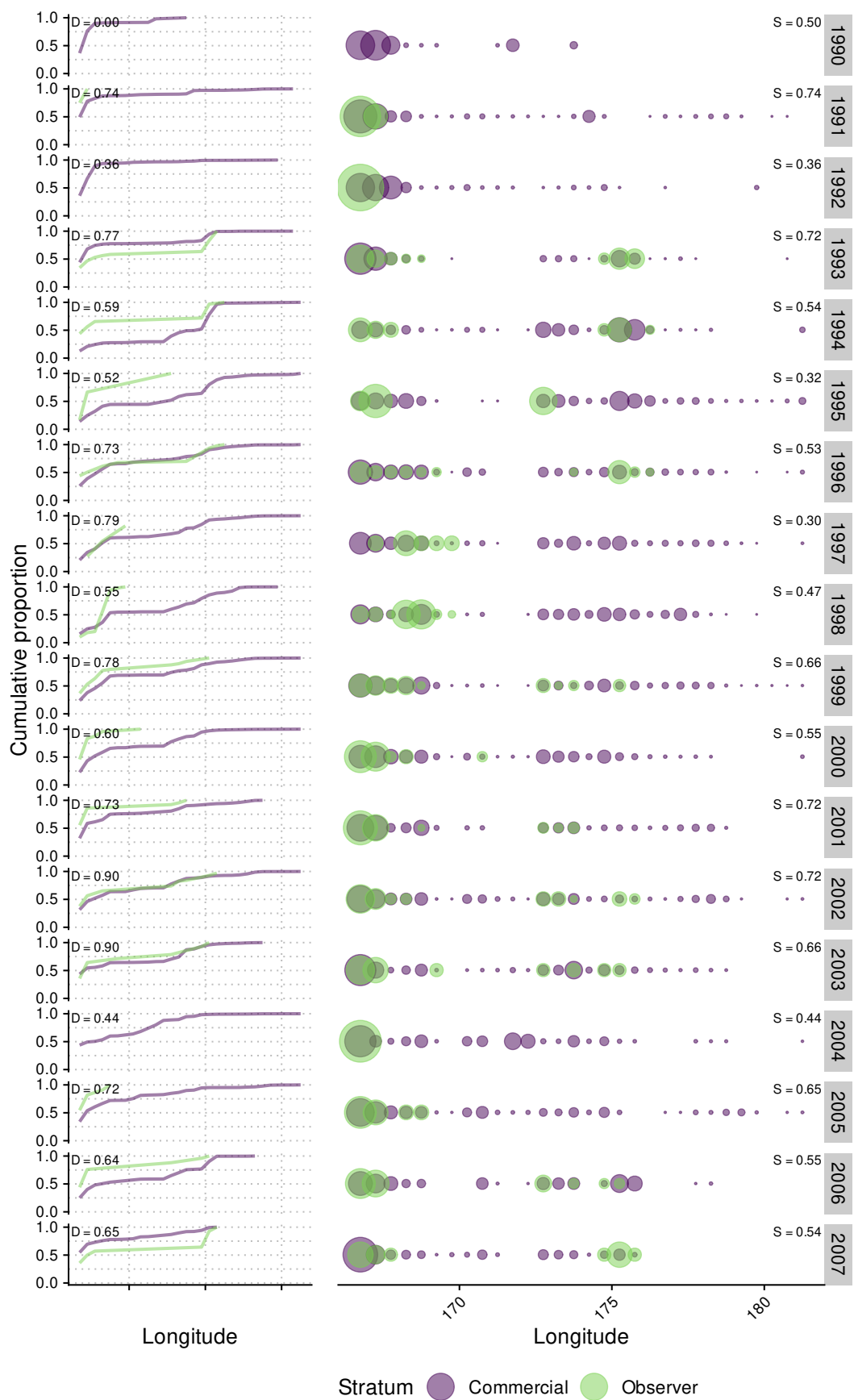


Figure 40: Representativeness of observer sampling coverage of midwater trawl fishing events that caught jack mackerels in 1990 to 2007 by fishing year and longitude. Observer data are for observed events with length sampling. Circle area is proportional to the proportion of events in a longitude bin, with proportions summing to one within each fishing year.

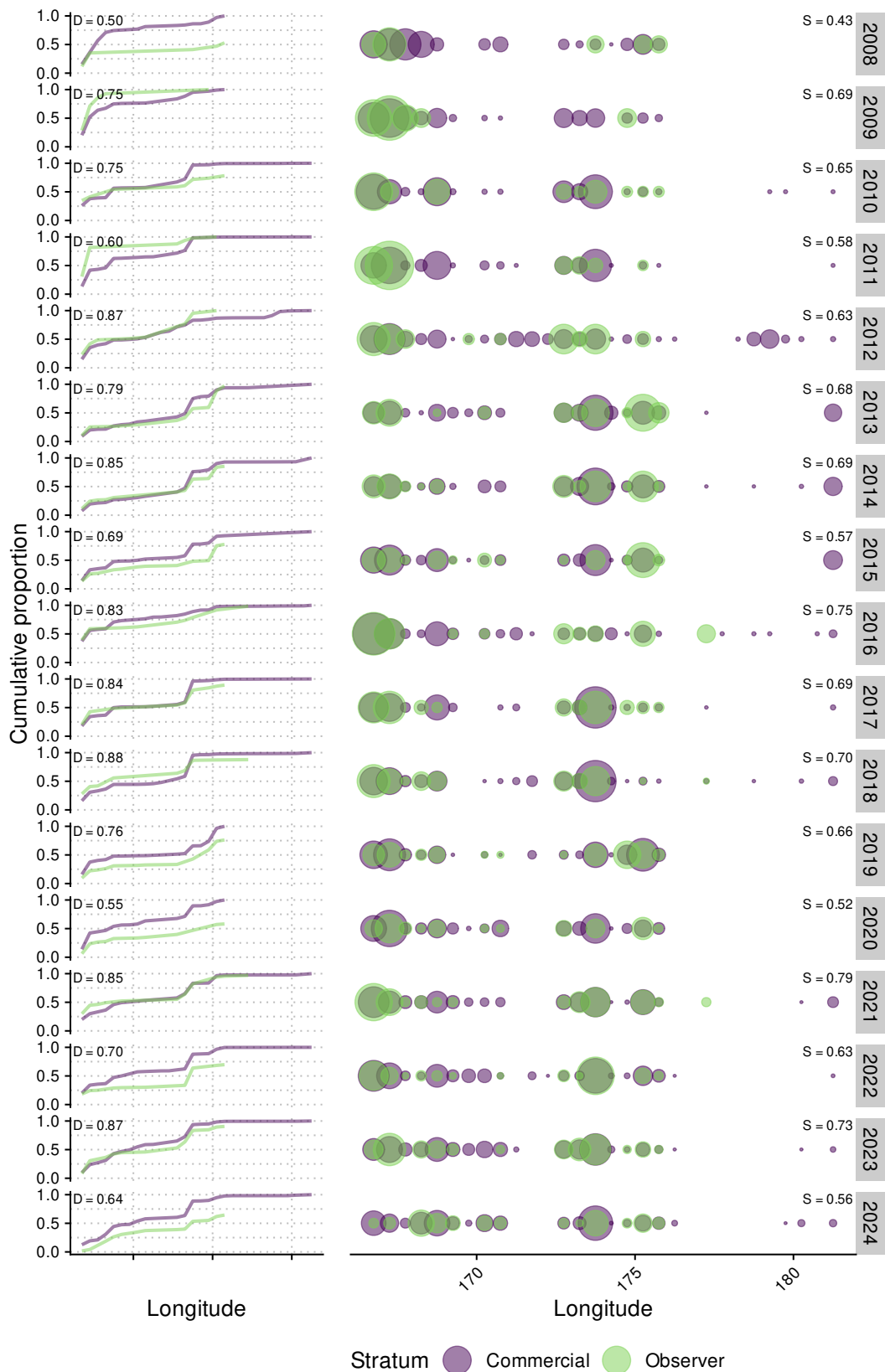


Figure 41: Representativeness of observer sampling coverage of midwater trawl fishing events that caught jack mackerels in 2008 to 2024 by fishing year and longitude. Observer data are for observed events with length sampling. Circle area is proportional to the proportion of events in a longitude bin, with proportions summing to one within each fishing year.

4.2 Length sampling

During the 1990s, the median sample size of observer length-frequency samples from the JMA 3 fishery was usually of the order of 100 fish, but this dropped below 30 fish during the 2000s (Figure 42). Larger sample sizes were restored in 2011 but, since 2012, larger samples have been rarer with samples of less than 30 fish being the norm. This contrasts with the situation in JMA 7, where median samples sizes of 100 or more jack mackerel have been taken consistently since the late 1980s (Middleton et al. 2024, figure 49). The observer samples are a mix of larger samples, stored in the Centralised Observer Database as tally-format length-frequency samples, and smaller samples stored as individual fish biological samples (Figure 43).

The number of jack mackerels sampled from a tow appears to be driven primarily by the target species of the tow, with larger sample sizes being taken when jack mackerels were the target species and smaller sample sizes occurring on barracouta and squid target tows (Figure 44). For squid target tows, the number of jack mackerels samples appears to be related to the size of the jack mackerel catch, but for barracouta and jack mackerel target tows there is little relationship between catch size and sample size once a minimum catch size threshold has been reached.

The influence of target species on the sample sizes of jack mackerels taken from a tow has been relatively consistent since the early 2010s (Figure 45).

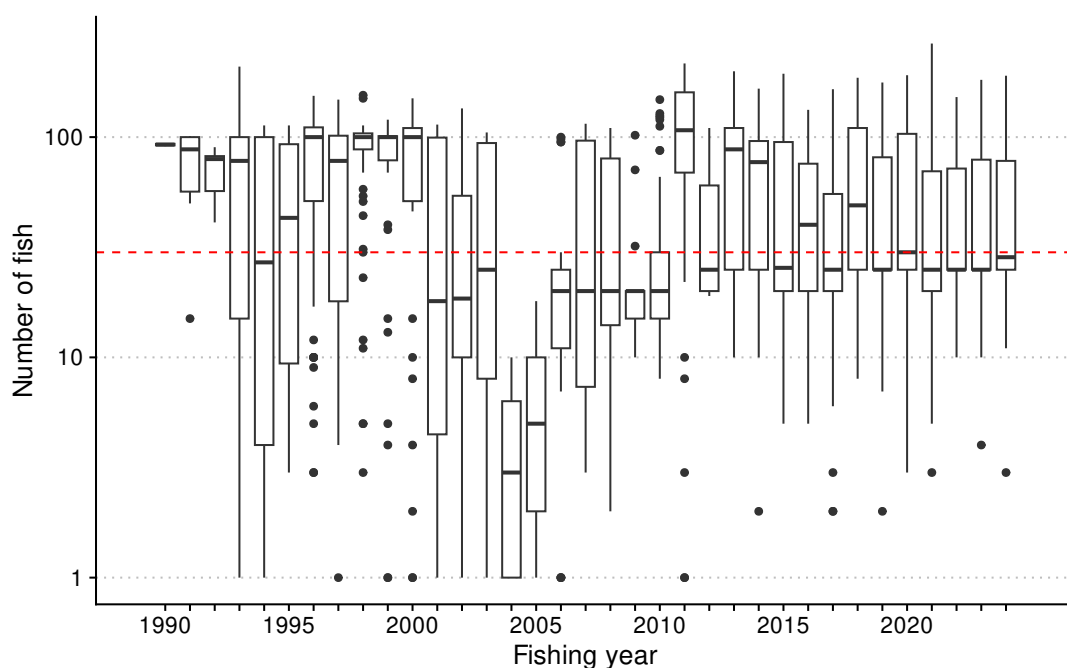


Figure 42: Length-frequency sample sizes for observed fishing events in JMA 3 where jack mackerels were sampled. The red dashed line indicates a sample size of 30 fish.

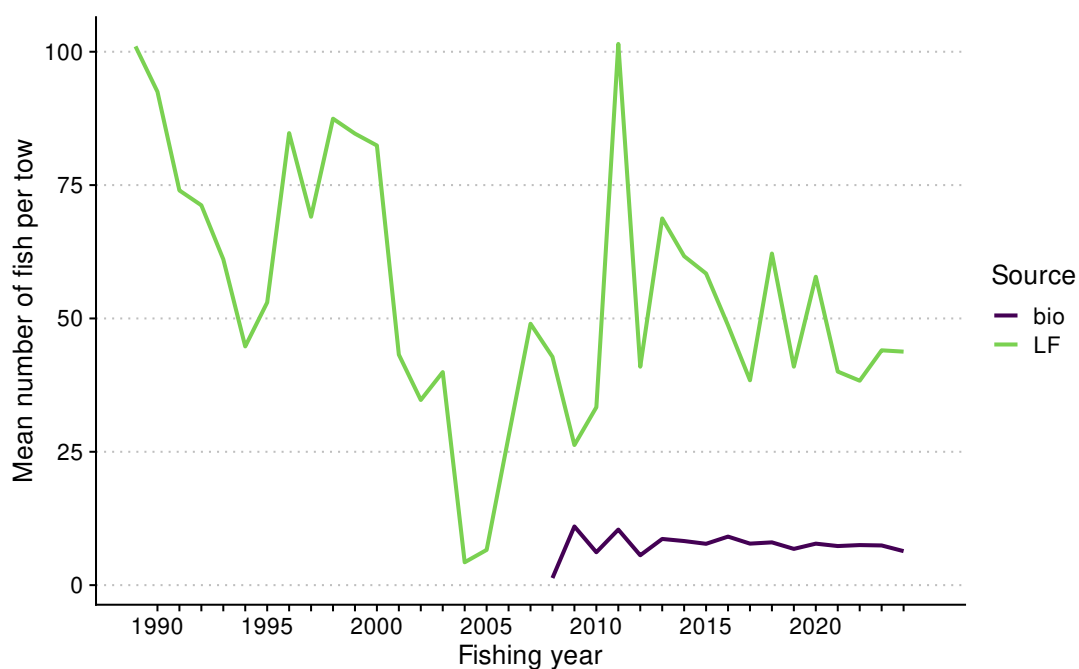


Figure 43: Storage of jack mackerel length-frequency sampling data in the Centralised Observer Database. Data with a source of LF are stored in the x_length_frequency table in a tally format, while a source of bio indicates data stored in the x_fishing_event_biological table with a row per fish.

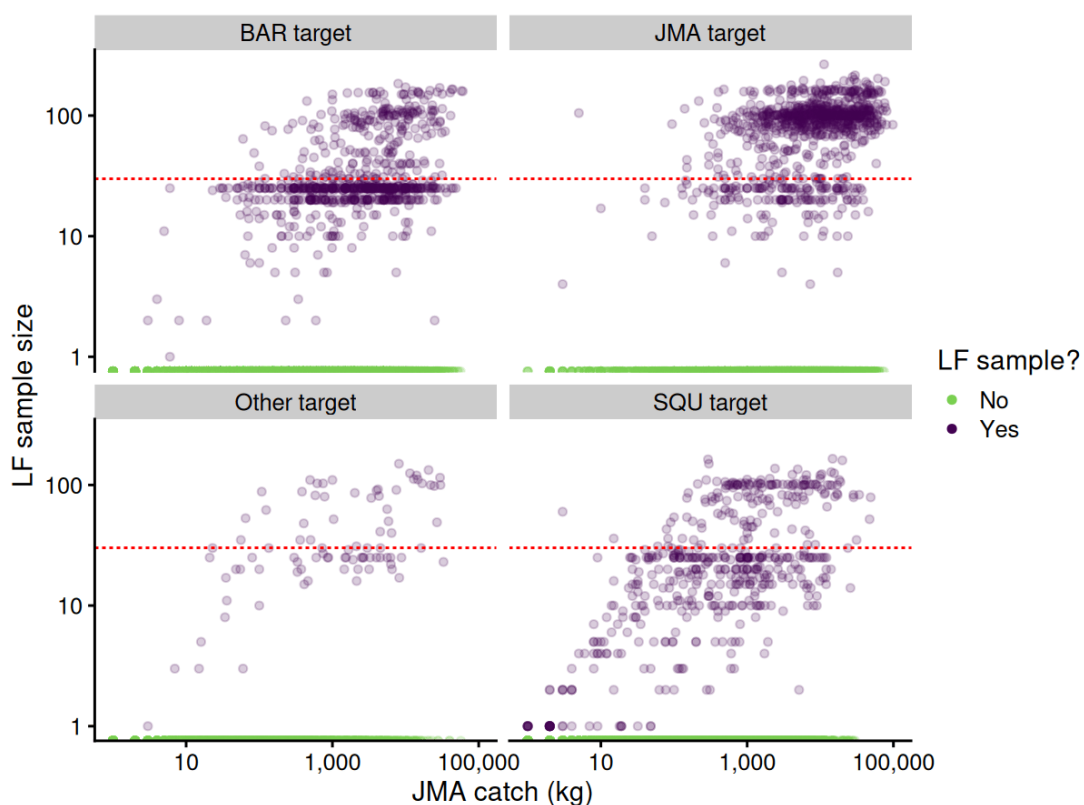


Figure 44: Length-frequency sample sizes (number of fish sampled) in relation to the total jack mackerel catch from a tow, separately for jack mackerel target tows and other target species. The red dashed line indicates a sample size of 30 fish.

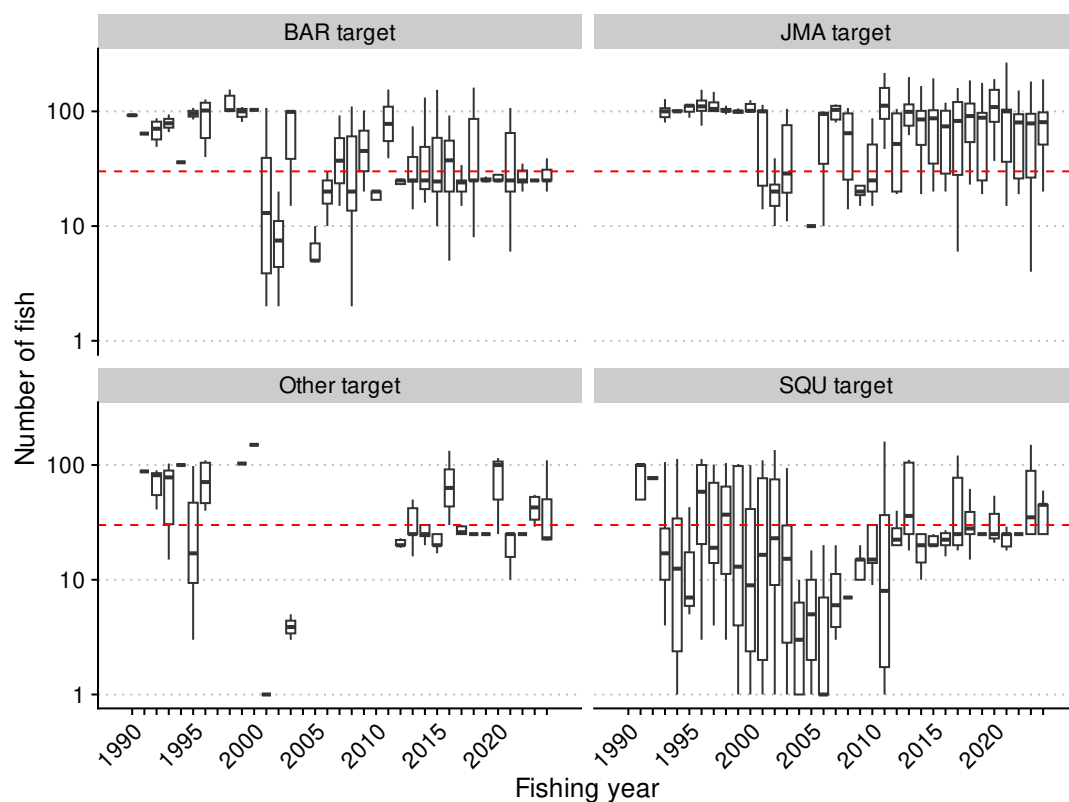


Figure 45: Boxplots summarising the distributions of length-frequency sample sizes for observed fishing events in JMA 3 where jack mackerels were sampled, by year and (observer defined) target species. The red dashed line indicates a sample size of 30 fish. Outliers are omitted from the boxplots.

5. SPECIES AND SIZE COMPOSITION IN JMA 3

Here the species and size composition in the JMA 3 fishery is characterised using the available observer length-frequency samples, noting the limitations in the observer coverage described above.

Annual distributions of tow-level proportions of the three species are illustrated in Figure 46. Proportions of *Trachurus novaezelandiae* (JMN) were uniformly very low, with only occasional tows having any JMN recorded. During the 1990s, the sampled tows consisted almost exclusively of *T. murphyi* (JMM) with a low proportion of *T. declivis* (JMD). During the early 2000s, the catch remained dominated by *T. murphyi* but with higher proportions of *T. declivis* recorded. *T. murphyi* remained the dominant species in most sampled tows until the early 2020s, with median proportions of *T. declivis* in sampled tows being greater than those of *T. murphyi* during 2022 to 2024.

The depth distributions of the three species from sampled tows in JMA 3 show considerable overlap (Figure 47). The catch weighted depth distribution suggests little catch from waters shallower than 80 m, although this is likely to be primarily related to spatial restrictions on the operation of the midwater fleet rather than the species' distributions. *T. novaezelandiae* was not recorded in tows with a seabed depth much greater than 200 m, while the other species were largely restricted to waters shallower than 250 m, although the depth distribution of *T. murphyi* was somewhat broader than that of *T. declivis*.

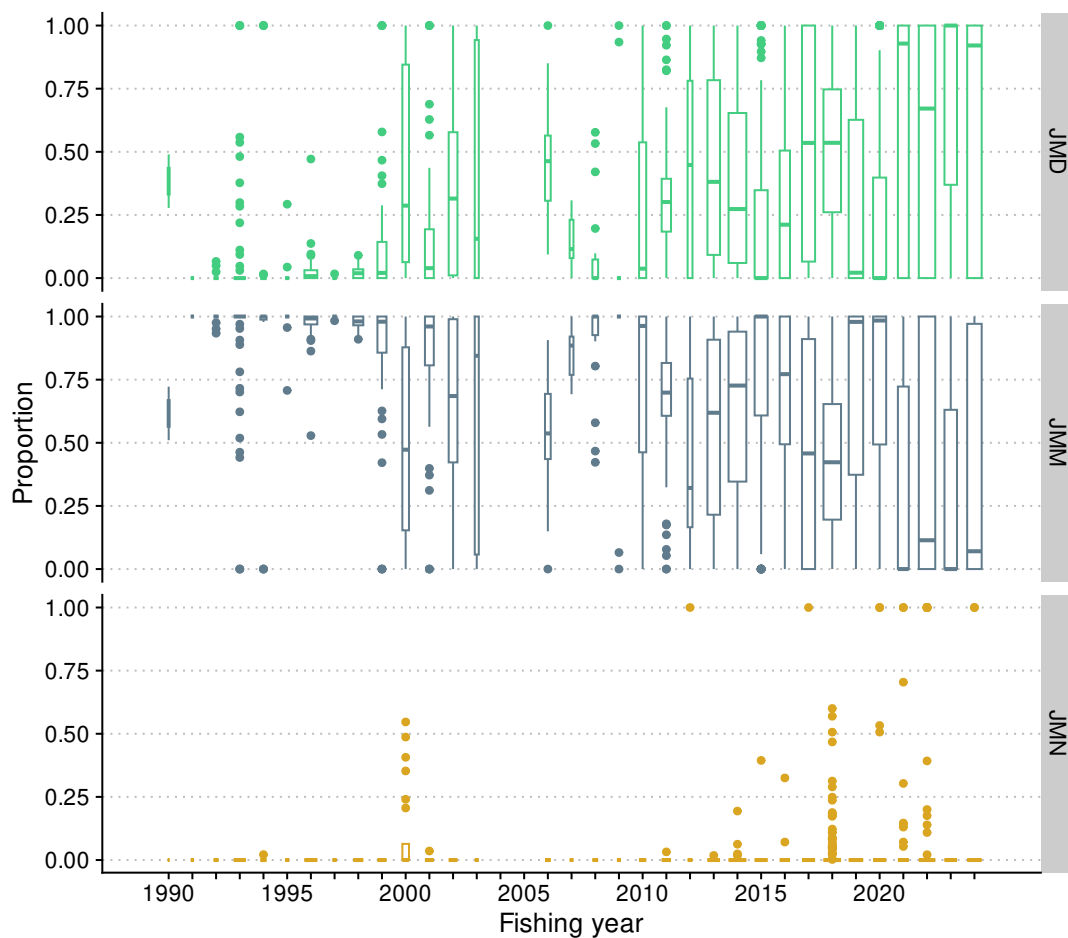


Figure 46: Box-plots of tow-level proportions of jack mackerel species by year, for tows sampled by observers and with a length-frequency sample of twenty or more fish.

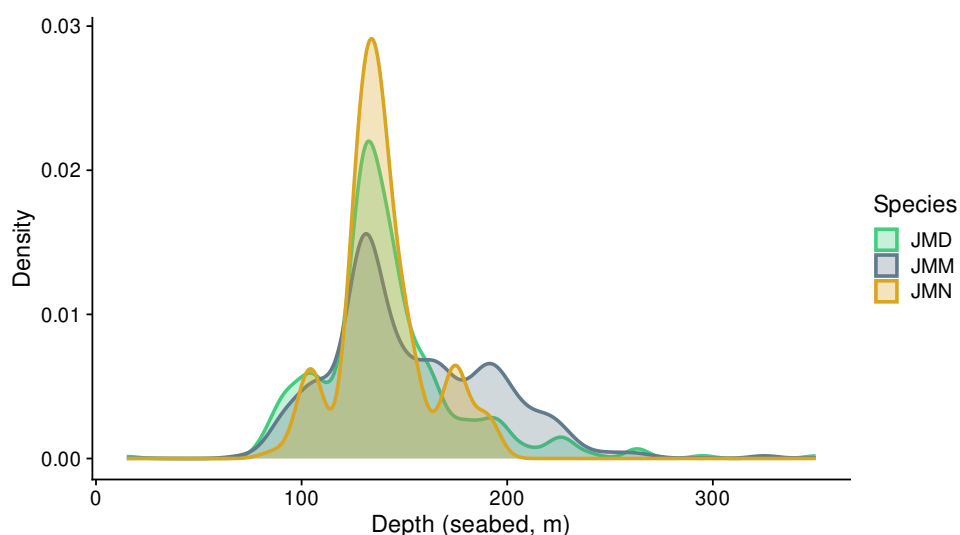


Figure 47: Density plots of the seabed depth distribution of sampled tows where at least thirty jack mackerels were sampled, weighted by the catch of the three jack mackerel species.

5.1 Spatial distributions

Nine spatial clusters of observed tows in JMA 3 with length-frequency samples of jack mackerels were identified by density-based clustering (Figure 48). These were labelled from east to west, based on the cluster centroid location; clusters C01 and C02 are around the Chatham Islands, C03 is on the western Chatham Rise (Mernoo Bank), C04 is on the east coast of the South Island off Banks Peninsula, clusters C05 to C08 are off the southeast of the South Island and on the Stewart-Snares shelf, while C09 is to the north of the Auckland Islands.

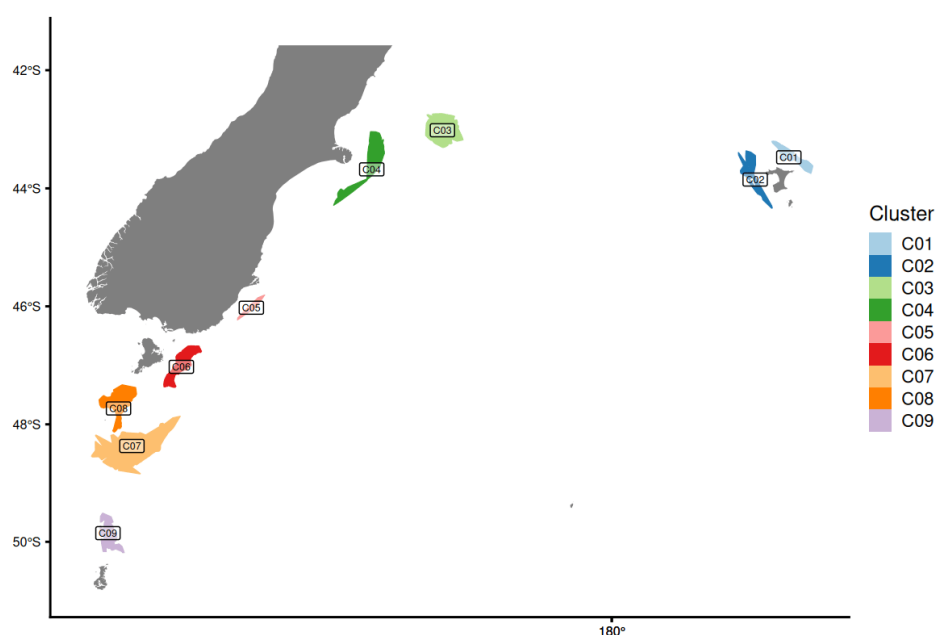


Figure 48: Spatial clusters used for summarising observed effort; the start positions of observed events were clustered using the Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm with ϵ set to 18 km and $minPts$ set to 10.

Annual distributions of the proportion of *T. declivis* in samples from the different areas illustrate that the temporal and spatial coverage of sampling has been variable (Figure 49). Nevertheless, some spatial patterns are apparent. There was little historical sampling around the Chatham Islands (C01 and C02), but sampling since the mid 2010s generally suggests a low proportion of *T. declivis* in that area.

The proportion of *T. declivis* appears to have been highest, for longest (since the late 2000s), in area C04, off the east coast of the South Island. Higher proportions of *T. declivis* have also been apparent, more recently, in areas C06 and C07, with the latter area generally having had a lower proportion of *T. declivis* prior to the mid 2010s.

Because *T. novaezelandiae* were generally not sampled in the JMA 3 fishery (Figure 46), the jack mackerel species composition can be visualised as the relative proportions of *T. declivis* and *T. murphyi*. In the 1990s, *T. murphyi* dominated in all areas, with increasing proportions of *T. declivis* apparent in the 2000s and 2010s (Figure 50). The increasing proportions of *T. declivis* were initially apparent in the areas closest to the South Island, but by the 2022–2024 period, *T. declivis* was the dominant species in all areas except those around the Chatham Islands.

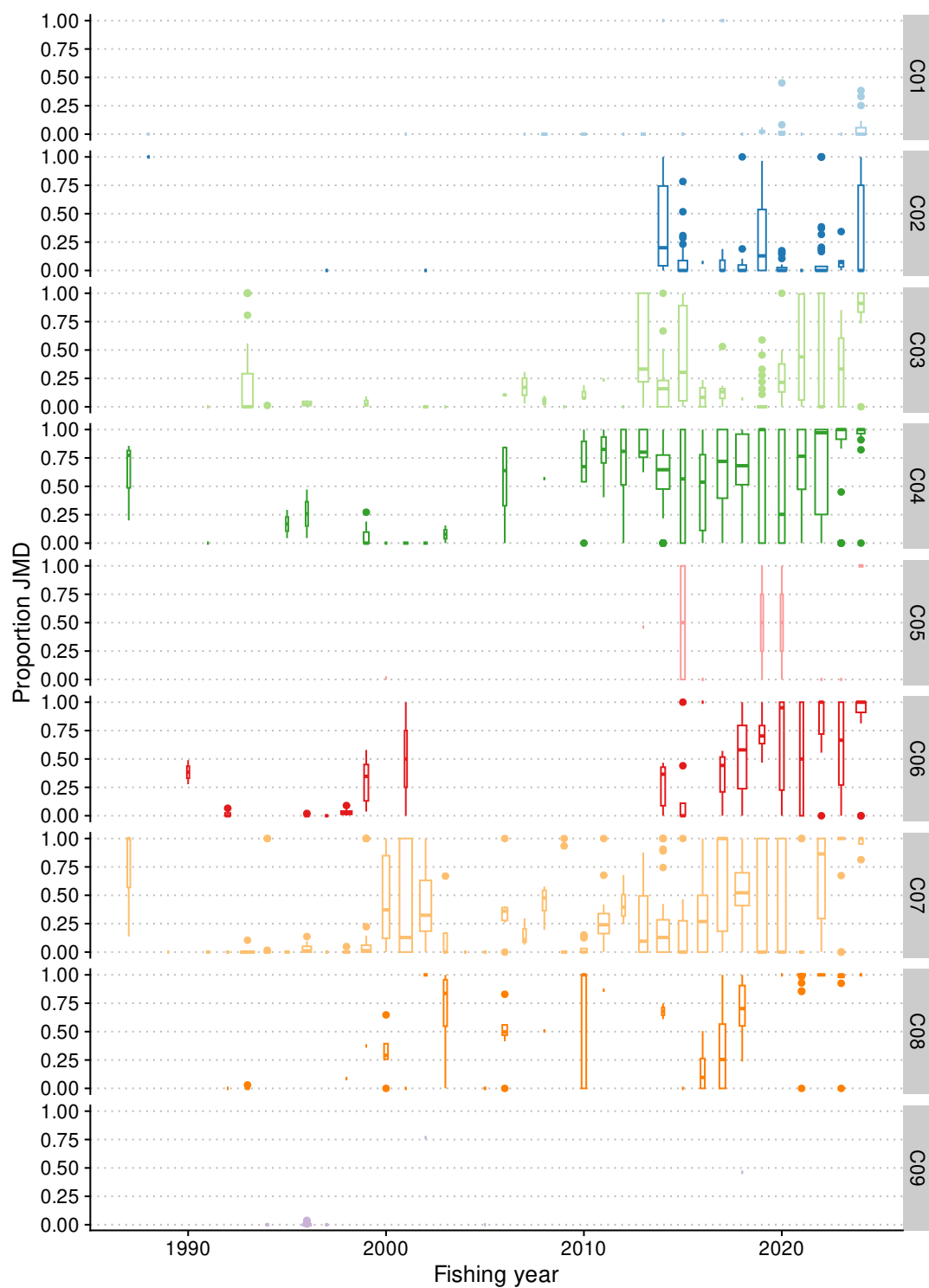


Figure 49: Box-plots of tow-level proportions of JMD by cluster and year, for tows with a length-frequency sample of ten or more fish. Box widths indicate the relative number of samples available.

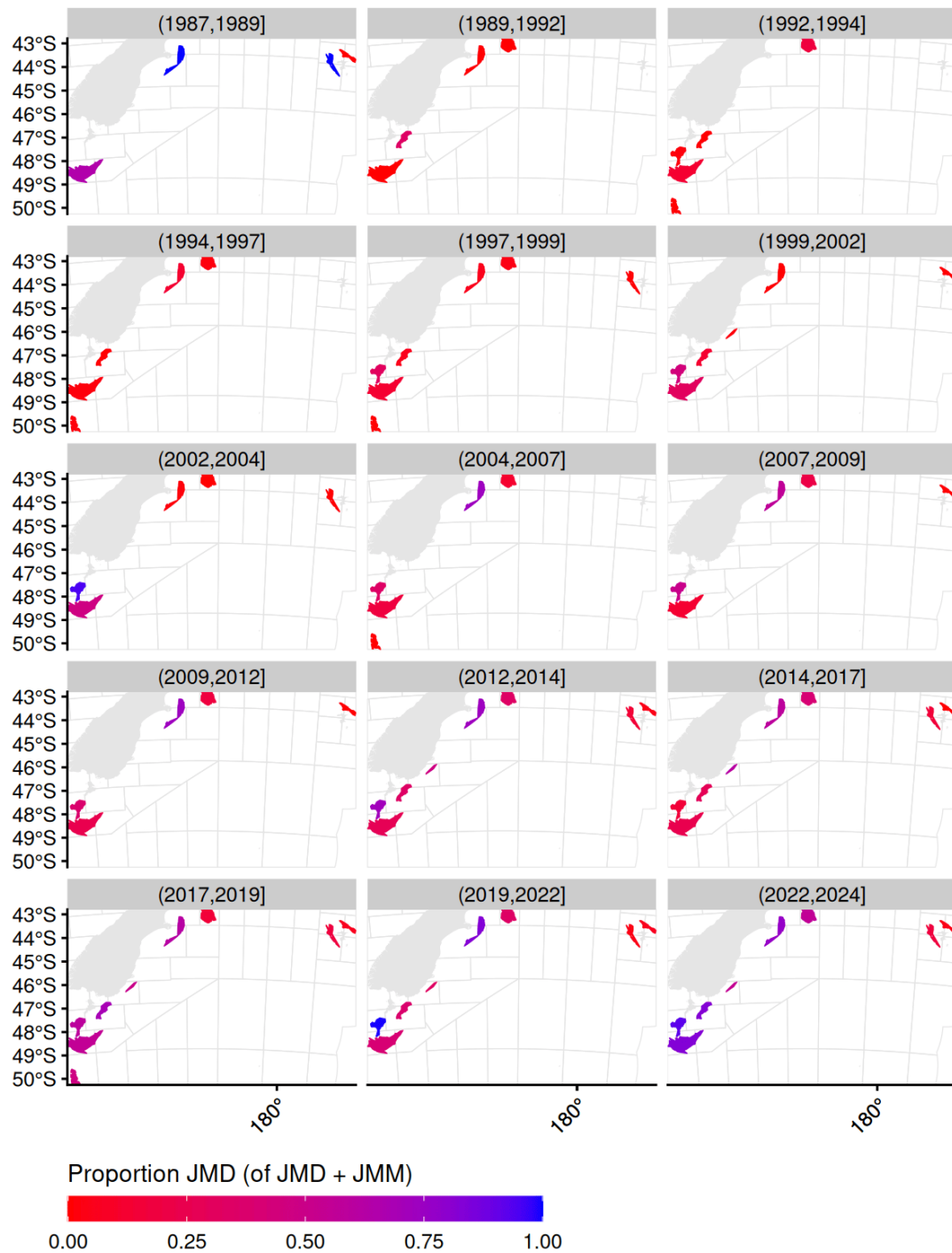


Figure 50: Estimated proportion of *T. declivis*, of the total catch of the large jack mackerels (*T. declivis* and *T. murphyi*), on observed tows.

5.2 Length-frequency distributions

Annual length-frequency distributions for the three jack mackerel species in JMA 3 are provided in Figure 51 (*T. declivis*), Figure 52 (*T. murphyi*), and Figure 53 (*T. novaezelandiae*). The sampled tows were scaled to the estimated catch of each species in a tow, and summed across sampled tows, but were not stratified or scaled to the fleet total catch.

An immediate observation is that all the jack mackerels sampled in JMA 3 were large, usually over 40 cm fork length. In the case of *T. murphyi*, the presence of exclusively large fish is not surprising; spawning of *T. murphyi* in New Zealand waters is believed to be rare, with fish periodically migrating in from the wider Pacific stock (Horn & Maolagáin 2021).

For *T. novaezelandiae* the occurrence of such large fish is surprising; the estimated L_{∞} for *T. novaezelandiae* in JMA 1 and JMA 7 is 34.5 cm (Fisheries New Zealand 2024). An obvious explanation, given the lack of smaller fish, is that these fish are not, in fact, *T. novaezelandiae* but are either misidentified or miscoded. Some specific recent samples were reviewed with the Observer Programme (see Appendix C) but a definitive conclusion on these samples was not reached.

The lack of smaller *T. declivis* in samples from JMA 3 is consistent with the observations of Horn et al. (2014) who, for the 2014 fishing year, found few *T. declivis* under 40 cm or younger than 9 years, and suggested that *T. declivis* in JMA 3 may not be a distinct stock with the adult fish arriving from other areas.

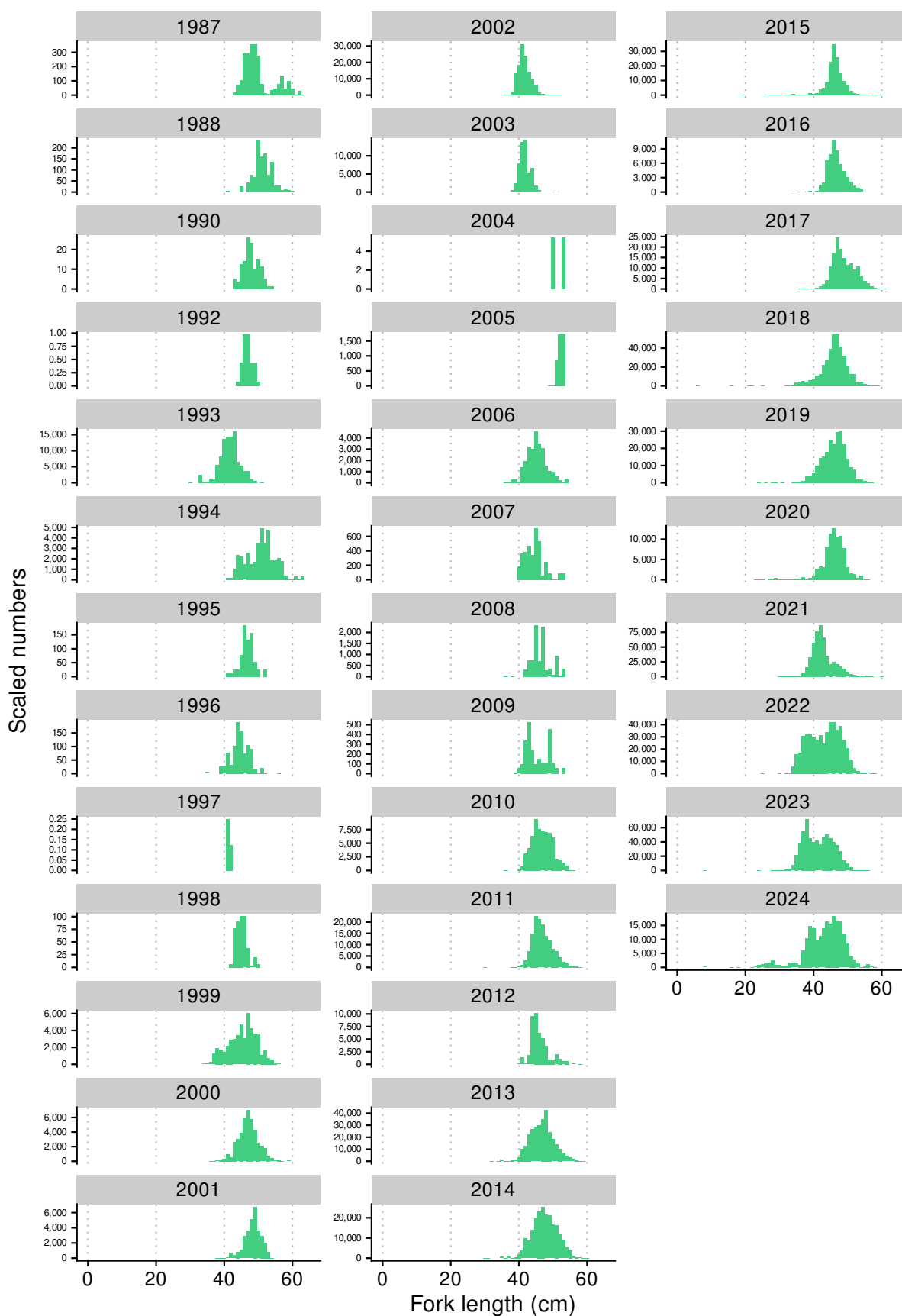


Figure 51: Scaled length-frequency samples of *T. declivis* from JMA 3.

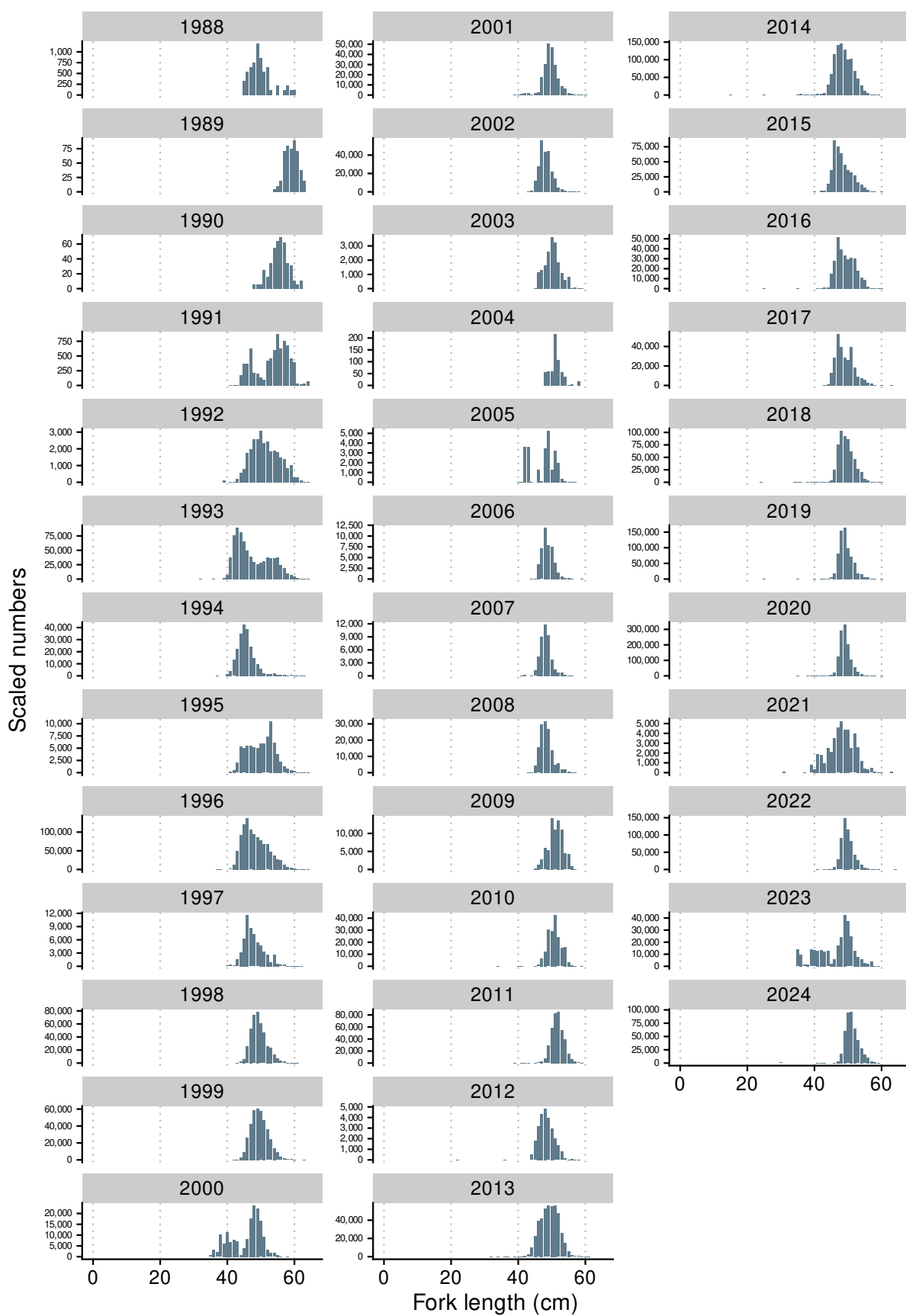


Figure 52: Scaled length-frequency samples of *T. murphyi* from JMA 3.

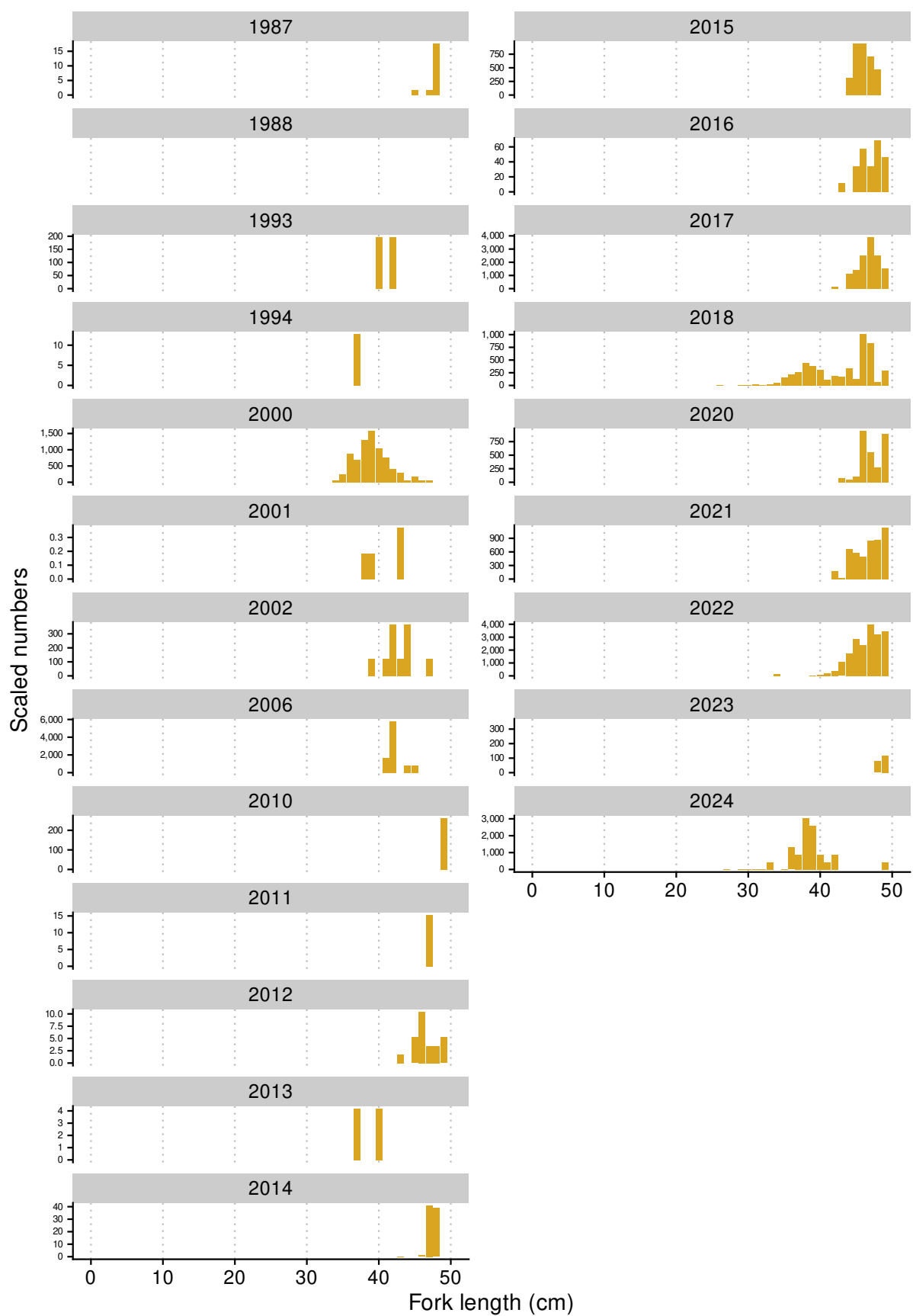


Figure 53: Scaled length-frequency samples of *T. novaezelandiae* from JMA 3. See the text for discussion of potential misidentification of *T. novaezelandiae*.

6. JACK MACKEREL STOCK STRUCTURE

Our exploration of the jack mackerel sampling data from JMA 3 collected by Fisheries New Zealand observers suggested that:

- *Trachurus novaezelandiae* (JMN) are largely absent in the JMA 3 area, and the small number of fish recorded may simply be misidentifications or miscodings;
- consistent with the hypothesis of Horn et al. (2014), *Trachurus declivis* (JMD) in JMA 3 appear to be exclusively adult fish rather than a distinct stock; and
- *Trachurus murphyi* (JMM) was the predominant species in the JMA 3 catch from the 1990s to 2020, but *T. declivis* has made up the larger part of the catch in the early 2020s.

6.1 Distributions in trawl surveys

Data collected on trawl surveys were investigated to further explore the distribution of jack mackerels in JMA 3, and more widely around New Zealand. The JMA 3 Quota Management Area is well represented in trawl surveys, including the regions sampled in the regular inshore East Coast South Island survey and the Chatham Rise and sub-Antarctic middle-depths surveys, and also previous surveys off Southland and around the Auckland Islands.

Figure 54 updates the overall distribution of jack mackerels from trawl surveys (previously provided by Anderson et al. 1998), showing the location of all trawl survey tows recorded in the Fisheries New Zealand trawl database, and those tows where jack mackerels have been recorded. Some trawl survey catches of jack mackerels were not identified to species, but there are no indications that these were in areas other than where the three known species occur.

Trachurus declivis has been recorded from survey tows around the New Zealand coastline, other than off East Northland and Fiordland. *T. declivis* appears to be recorded somewhat less frequently than *T. murphyi* off the southern coast of the South Island and across the Chatham Rise. *T. murphyi* was recorded around the North Island, other than off the north-east coast, but less frequently than the two native species were recorded. *T. novaezelandiae* has been recorded all round the North Island, and part way down the east and west coasts of the South Island, with occasional records off Southland but a notable absence from the Chatham Rise.

The mean lengths of jack mackerels sampled on trawl surveys (Figure 55) indicates that smaller *T. declivis* have mainly been observed in the Bay of Plenty and Hauraki Gulf, off the west coast of the North Island, and in Tasman Bay. Some smaller fish were also been recorded off the South Island east coast.

The mean length of *T. murphyi* on trawl survey tows was usually over 40 cm; a small number of tows recorded smaller fish, most of which occurred off the east and southeast coast of the North Island.

Smaller *T. novaezelandiae* were recorded in similar areas as smaller *T. declivis*, although less frequently in Tasman Bay than off the west coast of the North Island and in the Hauraki Gulf and Bay of Plenty. Smaller *T. novaezelandiae* extended to the area off East Northland. Some smaller *T. novaezelandiae* were also been recorded off the South Island east coast; however, some tows in this area also recorded fish with mean lengths greater than 40 cm. This raises the possibility that some jack mackerels have also been misidentified during trawl surveys.

Other than in the northern Taranaki Bight, tows where smaller jack mackerels were encountered (i.e., where the mean size of *T. declivis* was less than 30 cm and that of *T. novaezelandiae* was less than 20 cm) were inshore, in areas where larger trawl vessels (those over 46 m) cannot operate.

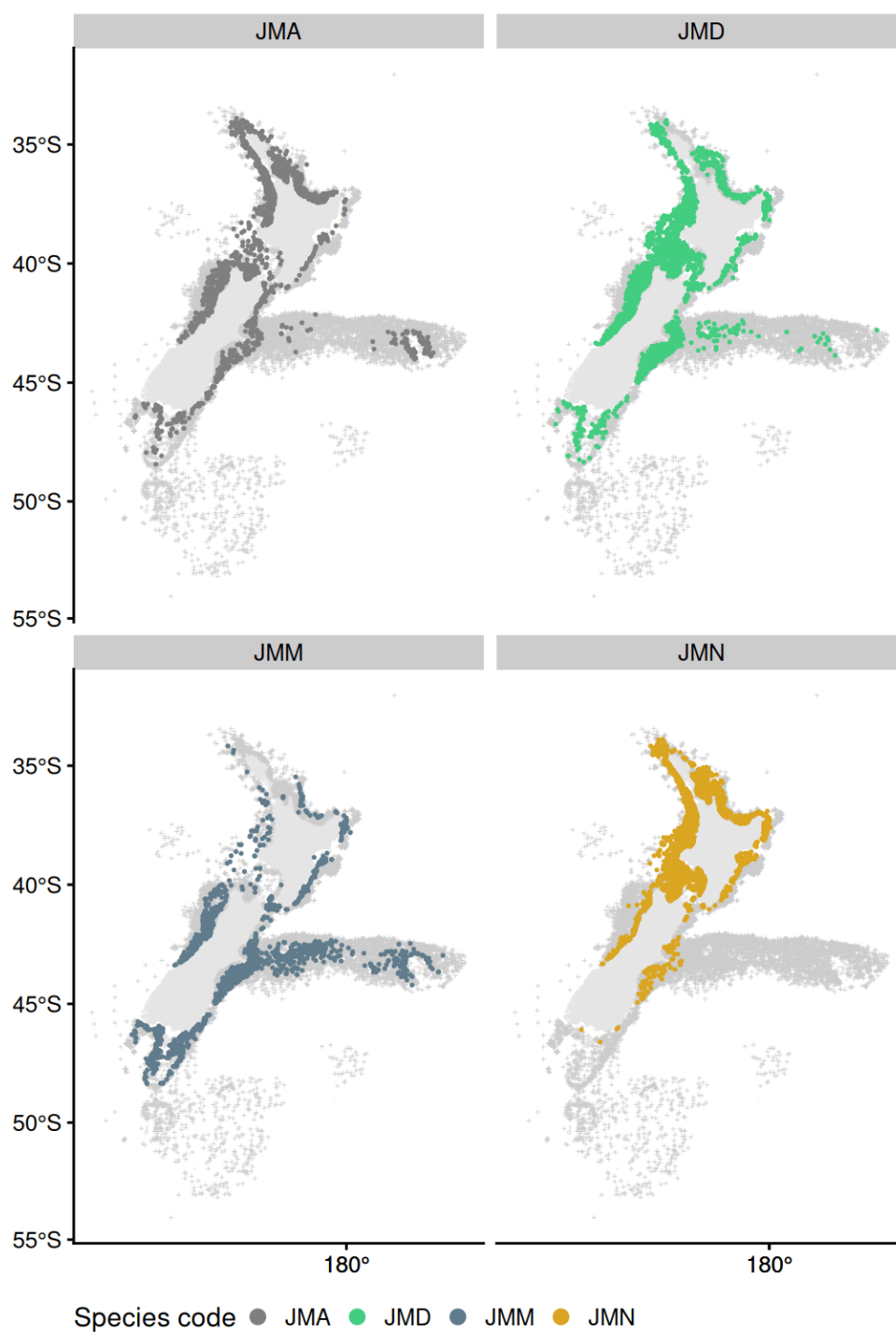


Figure 54: Locations of trawl survey catches of jack mackerels, including those not identified to species. The locations of tows without jack mackerel catches, on survey trips where some jack mackerel catch was recorded, are indicated with crosses.

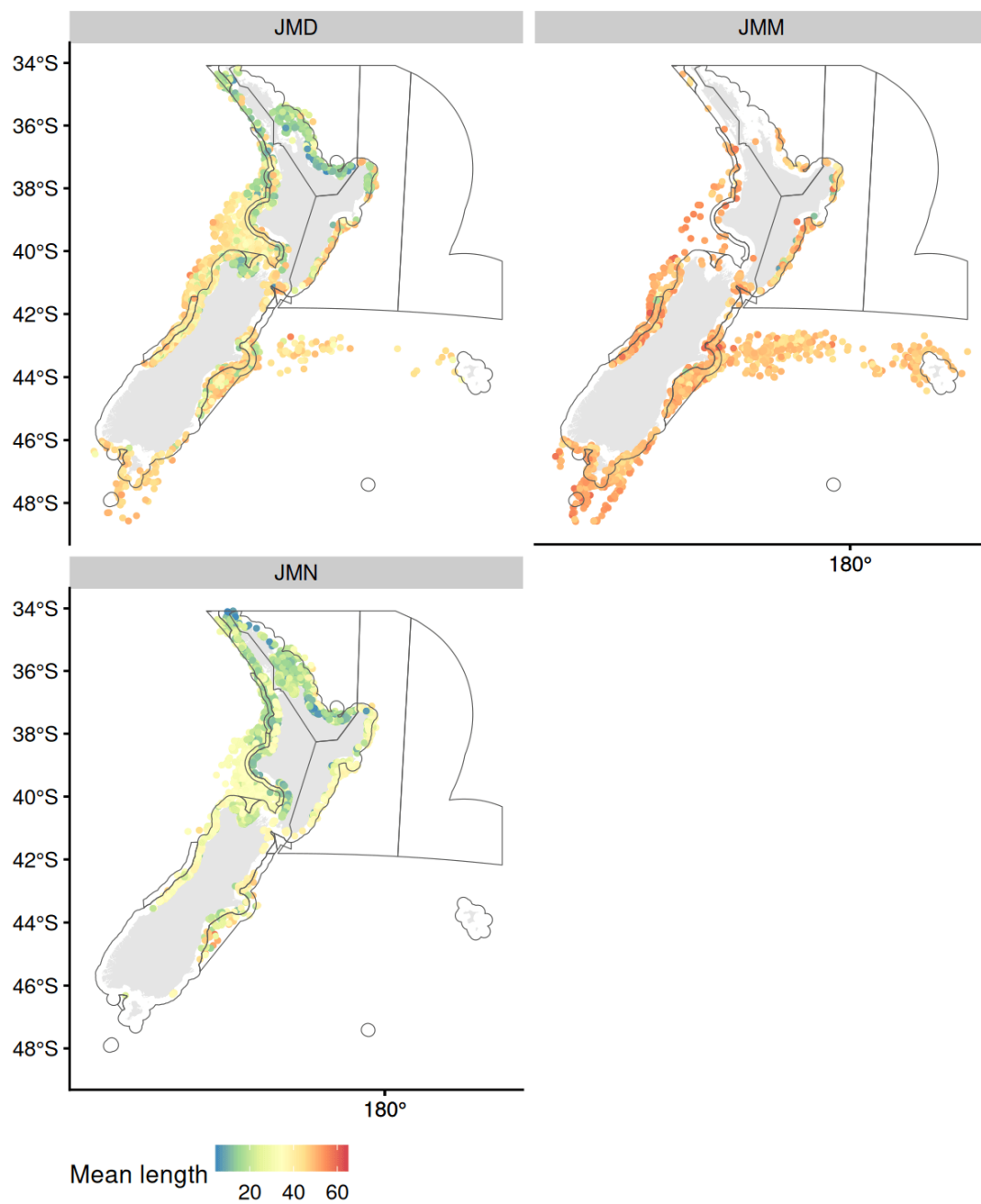


Figure 55: Tow-level mean lengths of jack mackerels measured on trawl surveys. The polygons outlined in black indicate the areas where trawl vessels longer than 46 m cannot operate.

Within the JMA 3 area, the proportions of *T. declivis* (of the total catch of *T. declivis* and *T. murphyi* on survey tows that caught these species) shows some variation between the inshore and middle depths survey series. For the Chatham Rise survey (and potentially also the Southland survey, although this is temporally sparser), survey catches were dominated by *T. murphyi* until the mid 2000s. In general, *T. murphyi* remained the dominant species thereafter, except that—in some years—some tows had a higher proportion of *T. declivis*.

In the inshore survey off the east coast of the South Island, *T. declivis* was typically the dominant species after the mid 2000s. Catch compositions were more variable in the 1990s, with *T. murphyi* dominating surveys in the mid 1990s.

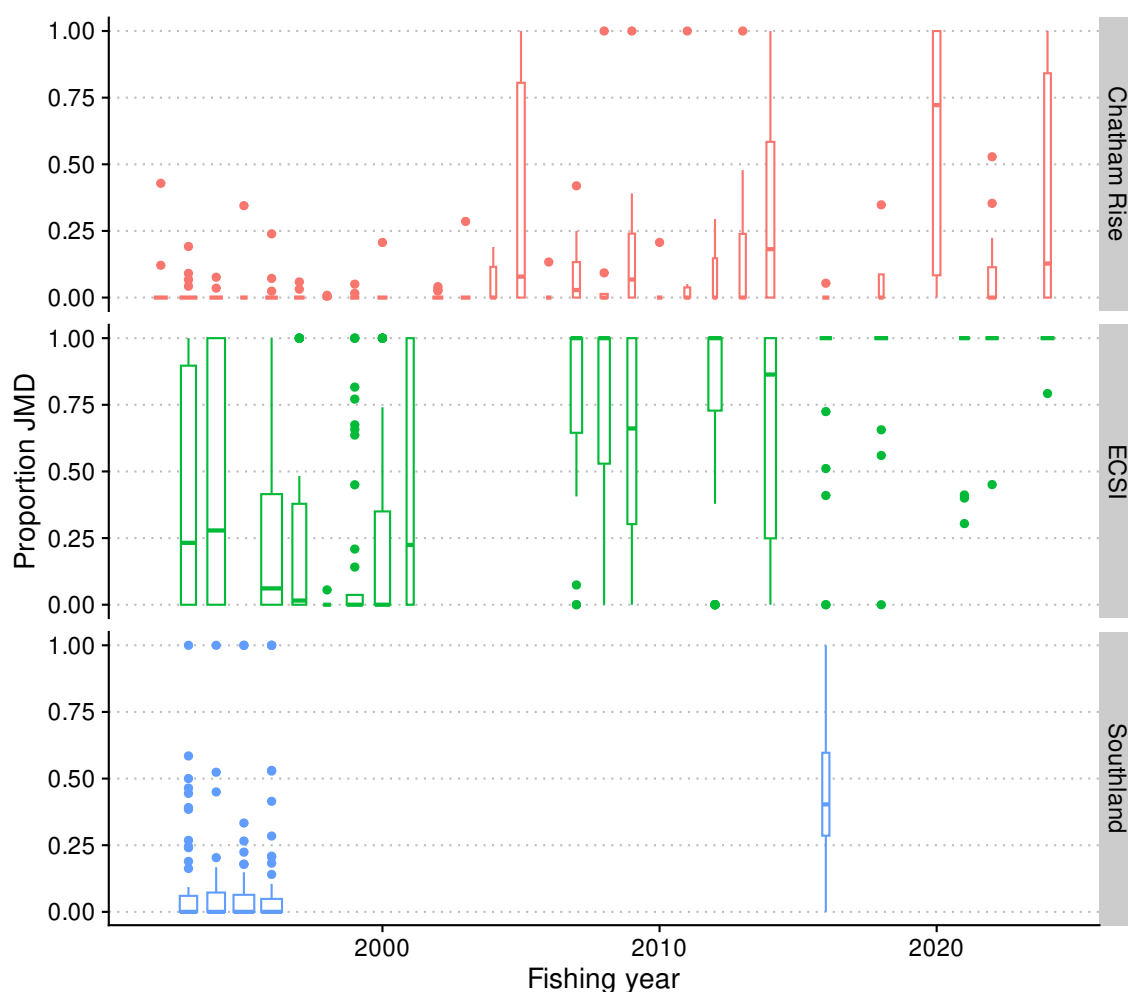


Figure 56: Box-plots of tow-level proportions of JMD (of JMD + JMM) by survey area and year, for tows where jack mackerels were caught. ECSI indicates the surveys by the *Kaharoa* in the ECSI area, while the Chatham Rise and Southland groups are survey tows by *Tangaroa* in the CHAT and STEW areas, respectively.

6.2 Maturity stages

Macroscopic maturity stages of jack mackerels were recorded during forty surveys, although 74.3% of the staged jack mackerels were sampled on just two surveys, in 1990 and 2012 (cor9001 and tan1202).

A small number of mature female (Figure 57) and male (Figure 58) *T. murphyi* were recorded from trawl surveys, but these were rare in comparison to the occurrence of mature native jack mackerels.

There were similar patterns in the distributions of mature *T. declivis* and *T. novaezelandiae* from trawl survey sampling, with most mature females encountered in the Taranaki Bight (Figure 57), although occasional ripe female *T. declivis* were recorded on the Chatham Rise. The distribution of mature males was similar (Figure 58), except that spent males were rarely recorded. In the case of *T. declivis*, spent males were recorded off the west coast of the South Island and off Southland.

Trawl survey sampling of jack mackerels was temporally restricted, with most samples taken in January to March (Figure 59, Figure 60). However, the available data are consistent with the understanding that the native species have a 'protracted spring-summer spawning season' (Fisheries New Zealand 2024), with similar timing in the limited number of mature *T. murphyi*.

Gonad staging of jack mackerels sampled by observers is similarly concentrated in the early part of the year in JMA 3, and late in the year in JMA 7 (Figure 61). However, in both these areas (and especially in JMA 7) a large number of fish have been staged; sampling by observers has been more limited in JMA 1. The observer data are also consistent with an extended spring-summer spawning period in all three species.

Most of the running ripe female jack mackerel recorded by observers have been from JMA 7, in the northern Taranaki Bight as far north as the Kaipara Harbour, and in the southern Taranaki Bight and off the north-western coast of the South Island (Figure 62). Despite limited observer sampling in JMA 1, running ripe *T. novaezelandiae* were also recorded from the Bay of Plenty.

Some running ripe fish were also recorded off the South Island south and east coasts, on the Mernoo Bank, and around the Chatham Islands. This includes a few *T. novaezelandiae*, noting that these may be misidentified fish.

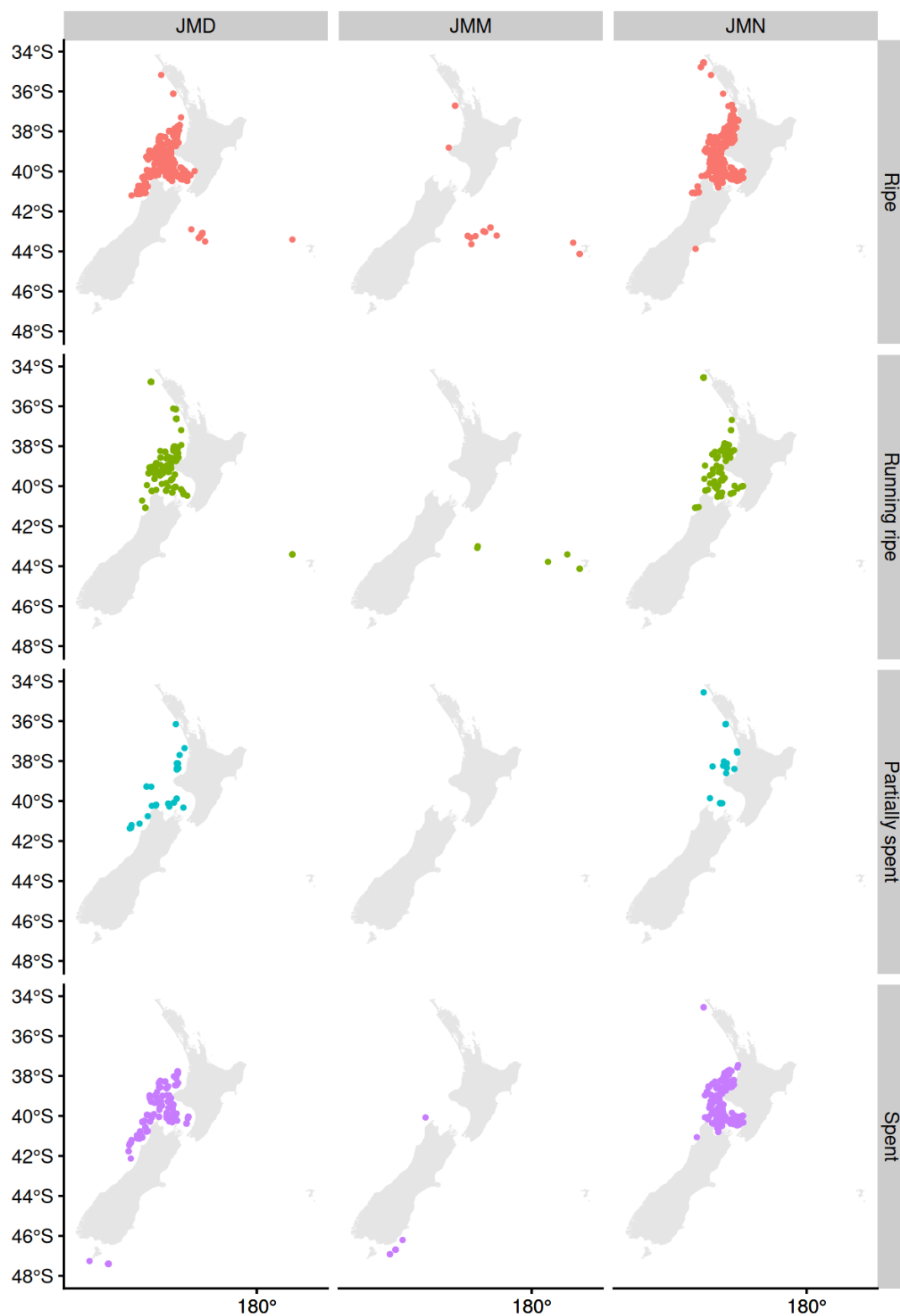


Figure 57: Locations of mature female jack mackerels identified on trawl surveys; stage 4 = ripe, stage 5 = running ripe, stage 6 = partially spent, stage 7 = spent.

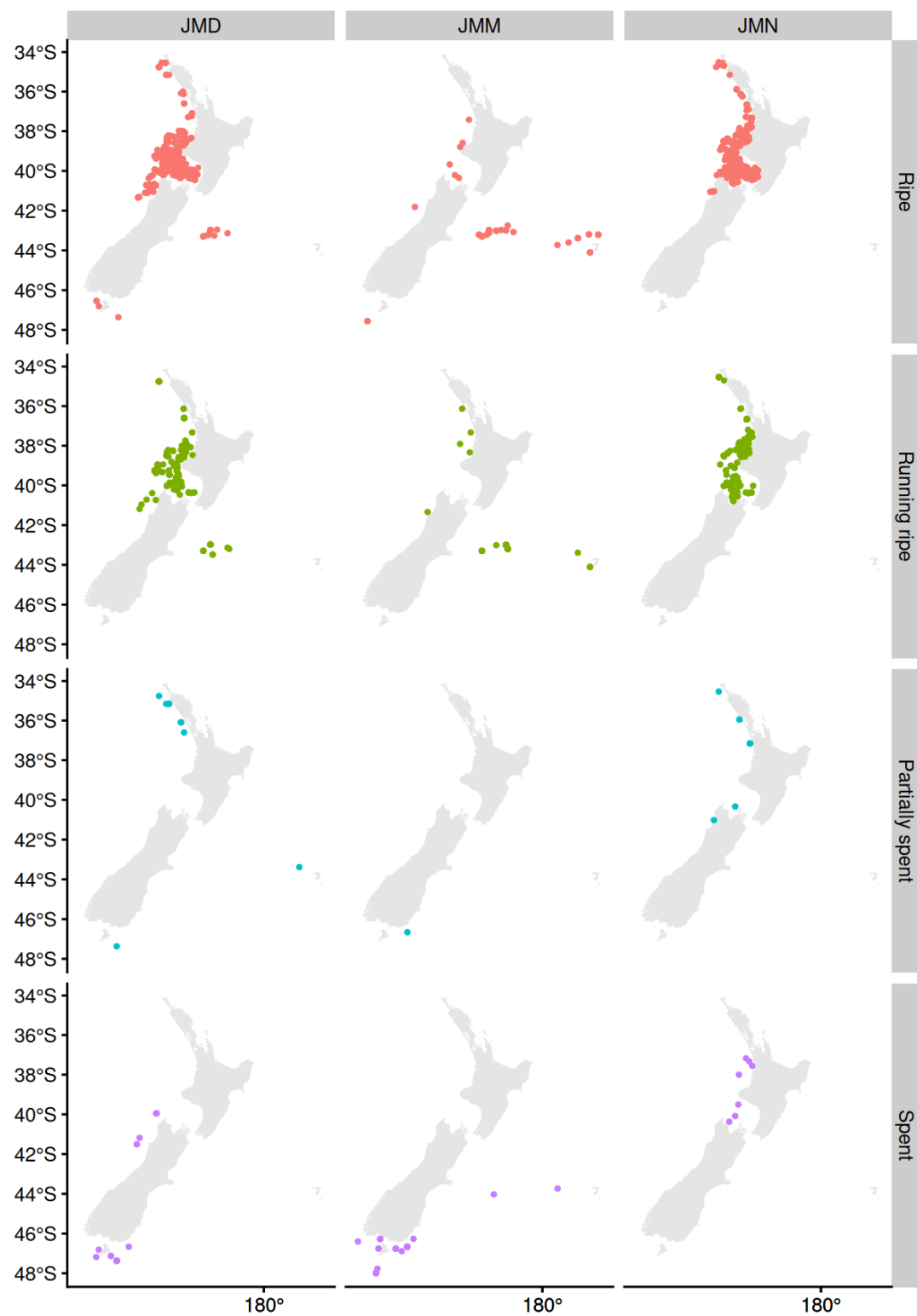


Figure 58: Locations of mature male jack mackerels identified on trawl surveys; stage 4 = ripe, stage 5 = running ripe, stage 6 = partially spent, stage 7 = spent.

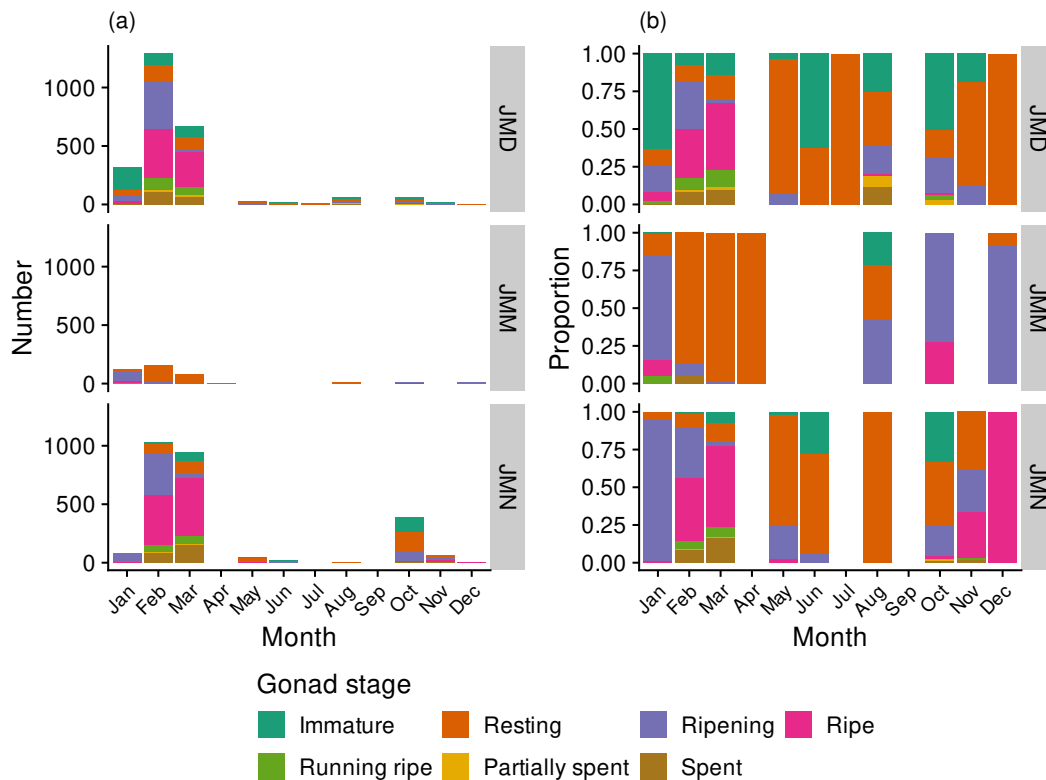


Figure 59: Gonad stages of female jack mackerels from trawl surveys, by month, in terms of (a) numbers of fish sampled and (b) proportions of sampled fish.

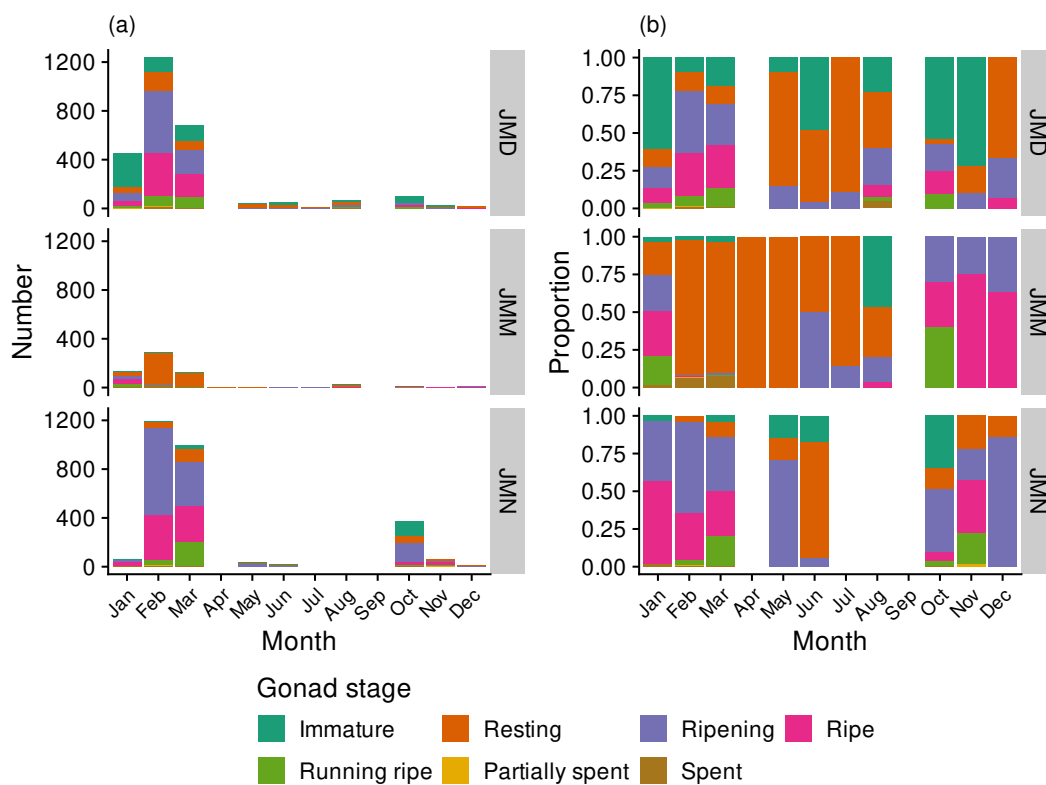


Figure 60: Gonad stages of male jack mackerels from trawl surveys, by month, in terms of (a) numbers of fish sampled and (b) proportions of sampled fish.

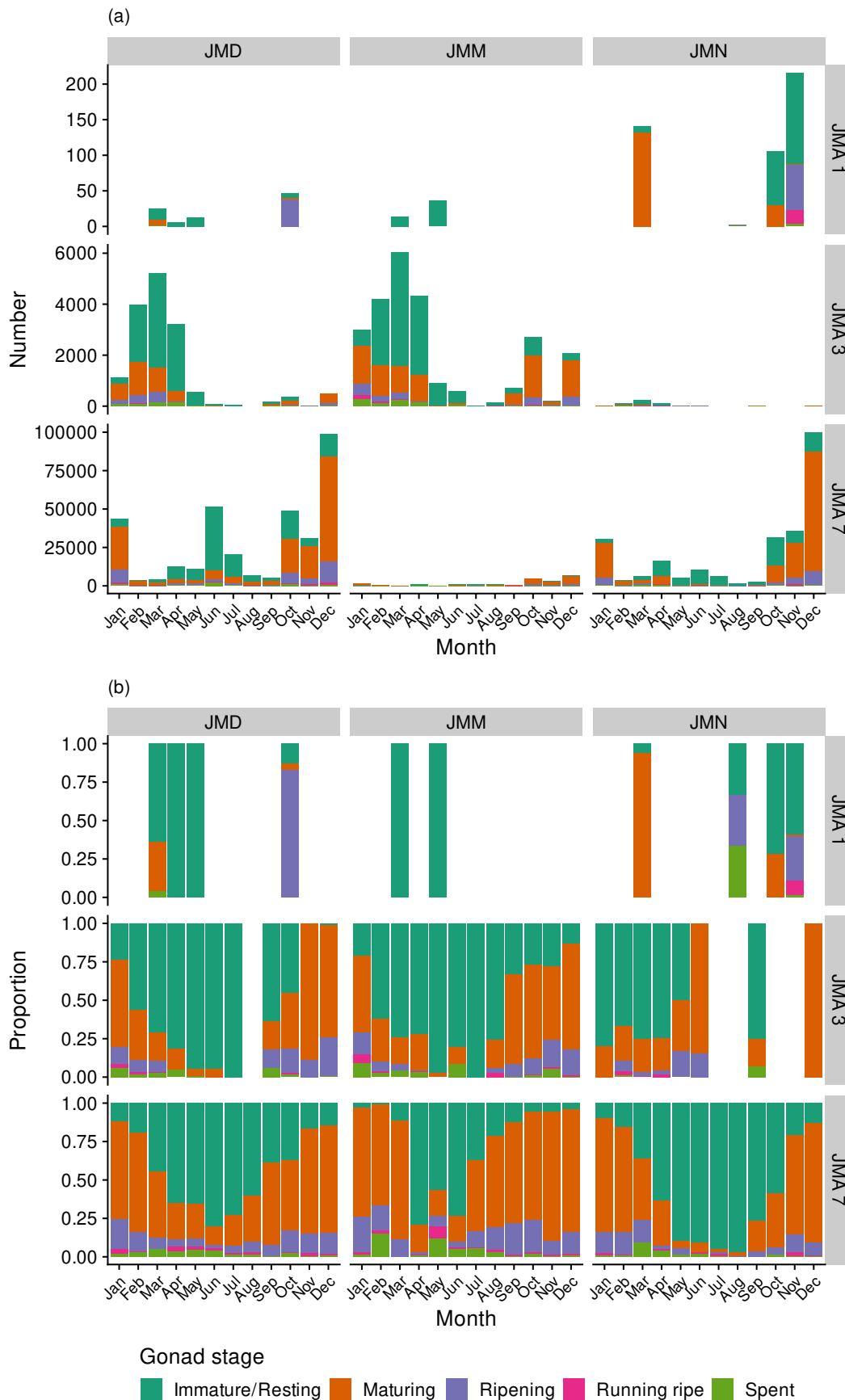


Figure 61: Gonad stages of female jack mackerels from observer sampling, by month and area, in terms of (a) numbers of fish sampled and (b) proportions of sampled fish.

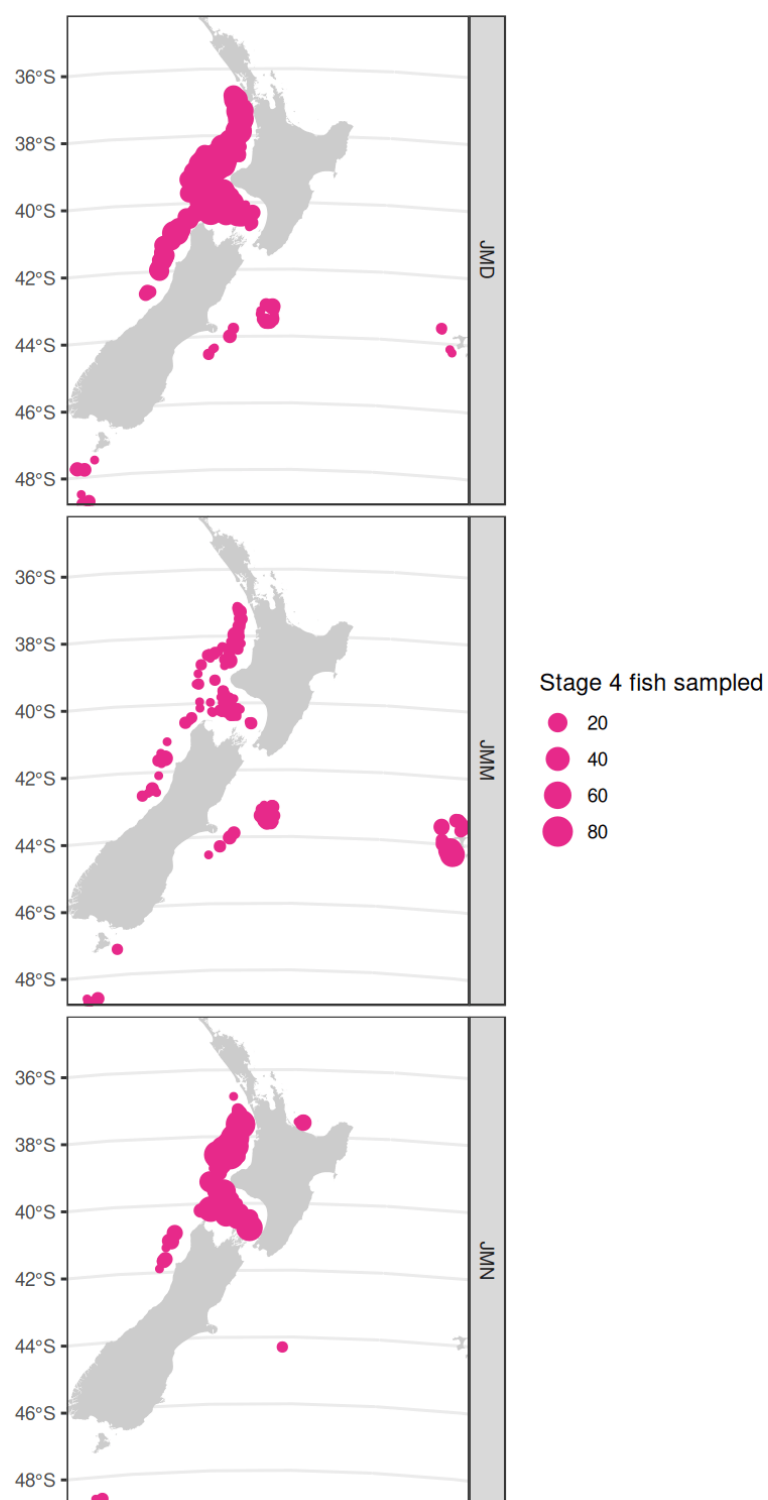


Figure 62: Numbers of running-ripe (maturity stage 4) female jack mackerels identified in observer sampling, plotted at sampled tow start locations. Samples were limited to those where all females in the sample were staged.

7. PREDICTING SPECIES COMPOSITION FOR UNOBSERVED EVENTS

The full model with spatio-temporal splines and explanatory variables showed the best cross-validation performance (Table 5), although the standard error in the ELPD difference was as large as the difference, suggesting that alternative models were only marginally less skillful at predicting jack mackerel species composition in FMA 3.

Table 5: Cross-validation (CV) expected log-predictive density (ELPD), difference (Δ) in ELPD between models, and the standard error (se) of the difference.

Model	CV ELPD	Δ ELPD	se(ELPD)
full	-8954	0	0
splineONLY	-8972	-17	16
noSTspline	-8998	-44	28
FMA _{noY}	-9006	-52	28
FMA	-9020	-66	29
FMA _{splineY}	-9048	-93	29
FMA _{Yonly}	-9048	-94	29
FMA _Y	-9052	-98	26
FMA _{linearY}	-9070	-115	30

7.1 Model Effects and Spatial Patterns

The fitted species distribution models showed temporally variable spatial patterns in jack mackerel species composition across JMA 3. Spatial effects demonstrated clear longitudinal and latitudinal gradients in species composition in recent years, with high proportions of JMM in high latitudes and to the east (around Chatham Islands; Figures 63, 64). Earlier in the time-series, however, there was little evidence for such strong spatial patterns, with high proportions of JMM encountered across latitudes and longitudes.

The trip random effect explained most of the remaining variation in the model (Table 6), suggesting either fine-scale spatio-temporal heterogeneity in species distributions or systematic differences in observer identification capabilities.

Table 6: Distribution of random effects in terms of mean, median, 5th and 95th percentile of the posterior distribution of standard deviations for random effects from the “full” species composition model.

Variable	Mean	Median	SD	5%	95%
Month	0.531	0.488	0.272	0.184	1.06
Target species	0.662	0.543	0.441	0.241	1.50
Trip	1.900	1.890	0.150	1.650	2.10

7.2 Cross-Validation Performance

Stratified cross-validation across degree latitude-longitude-year combinations revealed that model predictions were generally unbiased globally (Figure 65), and across spatial, temporal, and other model strata (Figure 66), as well as across levels of event catch (Figure 67). However, all predictions showed considerable uncertainty, reflecting variation across trips that was integrated over for predictions (removing this integration step led to tighter intervals in predictions; Figure 68). This integration step is necessary for unobserved trips, but the high uncertainty suggests limited precision in species composition predictions at the individual tow level for such trips.

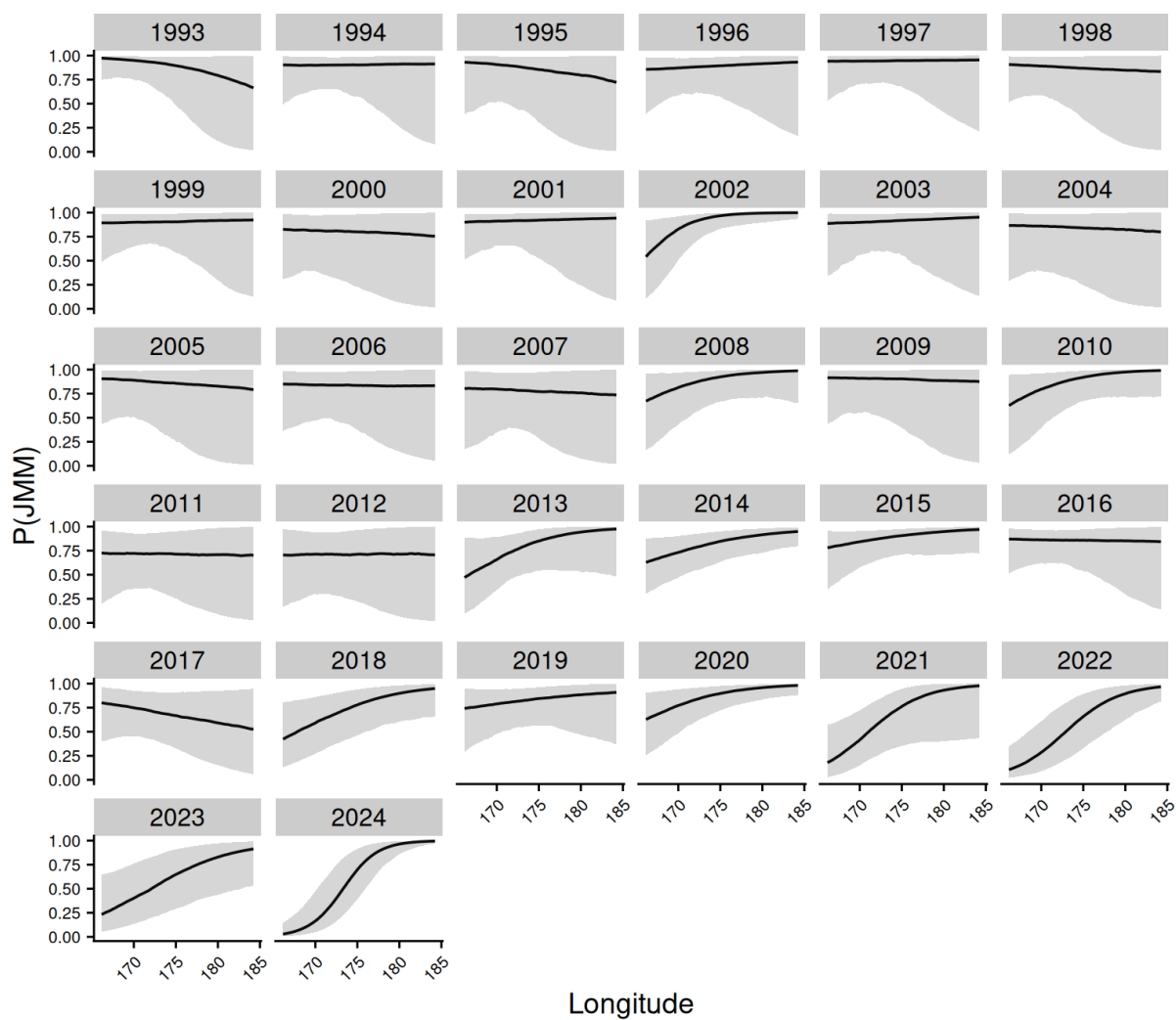


Figure 63: Estimated longitudinal effects on jack mackerel species composition (proportion, P , of JMM in catches) by year.

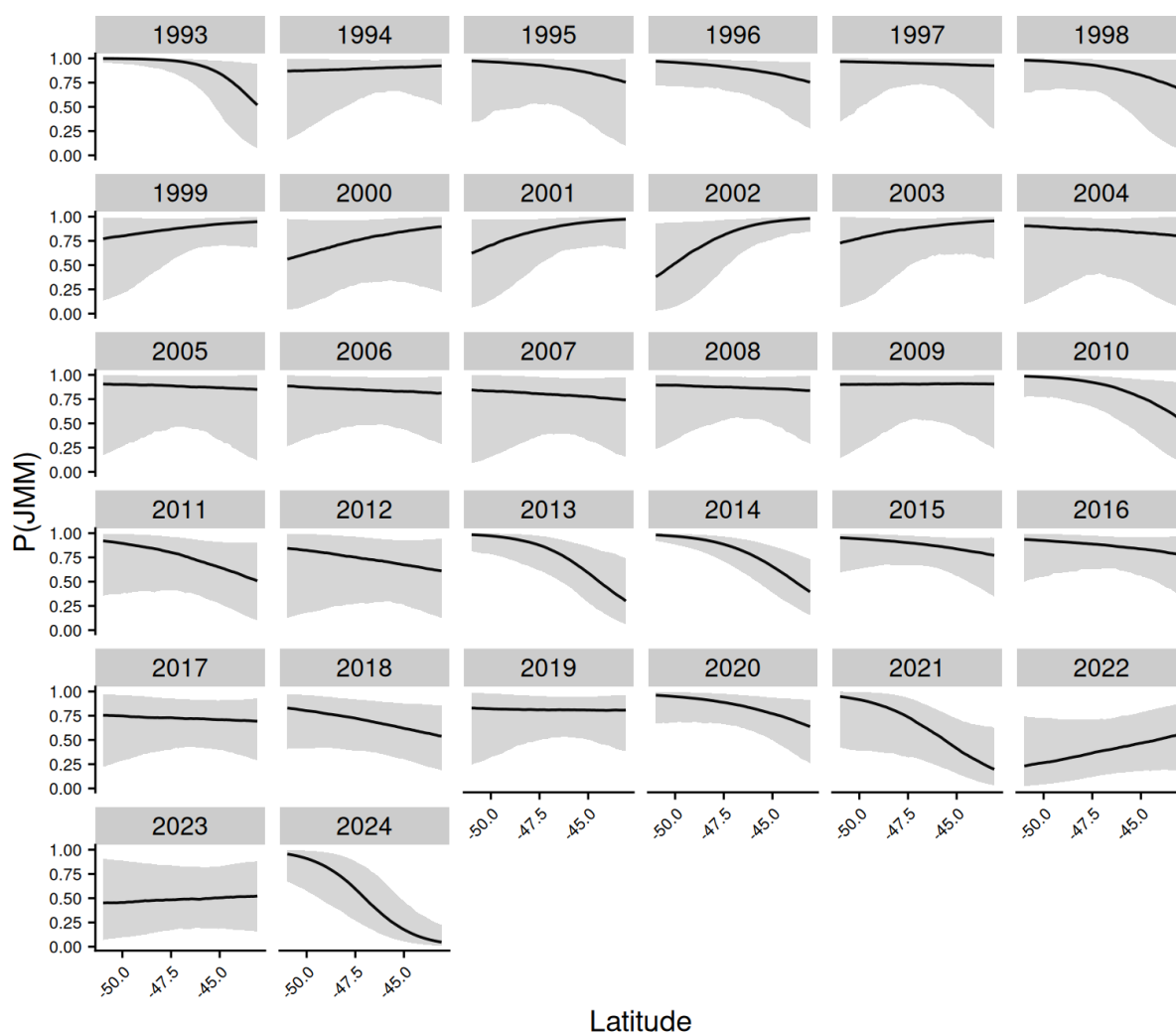


Figure 64: Estimated latitudinal effects on jack mackerel species composition (proportion, P , of JMM in catches) by year.

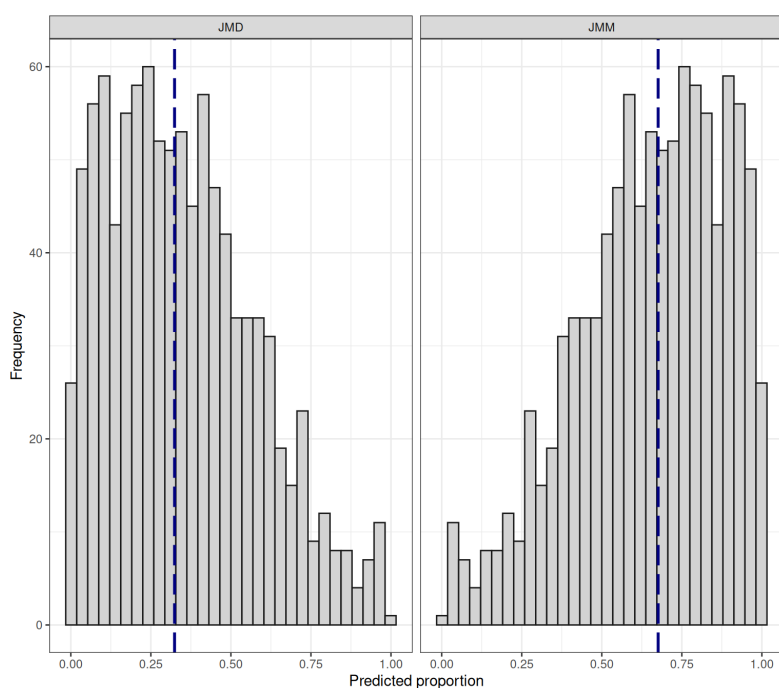


Figure 65: Posterior predictive distributions of species proportions, integrating over the trip random effect, and represented by a histogram across the full dataset, plotted by species.

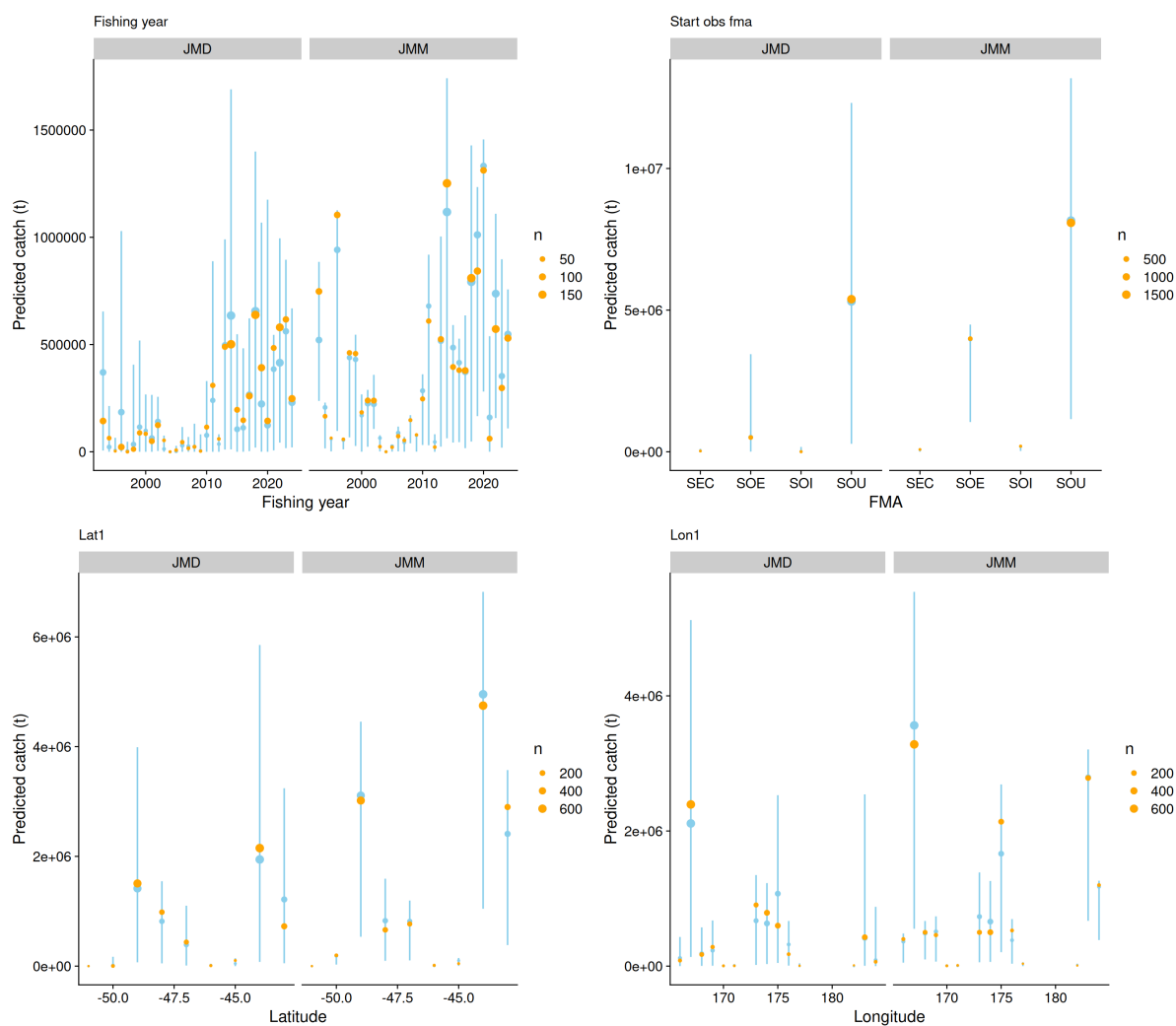


Figure 66: Posterior predictive distribution of species proportions across strata, integrating over the trip random effect, and represented by the posterior mean (blue point) and 95% credible interval, with observations shown in orange and point size scaled by the number (n) of observed events in each stratum.

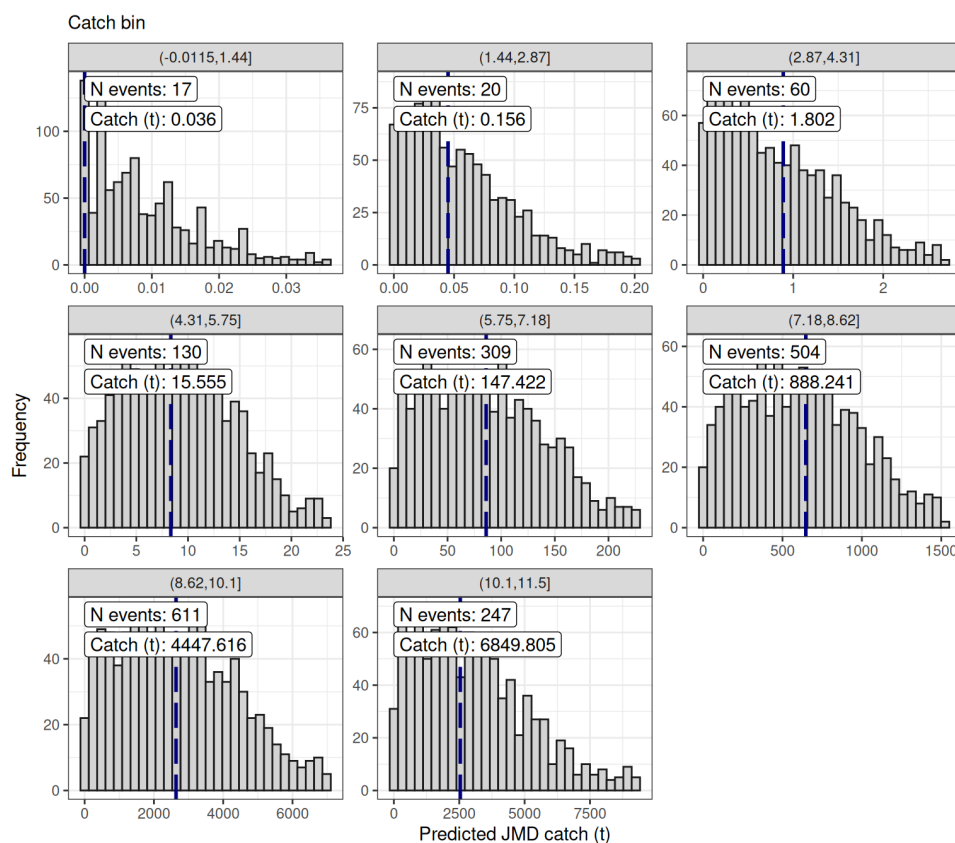


Figure 67: Posterior predictive distributions (histograms) of species proportions, integrating over the trip random effect, for observations divided into log-scaled catch bins; observed proportions are shown with dashed vertical lines, the catch across observations and number of observations in each bin are shown in the annotations.

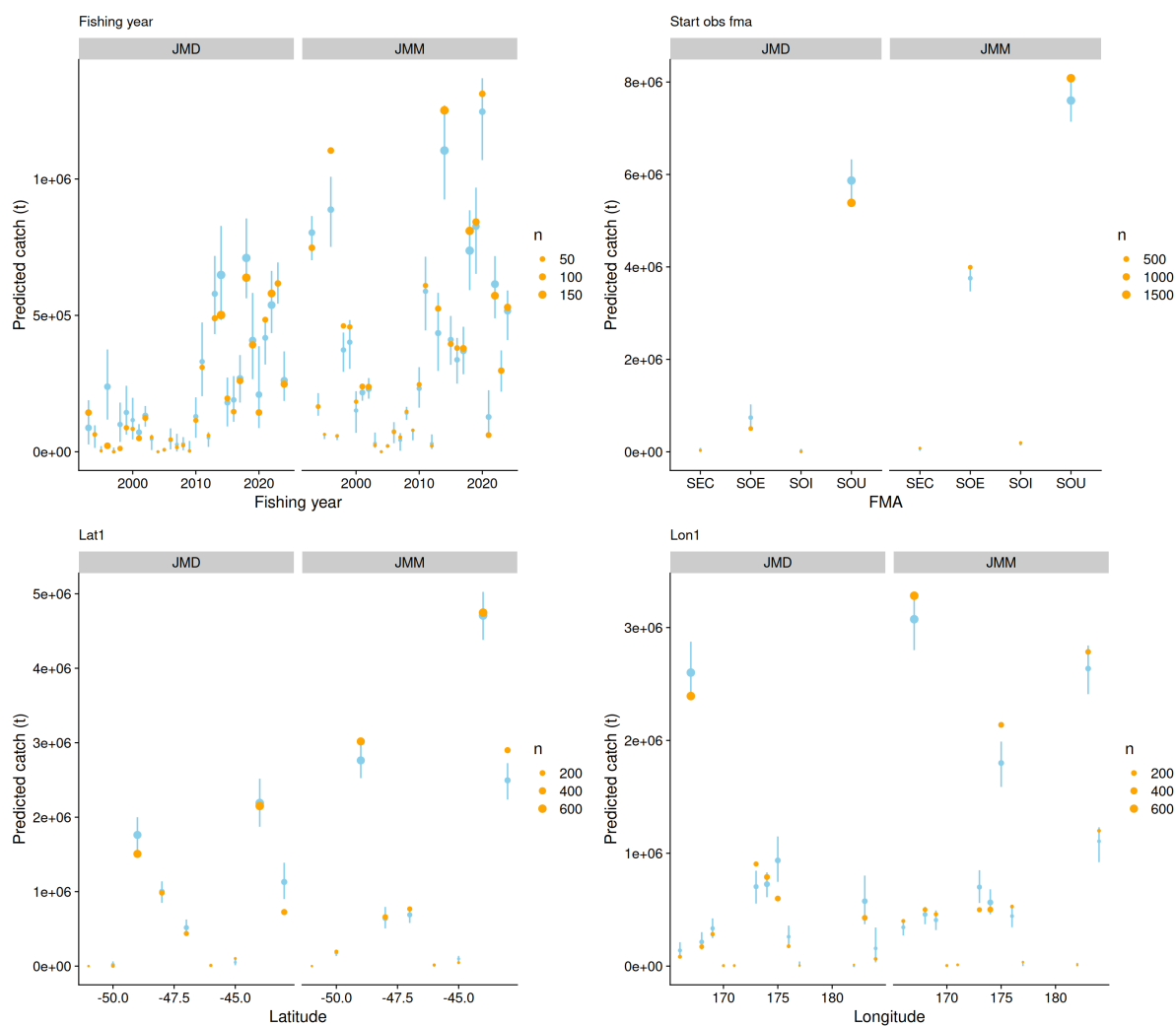


Figure 68: Posterior predictive distributions of species proportions across strata, without integrating over the trip random effect, and represented by the posterior mean (blue point) and 95% credible interval, with observations shown in orange and point size scaled by the number (n) of observed events in each stratum.

7.3 Predictive Ability Weighting

Analysis of the model's predictive ability revealed a bimodal distribution of prediction quality, characterized by “good” and “poor” prediction modes (Figure 69). This pattern was captured using a mixture model approach to assign data-point specific weights based on the expected prediction performance (Figure 70).

The mixture model for predictive ability incorporated spatial, temporal, and trip effects (Table 7). Most variation was attributed to the trip effect, suggesting that some trips were poorly predicted by our model, while spatio-temporal variation across years and FMAs contributed most to the predictive ability for observations where predictions were not classed as “poor” by the model.

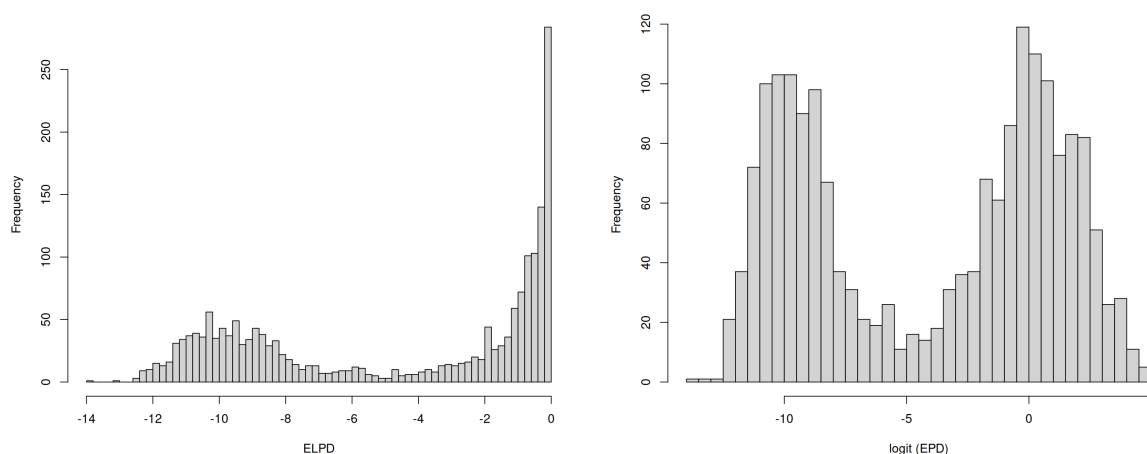


Figure 69: Distribution of the expected log predictive density (ELPD; left) and logit-transformed expected predictive density (EPD; left) showing the clear bimodal structure. The two modes represent “good” (higher values) and “poor” (lower values) prediction performance, suggesting systematic differences in model predictive ability across observations.

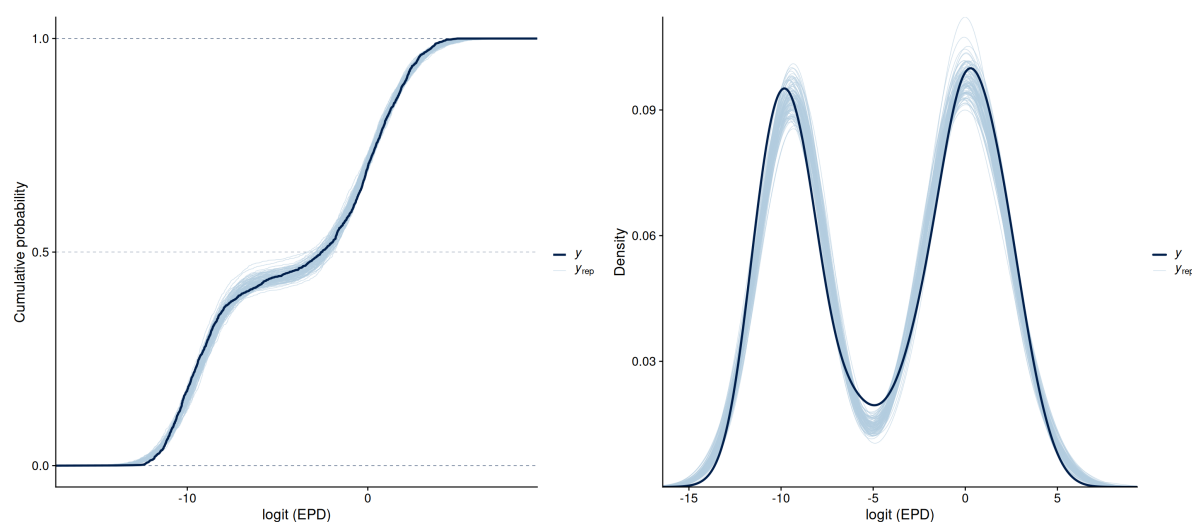


Figure 70: Cumulative density distribution of predicted (light blue lines) and observed (black line) logit(EPD) values (left), and corresponding density representation (right).

Table 7: Distribution of random effects by model component (see methods) from the mixture model in terms of mean, median, 5th and 95th percentile of the posterior distribution of standard deviations for random effects.

Component	Variable	Mean	Median	SD	5%	95%
μ_{good}	Fishing year	0.55	0.55	0.32	0.05	1.09
	FMA	0.45	0.35	0.38	0.03	1.18
	FMA:Fishing year	1.03	1.02	0.18	0.74	1.34
	Target species	0.82	0.76	0.33	0.41	1.47
$logit(p[\mu_{poor}])$	Fishing year	0.60	0.58	0.37	0.07	1.26
	FMA	1.13	1.00	0.70	0.19	2.53
	FMA:Fishing year	0.75	0.74	0.33	0.21	1.32
	Target species	1.16	1.03	0.52	0.55	2.20
	Trip	2.41	2.40	0.24	2.04	2.83

Alternative models were trialed to explore if the trip effect could be tied to individual observers. Including the observer ID as a random effect in the mixture component did not change the estimate of large variation in predictive ability between trips. However, strong confounding between trip and observer effects (most observers conducted single trips) limited the ability to definitively separate these sources of variation.

The derived posterior mean weights for the CPUE dataset often showed bi- or tri-modal distributions, reflecting the difference in prediction skill of the model across observations (Figure 71). In some years, most observations had low weights (e.g., 2011), effectively down-weighting the amount of information available for the CPUE model in those years. Weights were generally higher in recent years.

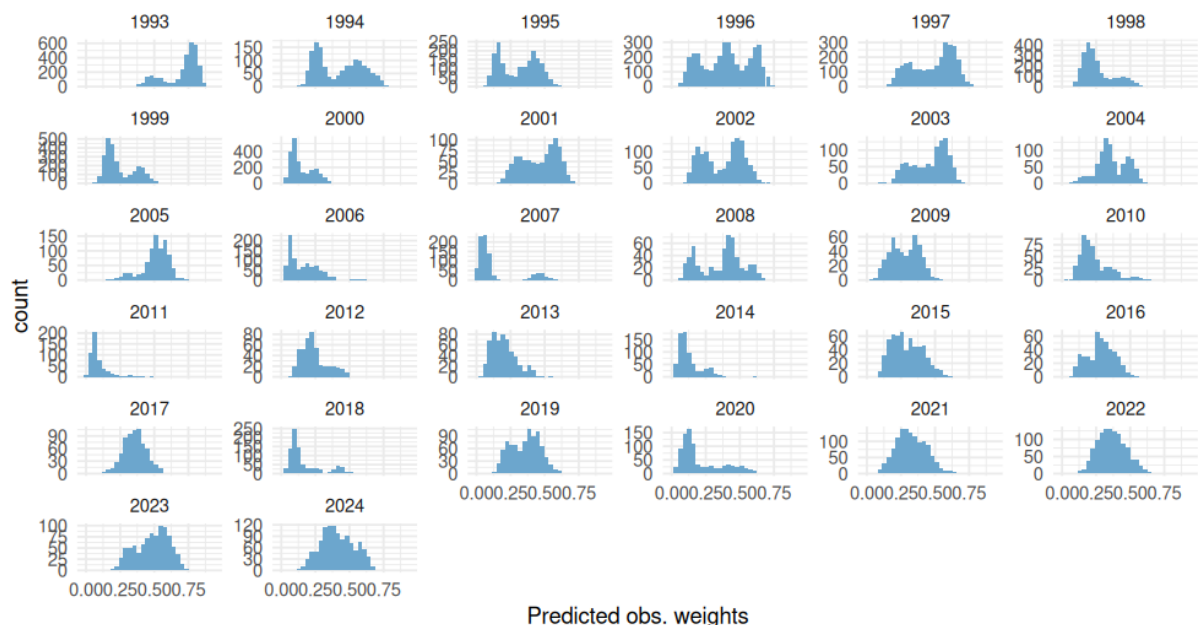


Figure 71: Distribution of estimated posterior mean weights by observation and year from the mixture model.

8. CATCH-PER-UNIT-EFFORT

A wide range of models for standardising Catch Per Unit Effort (CPUE) were investigated with the intention of establishing abundance indices for jack mackerels in JMA 3 (Table 8). These included:

- models for the aggregate catch of jack mackerels (JMA) using the commercial catch and effort data;
- models for the estimated catch of *T. declivis* (JMD) and *T. murphyi* (JMM) using observer data; and
- models for JMD and JMM using the commercial data where the species catches were estimated using the species composition modelling.

The models for aggregate jack mackerel catches are of secondary interest for stock monitoring, but were used for conducting sensitivity analyses on the core fleet selection and model structure. Sensitivities included:

- the impact of records where catch was allocated by effort;
- splitting vessels with long term participation in the fishery; and
- exploring how the seasonal effect is represented in the models.

Species-specific models focussed on catches of *T. declivis* (JMD) and *T. murphyi* (JMM) following the recognition that, to the extent *Trachurus novaezelandiae* (JMN) occurs in the JMA 3 area, it is not a significant catch of the current commercial fisheries. Initial species-specific models were constructed using data from fisheries observers, following the approach used to produce abundance indices for JMD and JMN in JMA 7 (Middleton et al. 2024). However, as a result of the more limited observer coverage in JMA 3 and the lower proportion of events where jack mackerel length-frequency sampling was carried out (that provide the basis for estimating catch proportions), the datasets for these models were found to be too sparse; as a result, these models were not pursued further.

Because of the sparse observer data, CPUE models for JMD and JMM were instead pursued using the full CPUE dataset (i.e., commercial catch and effort data, extracted in the same way as that used in the aggregate jack mackerel catch models) but with the species' catches predicted using the species composition models. A variety of methods of using the species composition models were investigated:

- predictions based on the means of multiple draws from the model posterior, with weights (the base approach);
- using unweighted predictions;
- applying thresholding where small predicted catches were set to zero; and
- multiple (10) models using single draws from the species composition model, combined to provide a composite index.

Diagnostics for the aggregate JMA3 MW event model, and the species specific models with catches predicted using the base approach for the composition modelling (JMA3 MW pred JMD event, JMA3 MW pred JMM event) are described below; diagnostics for other key models are included as appendices.

Stepwise selection of the explanatory variables offered to the models was not carried out, as investigations have demonstrated that stepwise selection can result in poorer performance when fishing year is forced into the model (P. Neubauer, unpublished analyses).

Table 8: Summary of models constructed for CPUE standardisation. The primary models are highlighted in darker grey and supporting diagnostics are included below. Diagnostics for secondary models, highlighted in lighter grey, are included in Appendix D.

Series name	Data resolution	Response variable	Explanatory variable selection process	Core fleet years	Core fleet trips	Assumed error distribution
JMA3 MW event	event	allockg_top5	All selected	5	5	lognormal
JMA3 MW event (allow effort allocation)	event	allockg_top5	All selected	5	5	lognormal
JMA3 MW event (split long vessels)	event	allockg_top5	All selected	5	3	lognormal
JMA3 MW event (season day)	event	allockg_top5	All selected	5	5	lognormal
JMA3 MW process daily	daily	prockg	All selected	5	5	gamma
JMA3 MW pred JMD event	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMM event	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event no weights	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMM event no weights	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event threshold	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMM event threshold	event	pred_catch_JMI	All selected	5	5	Weibull
JMN7 MW observer	observer	jmnkg	Stepwise	4	1	Weibull
JMA3 MW pred JMD event draws1	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws2	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws3	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws4	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws5	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws6	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws7	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws8	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws9	event	pred_catch_JMI	All selected	5	5	Weibull
JMA3 MW pred JMD event draws10	event	pred_catch_JMI	All selected	5	5	Weibull
JMD7 MW observer	observer	jmdkg	Stepwise	4	1	Weibull

8.1 JMA3 MW event

The JMA3 MW event series, defined in Table 9, models the aggregate catch of jack mackerels in JMA 3. Data were selected for events that used midwater trawling, targeting either jack mackerels, barracouta, or squid, and with a start position in the Statistical Areas that included the majority of the JMA 3 jack mackerel catch by midwater trawling. Data were extracted from the 1993 fishing year onwards, because the dataset became too sparse when previous years were included.

Vessels were retained in the core fleet if they had carried out five trips in at least five years; this retained 78.3% of the catch while reducing the core fleet in the modelling dataset to 12 vessels (Figure 72).

The core fleet showed good overlap and moderate fleet turnover (Figure 73), with one vessel participating throughout the series and three current vessels having joined the fleet in the 1990s. A range of data filters were applied to the CPUE dataset to remove covariates with null or outlying values; however, it was the core fleet selection process that had the greatest influence on the data retained for modelling (Table 10).

The core fleet dataset (Table 11) comprised between four and eight vessels each year, usually conducting at least 1000 tows per annum and taking a substantial part of the JMA 3 catch. There was substantial interannual variation in the proportion of tows that caught jack mackerels, with the highest proportions occurring in 2023 and 2024 (over 80% of tows reporting jack mackerels in the top 5 species caught).

One of the data filters removed any events where the catch from a trip was allocated to the events equally across all tows, rather than proportionally to estimated catches. This removed a number of

tows, but little catch, in the mid 2000s (Table 10) resulting in a dataset where all catches were allocated to tows on the basis of estimated catch (Figure 74). The impact of this is considered, below, in a sensitivity analysis.

Target species, year, and Statistical Area were responsible for most of the deviance explained in the model for the occurrence of jack mackerel catches (Table 12). There was little effect of standardisation (Figure 75); target species had the most substantial impact on the annual indices, but the effects were moderated by other variables (Figure 76).

The three most recent entrants to the core fleet were more likely to report a catch of jack mackerels (Figure 77), while tows targeting jack mackerels were most likely to report catching jack mackerels (Figure 78), with the relative targeting of squid, barracouta, and jack mackerels varying substantially from year to year through the series. Most effort by the core fleet was from January to April each year, with the result that the monthly patterns in the occurrence of jack mackerel catches were rather poorly determined outside this period (Figure 79).

Most effort by the core fleet has generally been in Statistical Area 028, with Area 602 (around the Auckland Islands) having the lowest probability of catching jack mackerels, and Area 029, at the southern extent of the Stewart-Snares shelf, the highest (Figure 80). Fishing duration (per tow) increased in the early 2000s, but have been stable since, with the highest probability of catching jack mackerels at the intermediate tow durations represented by the majority of the data (Figure 81). The daily fishing patterns of the fleet have changed little over the period of the series, but tows starting in the middle of the day have the lowest probability of catching jack mackerels (Figure 82). Tows in shallower water had the highest probability of catching jack mackerels, with the probability reducing to depths of 200 m before stabilising (Figure 83); however depths fished changed little over the series.

Net heights (the vertical opening of the trawl net) were likely to be vessel specific and had little influence on the likelihood of catching jack mackerels (Figure 84); fishing speed had a more substantial effect and showed some evidence of a recent shift to faster towing speeds (Figure 85).

In the lognormal model for positive catches, fishing year and target species were responsible for most of the deviance explained by the model (Table 13). Distributions of residuals suggest the lognormal model fits reasonably well (Figure 86), and somewhat better than either a gamma or Weibull model (Figure 87).

The impacts of standardisation were most apparent during the late 1990s and mid 2010s; in particular the standardised catch rate was highest in 1996, rather than 1999 in the unstandardised data (Figure 88). Target species was responsible for most of these major shifts, although most categorical variables have some effect (Figure 89).

Two of the recent entrants to the core fleet, that had a high probability of catching jack mackerels, were estimated to have the lowest catch rates of jack mackerels in positive catch tows (Figure 90). However, as expected, the catch rate was highest in tows targeting jack mackerels (Figure 91). There was little monthly effect on catch rates, although this was again poorly estimated outside the main January to April fishery (Figure 92).

The highest catch rates were estimated to occur in Statistical Areas 050 and 052, near the Chatham Islands, although these areas were not fished continuously over the series (Figure 93). Increased tow durations were associated with increased catches (Figure 94) with the result that the general increase in tow durations resulted in a general increase in influence over the period. Like the occurrence of catches of jack mackerel, catch rates were lowest for tows starting in the middle of the day (Figure 95), with the highest catch rates estimated to occur in waters of around 100 m depth (Figure 96).

Net heights appeared to influence catch rates only when this was less than about 25 m (Figure 97), while increased towing speeds were generally associated with higher catches (Figure 98).

Residual implied coefficients by target species (Figure 99) did not suggest very substantial differences in jack mackerel catch rates over time between the different target fisheries. Data were temporally restricted in several of the statistical areas included in the modelling, but the areas with the greatest temporal continuity in effort all showed a good correlation with the overall series (Figure 100).

The binomial and positive models showed similar trends during the 1990s, that reinforced the increased abundance estimated in the combined series during this period (Figure 101, Table 14). However, after the mid 2010s, there were diverging trends resulting in a flattening of the combined series.

Table 9: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW event CPUE series.

Series	JMA3 MW event
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	allockg_top5 ~ fyear + vessel_key + target_species + month + stat_area + ns(log(fishing_duration), 3) + ns(log(start_time), 3) + ns(log(bottom_depth), 3) + ns(log(effort_height), 3) + ns(effort_speed, 3)
Stepwise selection	No
Positive catch distribution	Lognormal

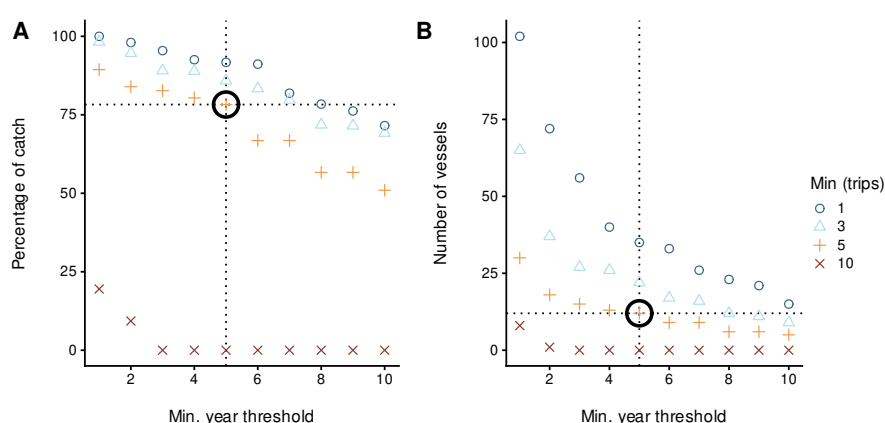


Figure 72: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW event CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

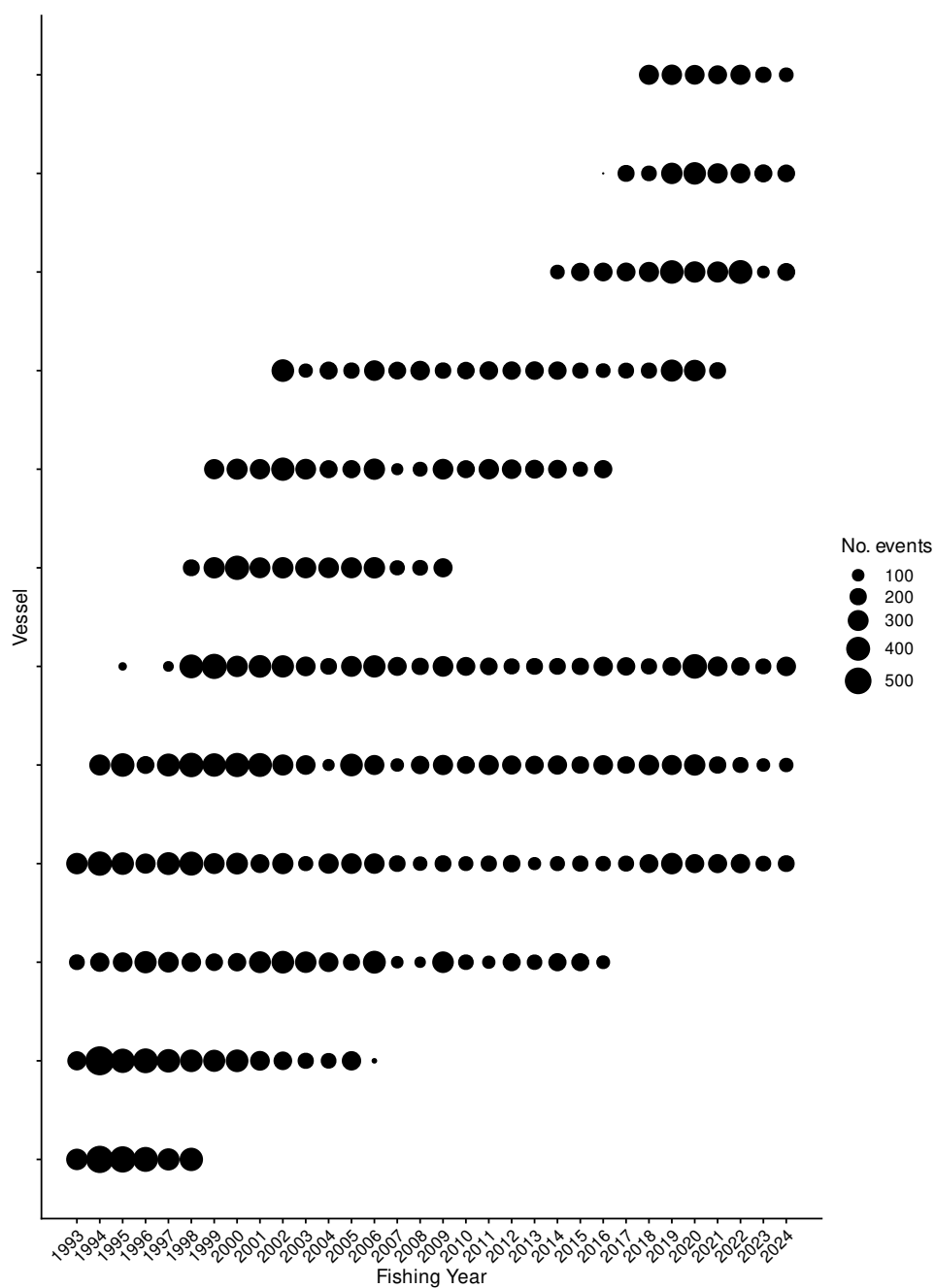


Figure 73: Number of events by fishing year for core vessels in the JMA3 MW event series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table 10: Summary of the JMA3 MW event dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	9582 (100%) n: 7120	5046 (100%) n: 6431	7167 (100%) n: 7634	13816 (100%) n: 8007	12174 (100%) n: 5773	12098 (100%) n: 5656	14572 (100%) n: 5261	8247 (100%) n: 3762	2001 (100%) n: 3011
Fishing speed not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13810 (100%) n: 7999	12150 (100%) n: 5767	12098 (100%) n: 5652	14570 (100%) n: 5257	8247 (100%) n: 3762	2001 (100%) n: 3010
Fishing speed lt 10kts	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
Start date not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
End date not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
Start depth not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7960	12122 (100%) n: 5739	11950 (99%) n: 5634	14548 (100%) n: 5245	8246 (100%) n: 3759	1998 (100%) n: 3000
Headline height not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13746 (99%) n: 7811	12120 (100%) n: 5731	11948 (99%) n: 5623	14531 (100%) n: 5238	8236 (100%) n: 3755	1998 (100%) n: 2999
Fishing speed >3.5kn	9203 (96%) n: 6839	5017 (99%) n: 6143	7114 (99%) n: 7490	13660 (99%) n: 7520	12039 (99%) n: 5480	11904 (98%) n: 5399	14418 (99%) n: 5123	8176 (99%) n: 3702	1988 (99%) n: 2985
Headline height >15m	9180 (96%) n: 6818	4980 (99%) n: 6093	7064 (99%) n: 7447	13389 (97%) n: 7414	11960 (98%) n: 5394	11866 (98%) n: 5374	14363 (99%) n: 5027	8170 (99%) n: 3692	1987 (99%) n: 2978
Headline height <90m	8535 (89%) n: 6666	4946 (98%) n: 6091	7064 (99%) n: 7447	13377 (97%) n: 7403	10684 (88%) n: 5191	10849 (90%) n: 4986	14312 (98%) n: 5013	8158 (99%) n: 3682	1987 (99%) n: 2977
Fishing duration >15mins	8398 (88%) n: 6634	4929 (98%) n: 6074	7031 (98%) n: 7430	13264 (96%) n: 7374	10609 (87%) n: 5175	10833 (90%) n: 4972	14303 (98%) n: 5002	8158 (99%) n: 3679	1987 (99%) n: 2970
Fishing duration <15h	8380 (87%) n: 6616	4918 (97%) n: 6057	7006 (98%) n: 7421	13224 (96%) n: 7356	10435 (86%) n: 5144	10791 (89%) n: 4957	14263 (98%) n: 4993	8098 (98%) n: 3660	1987 (99%) n: 2970
Seabed depth >50m	8380 (87%) n: 6616	4918 (97%) n: 6057	7006 (98%) n: 7420	13224 (96%) n: 7356	10435 (86%) n: 5144	10768 (89%) n: 4954	14263 (98%) n: 4992	8098 (98%) n: 3659	1987 (99%) n: 2970
Seabed depth <350m	8344 (87%) n: 6577	4906 (97%) n: 6017	6996 (98%) n: 7243	13197 (96%) n: 7327	10398 (85%) n: 5131	10756 (89%) n: 4950	14231 (98%) n: 4969	8096 (98%) n: 3649	1982 (99%) n: 2967
Start time >0	8004 (84%) n: 6515	4803 (95%) n: 5975	6792 (95%) n: 7172	12752 (92%) n: 7235	10050 (83%) n: 5077	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3627	1958 (98%) n: 2956
SA subset	8004 (84%) n: 6515	4803 (95%) n: 5975	6792 (95%) n: 7172	12752 (92%) n: 7235	10050 (83%) n: 5077	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3627	1958 (98%) n: 2956
No effort allocation	7991 (83%) n: 6469	4743 (94%) n: 5846	6770 (94%) n: 7039	12752 (92%) n: 7235	10050 (83%) n: 5076	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3623	1958 (98%) n: 2956
Core fleet selection	3053 (32%) n: 1050	3108 (62%) n: 2092	4062 (57%) n: 1942	6483 (47%) n: 1701	5882 (48%) n: 1816	7330 (61%) n: 2399	9081 (62%) n: 2270	6510 (79%) n: 2354	1728 (86%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed lt 10kts	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Start date not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
End date not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Start depth not null	3661 (100%) n: 3306	1681 (100%) n: 3109	528 (100%) n: 3279	570 (100%) n: 3636	4607 (100%) n: 2831	1445 (100%) n: 2412	2235 (100%) n: 2249	1800 (100%) n: 2188	2226 (100%) n: 1316
Headline height not null	3661 (100%) n: 3306	1681 (100%) n: 3109	528 (100%) n: 3279	570 (100%) n: 3636	4607 (100%) n: 2831	1445 (100%) n: 2412	2235 (100%) n: 2249	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed >3.5kn	3659 (100%) n: 3266	1671 (99%) n: 3064	526 (100%) n: 3168	570 (100%) n: 3521	4601 (100%) n: 2794	1443 (100%) n: 2380	2205 (99%) n: 2225	1751 (97%) n: 2133	2226 (100%) n: 1303
Headline height >15m	3614 (99%) n: 3243	1669 (99%) n: 3046	519 (98%) n: 3151	570 (100%) n: 3513	4601 (100%) n: 2790	1443 (100%) n: 2359	2205 (99%) n: 2208	1741 (97%) n: 2129	2225 (100%) n: 1300
Headline height <90m	3614 (99%) n: 3243	1669 (99%) n: 3046	516 (98%) n: 3150	570 (100%) n: 3513	4601 (100%) n: 2789	1443 (100%) n: 2359	2205 (99%) n: 2207	1741 (97%) n: 2129	2225 (100%) n: 1300
Fishing duration >15mins	3575 (98%) n: 3229	1669 (99%) n: 3041	516 (98%) n: 3141	570 (100%) n: 3502	4598 (100%) n: 2782	1442 (100%) n: 2354	2204 (99%) n: 2201	1741 (97%) n: 2127	2225 (100%) n: 1298
Fishing duration <15h	3574 (98%) n: 3226	1664 (99%) n: 3040	516 (98%) n: 3139	570 (100%) n: 3502	4598 (100%) n: 2780	1442 (100%) n: 2353	2192 (98%) n: 2198	1740 (97%) n: 2123	2225 (100%) n: 1297
Seabed depth >50m	3569 (97%) n: 3224	1664 (99%) n: 3040	516 (98%) n: 3139	570 (100%) n: 3502	4598 (100%) n: 2780	1442 (100%) n: 2353	2192 (98%) n: 2198	1740 (97%) n: 2123	2225 (100%) n: 1297
Seabed depth <350m	3564 (97%) n: 3222	1664 (99%) n: 3036	516 (98%) n: 3135	570 (100%) n: 3501	4598 (100%) n: 2779	1442 (100%) n: 2351	2192 (98%) n: 2196	1722 (96%) n: 2121	2225 (100%) n: 1296
Start time >0	3500 (96%) n: 3198	1639 (98%) n: 3028	509 (96%) n: 3120	556 (98%) n: 3459	4508 (98%) n: 2766	1402 (97%) n: 2334	2166 (97%) n: 2185	1660 (92%) n: 2109	2181 (98%) n: 1283
SA subset	3500 (96%) n: 3198	1639 (98%) n: 3028	509 (96%) n: 3120	556 (98%) n: 3459	4508 (98%) n: 2766	1402 (97%) n: 2334	2166 (97%) n: 2185	1660 (92%) n: 2109	2181 (98%) n: 1283
No effort allocation	3500 (96%) n: 3196	1638 (97%) n: 2489	507 (96%) n: 2363	555 (97%) n: 2582	4508 (98%) n: 2593	1399 (97%) n: 1705	2162 (97%) n: 1590	1654 (92%) n: 1991	2181 (98%) n: 1263
Core fleet selection	3322 (91%) n: 2598	1466 (87%) n: 1905	495 (94%) n: 1725	551 (97%) n: 2103	4445 (96%) n: 2204	1245 (86%) n: 1109	1750 (78%) n: 1226	1256 (70%) n: 1810	2077 (93%) n: 1194

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5024 (100%) n: 1678	4301 (100%) n: 2307
Fishing speed not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5024 (100%) n: 1678	4301 (100%) n: 2307
Fishing speed lt 10kts	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Start date not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
End date not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Start depth not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Headline height not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Fishing speed >3.5kn	3389 (100%) n: 1414	2668 (99%) n: 1465	3486 (100%) n: 1229	4347 (100%) n: 1456	3621 (100%) n: 1382	2507 (100%) n: 1506	4141 (100%) n: 1359	4995 (99%) n: 1625	4293 (100%) n: 2269
Headline height >15m	3341 (98%) n: 1397	2668 (99%) n: 1464	3486 (100%) n: 1229	4347 (100%) n: 1456	3618 (100%) n: 1380	2507 (100%) n: 1506	4102 (99%) n: 1356	4995 (99%) n: 1625	4293 (100%) n: 2263
Headline height <90m	3341 (98%) n: 1397	2668 (99%) n: 1463	3486 (100%) n: 1229	4347 (100%) n: 1456	3618 (100%) n: 1380	2507 (100%) n: 1506	4102 (99%) n: 1356	4994 (99%) n: 1624	4293 (100%) n: 2263
Fishing duration >15mins	3339 (98%) n: 1396	2668 (99%) n: 1459	3482 (100%) n: 1224	4347 (100%) n: 1451	3618 (100%) n: 1379	2507 (100%) n: 1501	4102 (99%) n: 1354	4994 (99%) n: 1624	4293 (100%) n: 2260
Fishing duration <15h	3339 (98%) n: 1394	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2507 (100%) n: 1500	4102 (99%) n: 1354	4994 (99%) n: 1624	4279 (99%) n: 2257
Seabed depth >50m	3339 (98%) n: 1394	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2507 (100%) n: 1500	4102 (99%) n: 1354	4994 (99%) n: 1624	4279 (99%) n: 2257
Seabed depth <350m	3339 (98%) n: 1392	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2506 (100%) n: 1494	4102 (99%) n: 1354	4994 (99%) n: 1623	4279 (99%) n: 2256
Start time >0	3297 (97%) n: 1384	2658 (99%) n: 1453	3439 (99%) n: 1217	4181 (96%) n: 1440	3556 (98%) n: 1371	2454 (98%) n: 1486	4034 (97%) n: 1350	4979 (99%) n: 1617	4279 (99%) n: 2252
SA subset	3297 (97%) n: 1384	2658 (99%) n: 1453	3439 (99%) n: 1217	4181 (96%) n: 1440	3556 (98%) n: 1371	2454 (98%) n: 1486	4034 (97%) n: 1350	4979 (99%) n: 1617	4279 (99%) n: 2252
No effort allocation	3297 (97%) n: 1384	2657 (99%) n: 1390	3438 (99%) n: 1216	4181 (96%) n: 1438	3556 (98%) n: 1371	2431 (97%) n: 1450	4034 (97%) n: 1337	4979 (99%) n: 1616	4279 (99%) n: 2252
Core fleet selection	3273 (96%) n: 1303	2573 (96%) n: 1344	3375 (97%) n: 1169	4171 (96%) n: 1422	3544 (98%) n: 1363	2385 (95%) n: 1412	3996 (96%) n: 1213	4965 (99%) n: 1599	4126 (96%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Fishing speed not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Fishing speed lt 10kts	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Start date not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
End date not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Start depth not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Headline height not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Fishing speed >3.5kn	4458 (100%) n: 2430	5242 (100%) n: 1919	4624 (100%) n: 1794	4760 (100%) n: 1037	3025 (99%) n: 1342
Headline height >15m	4451 (100%) n: 2426	5242 (100%) n: 1917	4624 (100%) n: 1792	4760 (100%) n: 1035	3014 (99%) n: 1336
Headline height <90m	4451 (100%) n: 2426	5242 (100%) n: 1917	4624 (100%) n: 1792	4760 (100%) n: 1035	3014 (99%) n: 1336
Fishing duration >15mins	4451 (100%) n: 2421	5195 (99%) n: 1912	4624 (100%) n: 1785	4759 (100%) n: 1032	3014 (99%) n: 1331
Fishing duration <15h	4451 (100%) n: 2421	5191 (99%) n: 1910	4624 (100%) n: 1785	4756 (100%) n: 1031	3014 (99%) n: 1330
Seabed depth >50m	4451 (100%) n: 2421	5191 (99%) n: 1910	4624 (100%) n: 1784	4756 (100%) n: 1031	3014 (99%) n: 1330
Seabed depth <350m	4451 (100%) n: 2419	5191 (99%) n: 1910	4624 (100%) n: 1783	4756 (100%) n: 1030	3014 (99%) n: 1329
Start time >0	4449 (100%) n: 2415	5026 (96%) n: 1902	4607 (100%) n: 1781	4746 (100%) n: 1029	3013 (99%) n: 1326
SA subset	4449 (100%) n: 2415	5026 (96%) n: 1902	4607 (100%) n: 1781	4746 (100%) n: 1029	3013 (99%) n: 1326
No effort allocation	4449 (100%) n: 2414	5026 (96%) n: 1898	4607 (100%) n: 1775	4746 (100%) n: 1029	3013 (99%) n: 1306
Core fleet selection	3994 (90%) n: 2235	4852 (93%) n: 1744	4257 (92%) n: 1603	4664 (98%) n: 953	2862 (94%) n: 1157

Table 11: Summary of the JMA3 MW event dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	3 053.25	50.10
1994	5	40	2 092	5 319.38	3 108.26	34.56
1995	6	38	1 942	5 295.32	4 062.46	37.54
1996	5	31	1 701	4 954.40	6 482.66	59.67
1997	6	23	1 816	5 499.75	5 882.38	52.75
1998	7	36	2 399	6 517.62	7 330.38	49.48
1999	7	29	2 270	6 685.70	9 080.71	58.33
2000	7	34	2 354	7 038.89	6 509.72	60.54
2001	7	29	2 174	7 230.32	1 727.70	29.62
2002	8	32	2 598	8 281.02	3 322.19	41.15
2003	8	34	1 905	6 719.95	1 465.71	21.52
2004	8	23	1 725	6 488.50	495.38	10.09
2005	8	28	2 103	7 303.95	551.40	9.94
2006	8	33	2 204	8 642.28	4 445.49	34.48
2007	7	27	1 109	4 762.03	1 245.18	24.89
2008	7	28	1 226	5 773.53	1 750.48	18.43
2009	7	38	1 810	8 965.45	1 255.82	13.31
2010	6	25	1 194	5 190.56	2 077.08	38.36
2011	6	21	1 303	5 820.35	3 272.59	33.00
2012	6	27	1 344	5 844.70	2 572.85	31.70
2013	6	25	1 169	4 960.32	3 374.93	42.86
2014	7	36	1 422	6 230.98	4 171.12	46.84
2015	7	37	1 363	6 244.58	3 544.22	41.60
2016	8	48	1 412	6 318.30	2 385.11	25.99
2017	6	29	1 213	6 426.98	3 995.89	47.82
2018	7	33	1 599	7 557.02	4 965.42	52.47
2019	7	36	2 156	9 997.48	4 126.08	36.83
2020	7	44	2 235	10 344.52	3 993.53	34.54
2021	7	32	1 744	7 955.15	4 852.39	63.65
2022	6	35	1 603	7 543.75	4 257.34	63.32
2023	6	25	953	4 692.92	4 664.04	88.98
2024	6	34	1 157	5 419.63	2 862.00	85.13

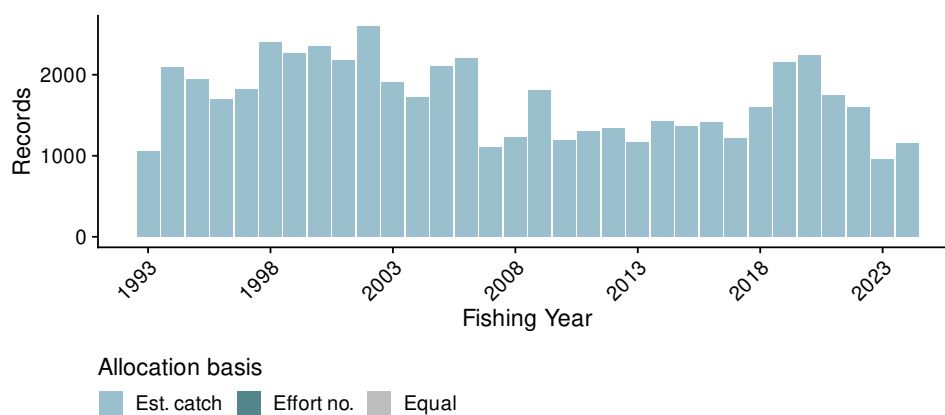


Figure 74: The allocation approach used for attributing catches to records in the JMA3 MW event catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table 12: Summary table for occurrence of positive catch in the JMA3 MW event series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	73 549.72	0.00	0.00	*
fyear	31	66 062.59	10.26	10.26	*
vessel_key	11	65 796.24	10.66	0.39	*
target_species	2	46 895.55	36.36	25.70	*
month	11	46 144.63	37.41	1.05	*
stat_area	12	42 365.58	42.58	5.17	*
ns(log(fishing_duration), 3)	3	42 322.95	42.65	0.07	*
ns(log(start_time), 3)	3	42 220.37	42.80	0.15	*
ns(log(bottom_depth), 3)	3	41 454.27	43.85	1.05	*
ns(log(effort_height), 3)	3	41 444.70	43.87	0.02	*
ns(effort_speed, 3)	3	40 943.57	44.56	0.69	*

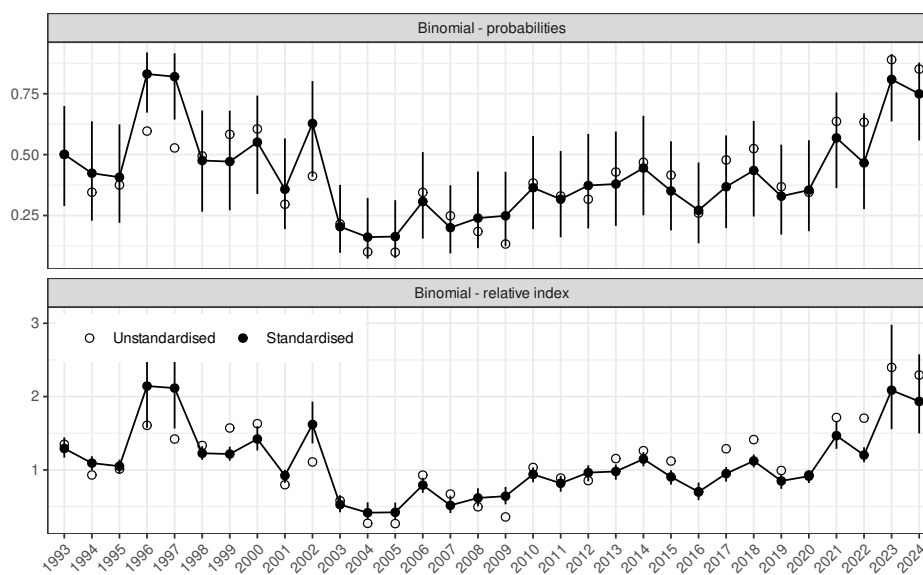


Figure 75: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW event dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

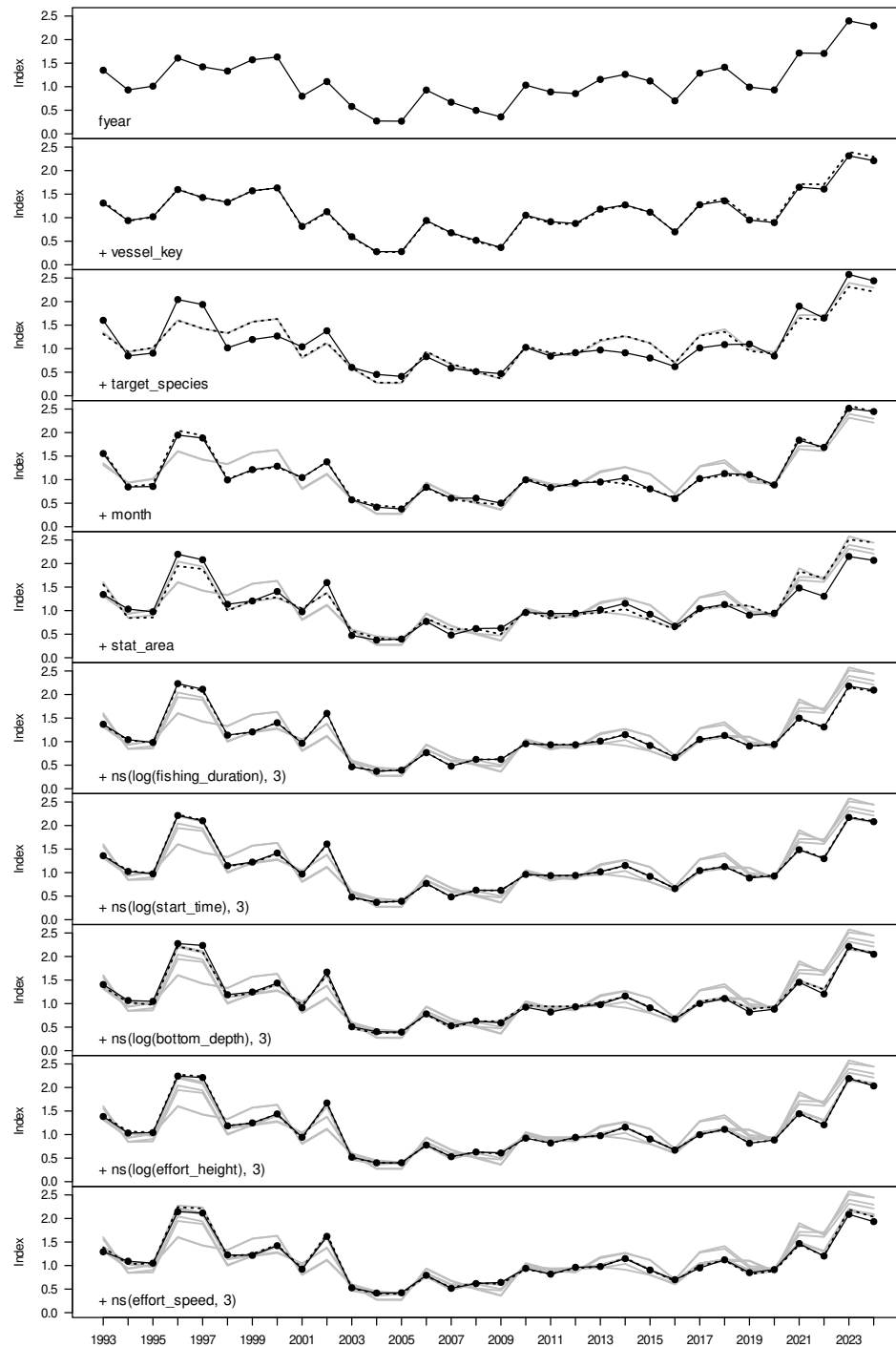


Figure 76: Step plot for occurrence of catch in the JMA3 MW event dataset.

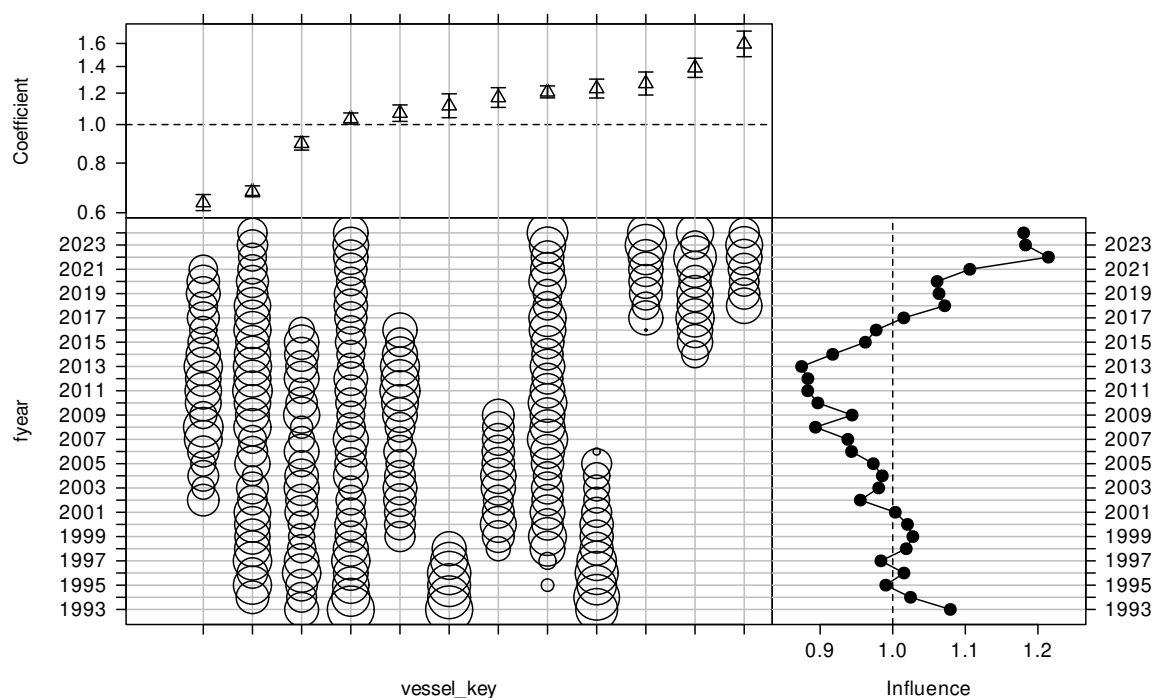


Figure 77: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

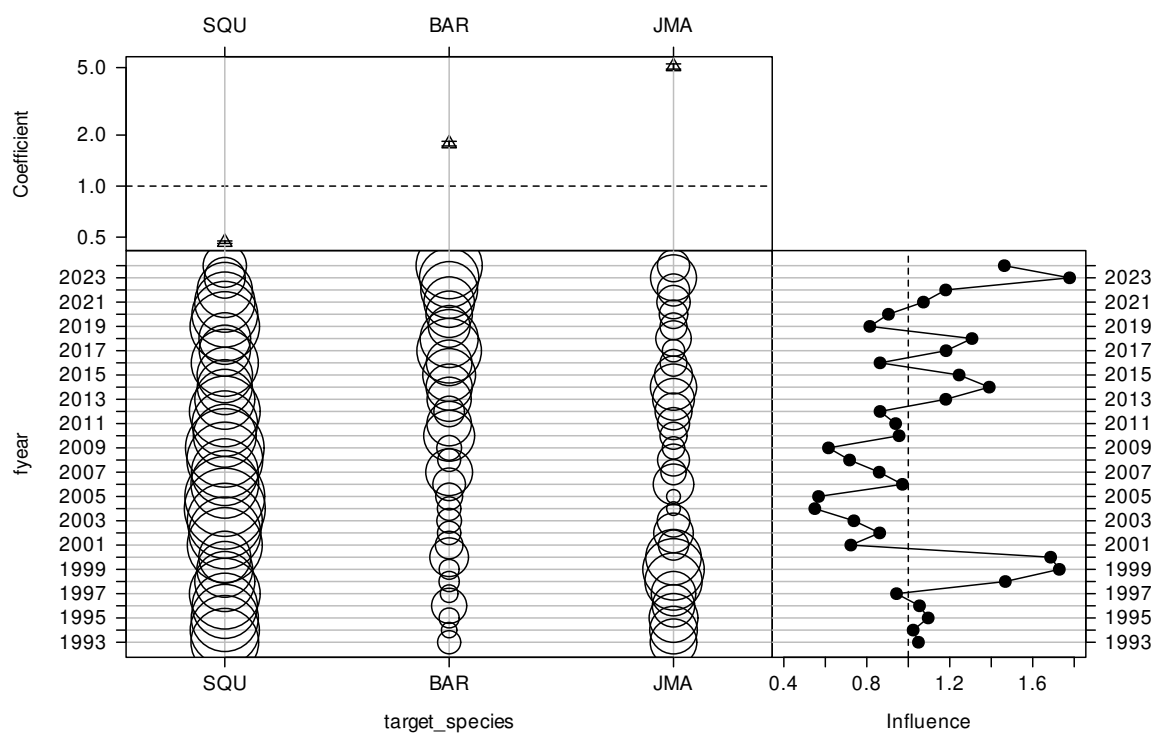


Figure 78: CDI plot for target species for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

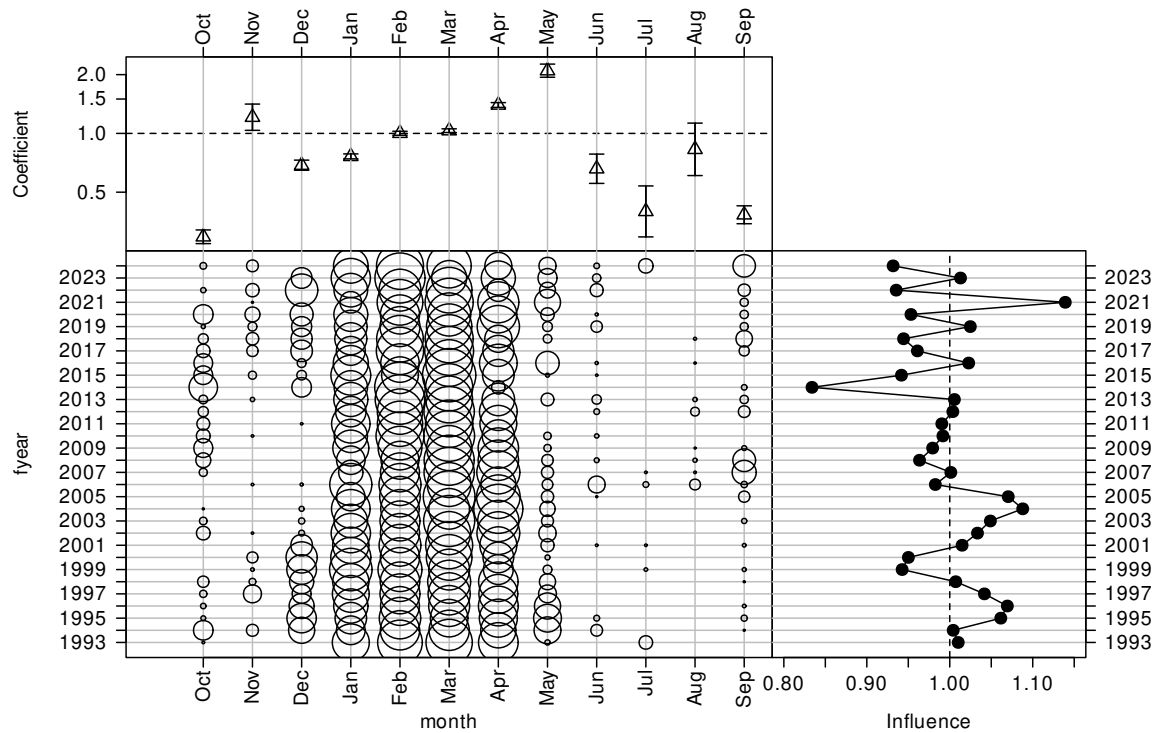


Figure 79: CDI plot for month for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

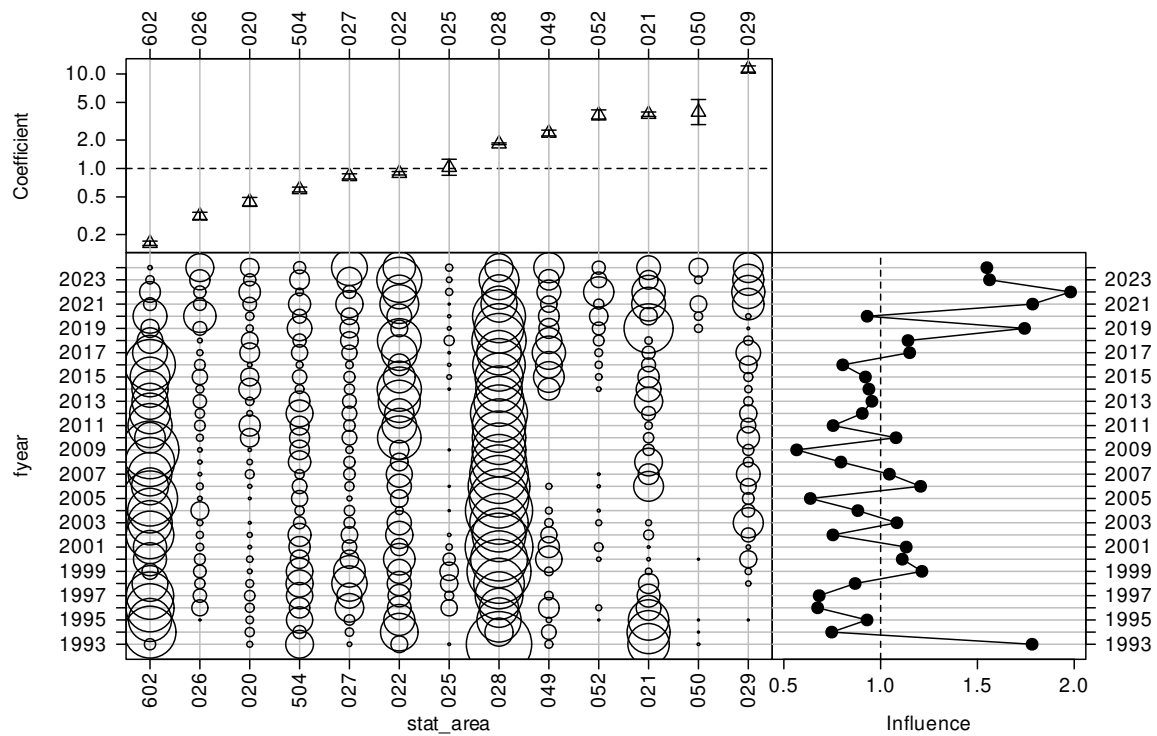


Figure 80: CDI plot for statistical area for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

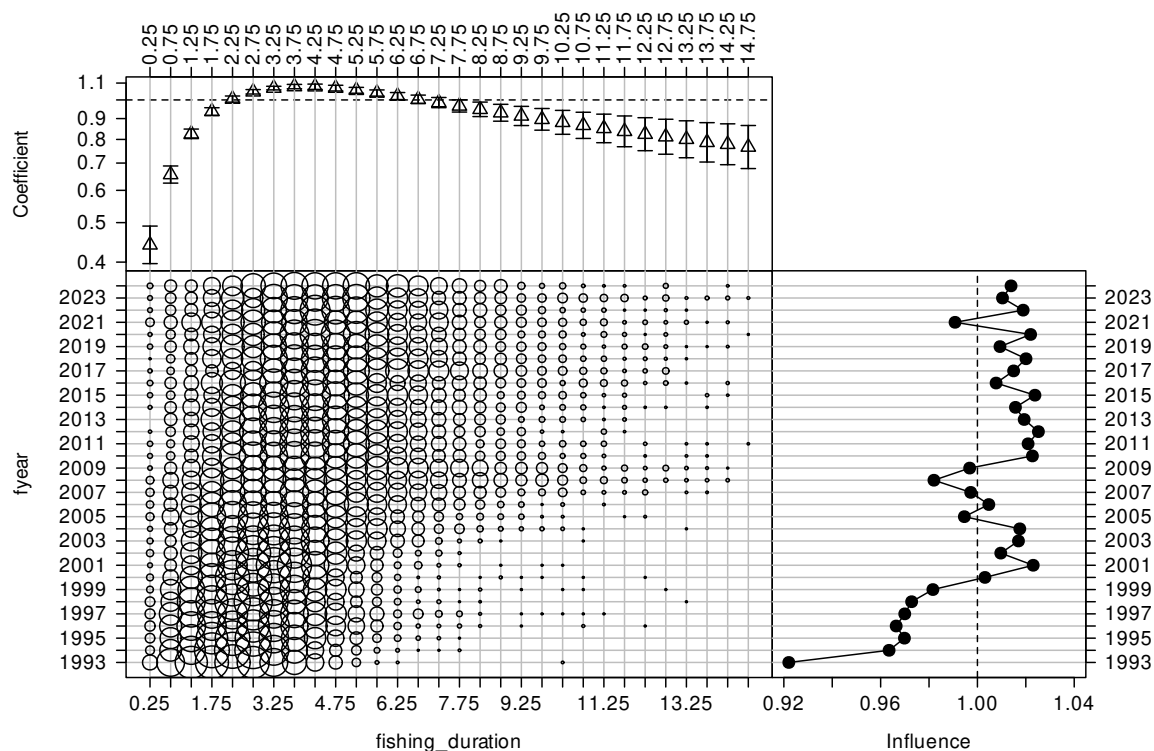


Figure 81: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

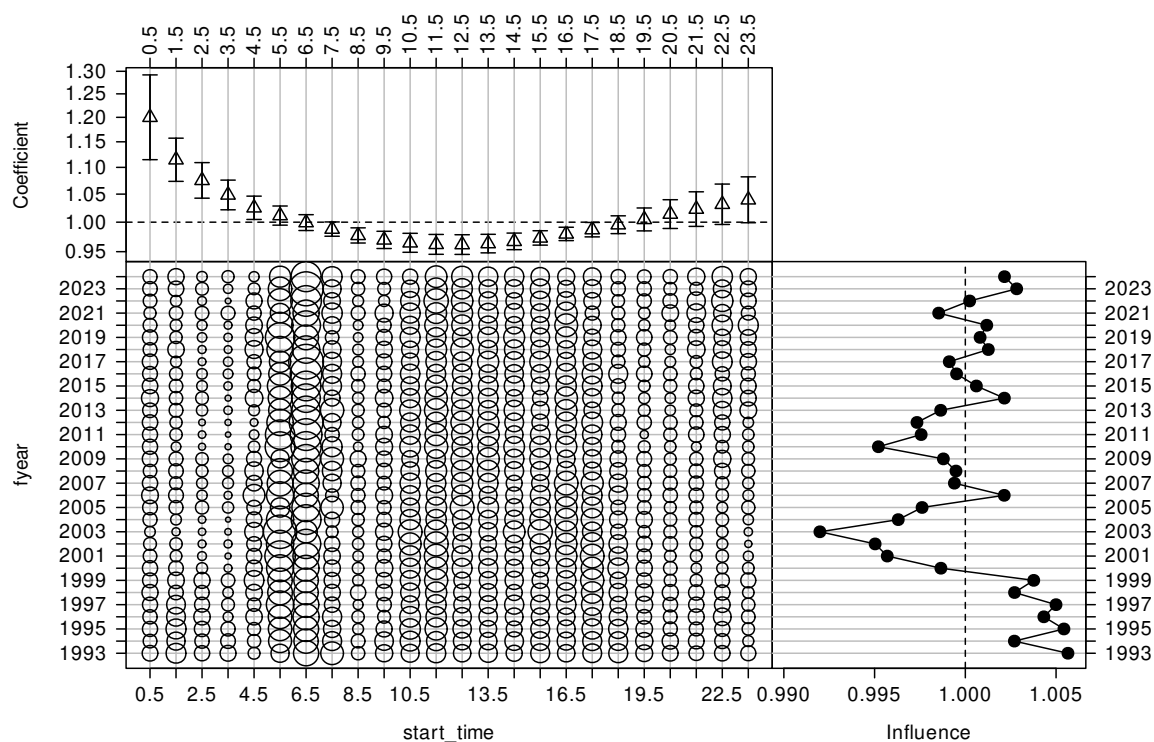


Figure 82: CDI plot for start time for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

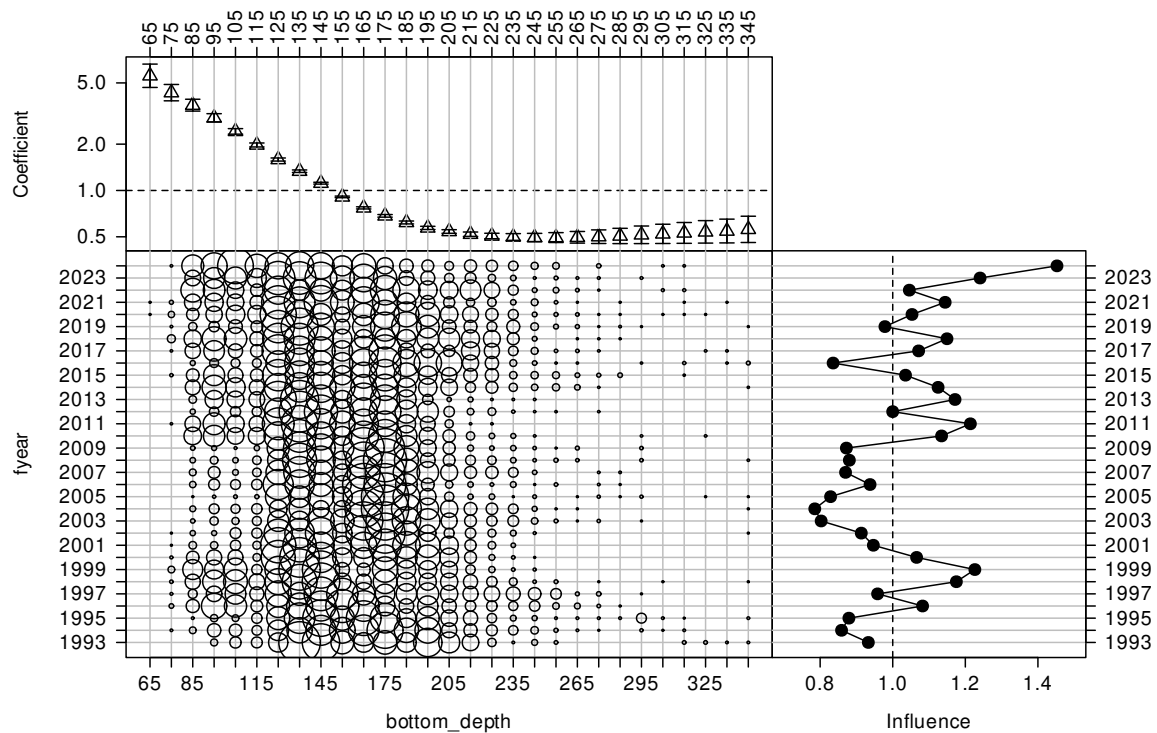


Figure 83: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

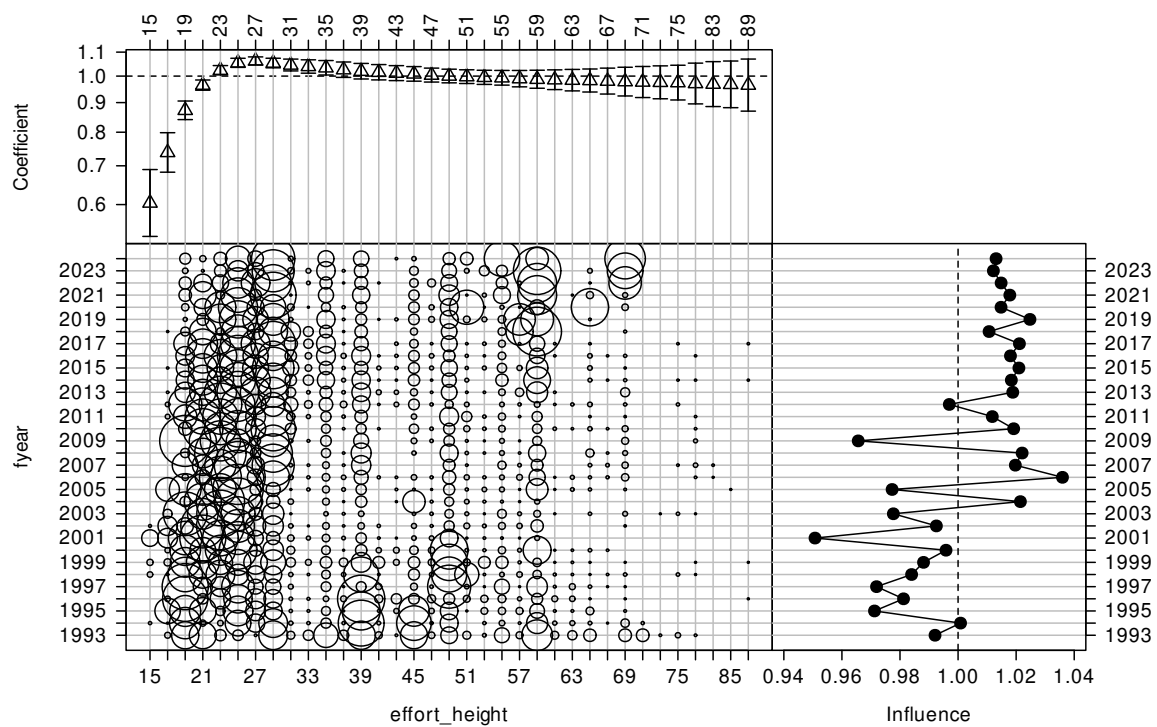


Figure 84: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

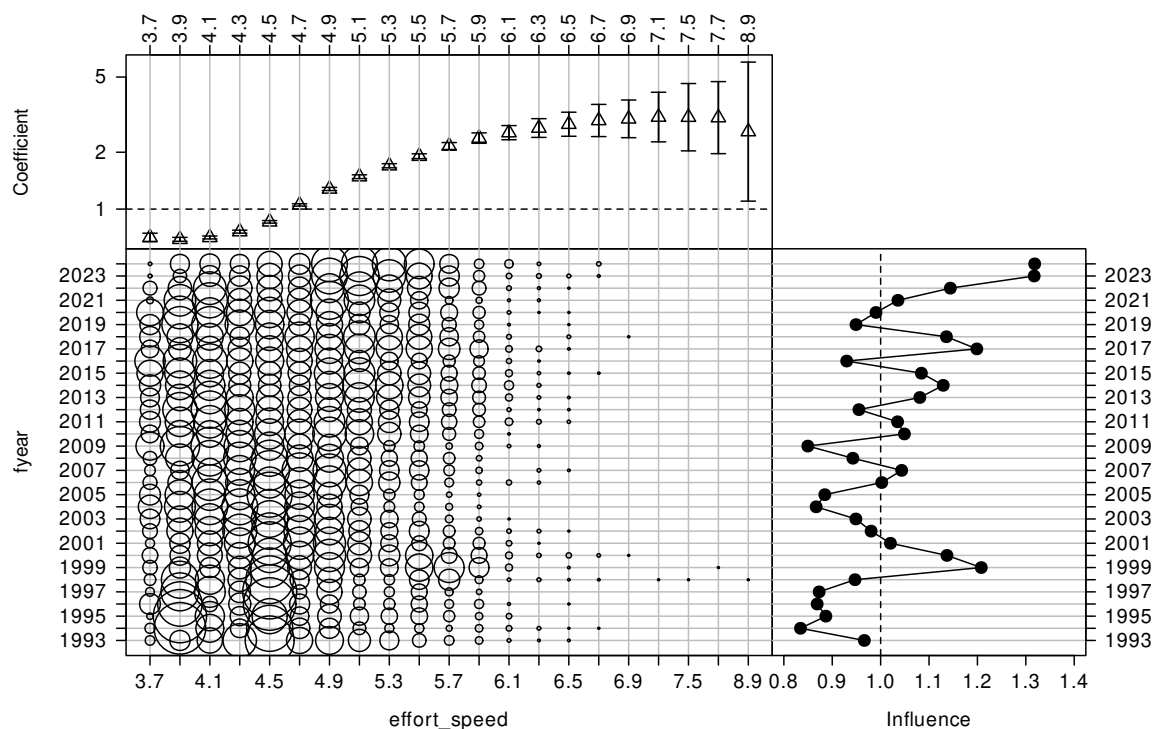


Figure 85: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW event catch-per-unit-effort dataset.

Table 13: Summary table for the lognormal model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	85 754.07	0.00	0.00	*
fyear	31	83 653.55	9.26	9.26	*
vessel_key	11	83 059.48	11.74	2.48	*
target_species	2	80 391.64	21.72	9.99	*
month	11	80 080.51	22.89	1.16	*
stat_area	12	79 537.96	24.82	1.94	*
ns(log(fishing_duration), 3)	3	79 458.82	25.11	0.29	*
ns(log(start_time), 3)	3	79 304.81	25.65	0.54	*
ns(log(bottom_depth), 3)	3	79 070.58	26.45	0.80	*
ns(log(effort_height), 3)	3	78 993.03	26.72	0.28	*
ns(effort_speed, 3)	3	78 842.01	27.24	0.52	*

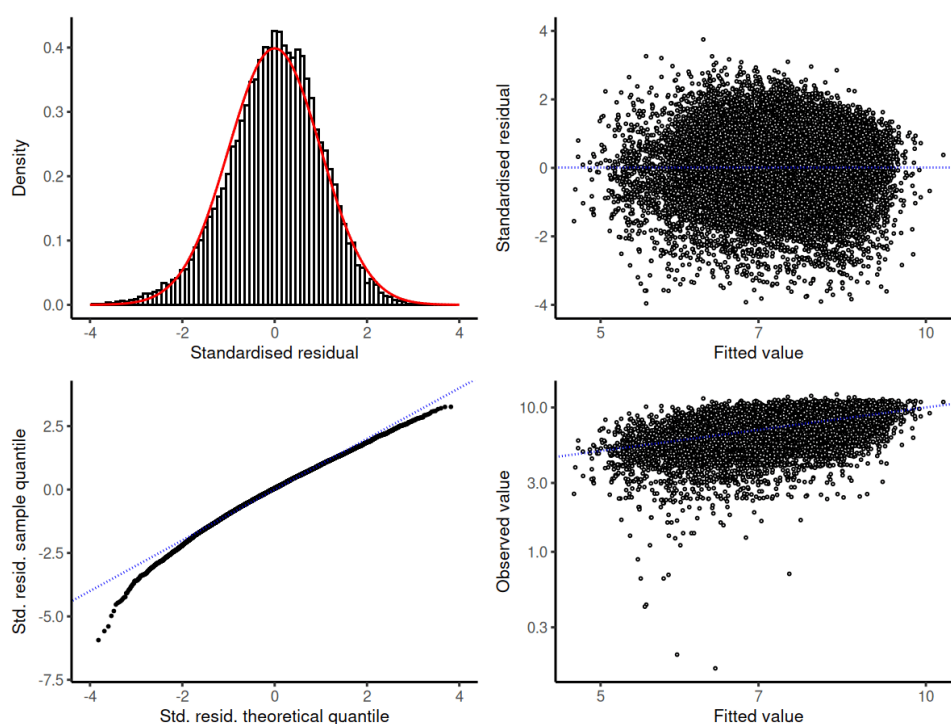


Figure 86: Diagnostic plots for the selected lognormal model for positive catches in the JMA3 MW event dataset.

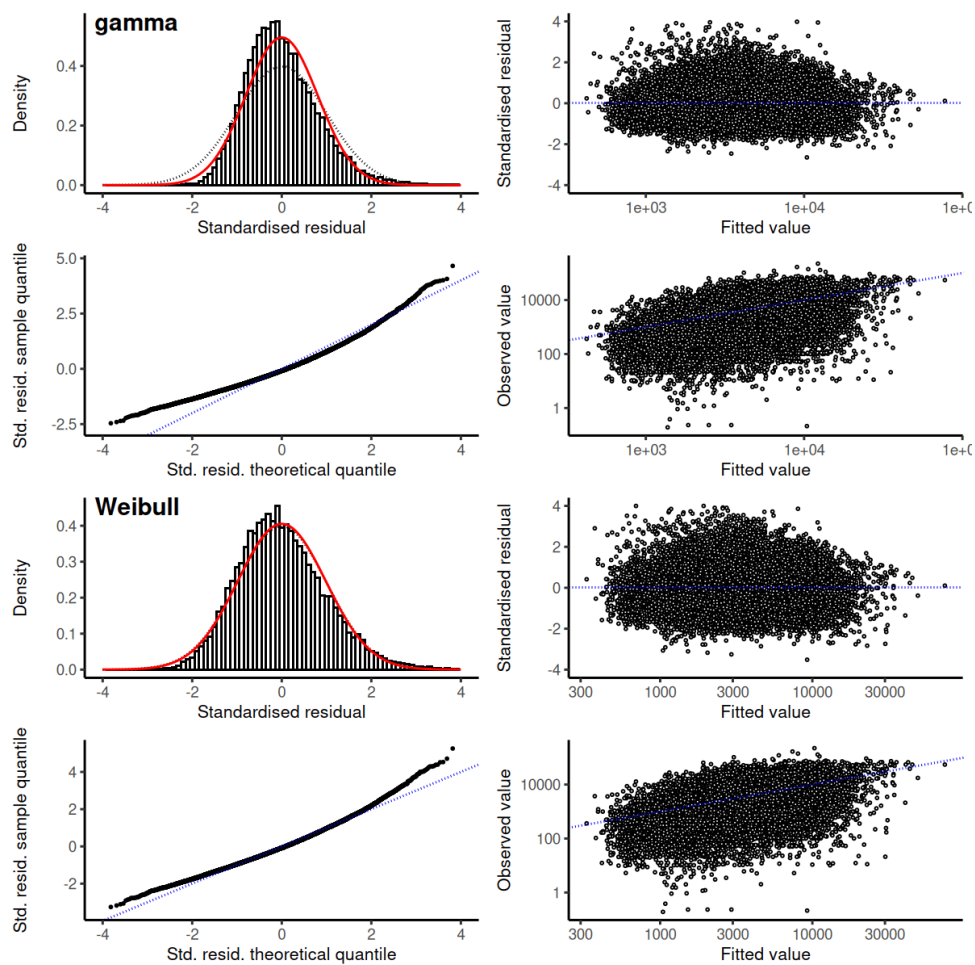


Figure 87: Diagnostic plots for the alternative gamma and Weibull models considered for positive catches in the JMA3 MW event dataset.

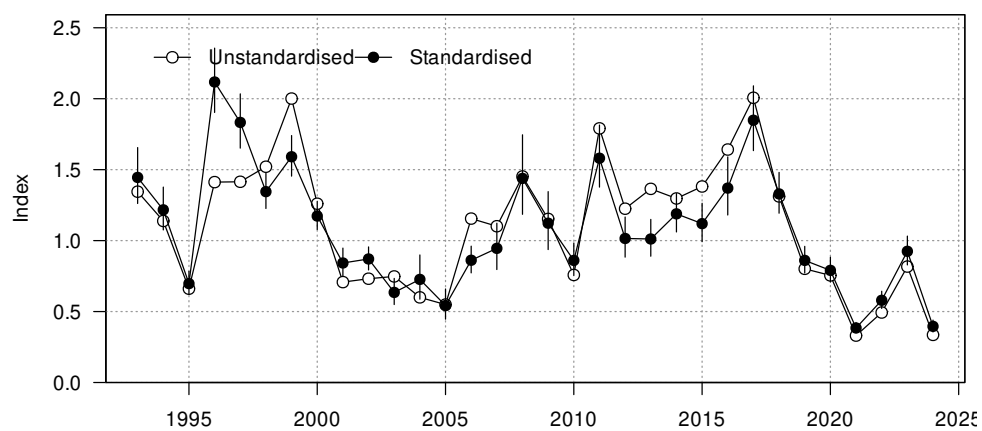


Figure 88: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the lognormal model for the JMA3 MW event dataset.

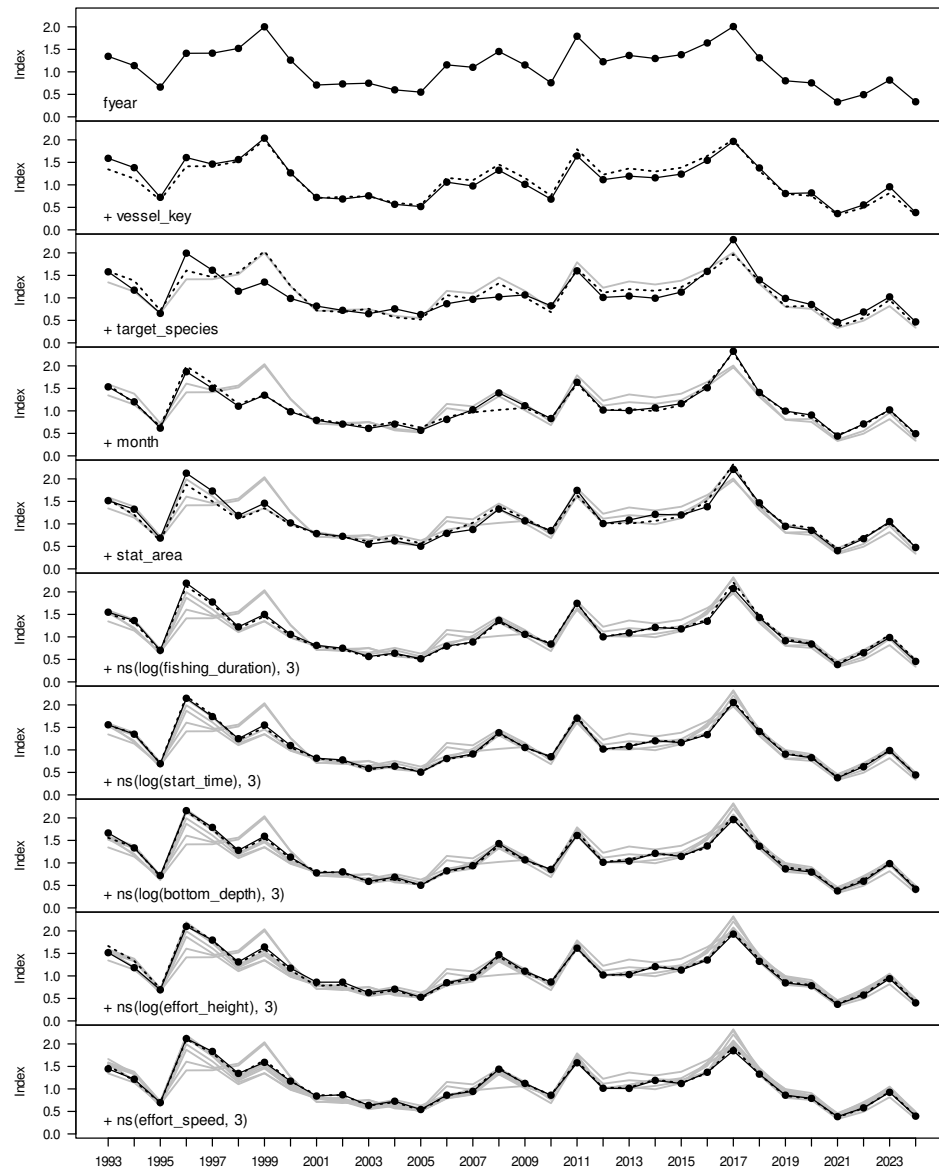


Figure 89: Changes to the JMA3 MW event positive catch index as terms are successively entered into the lognormal model.

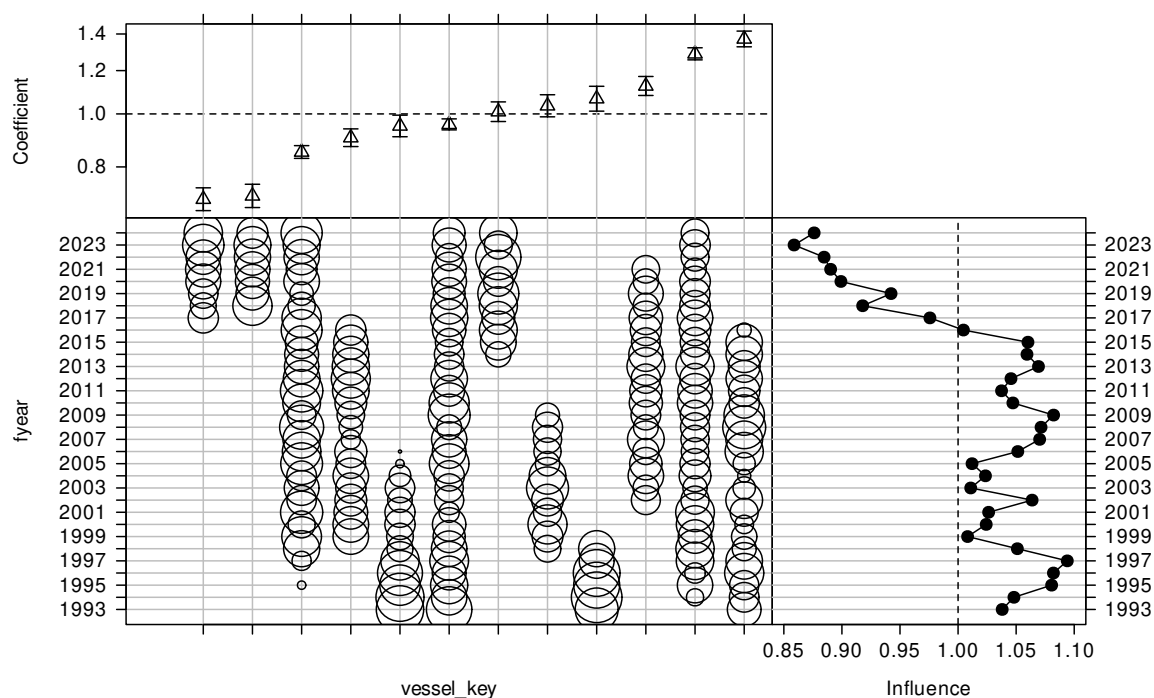


Figure 90: CDI plot for vessel key for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

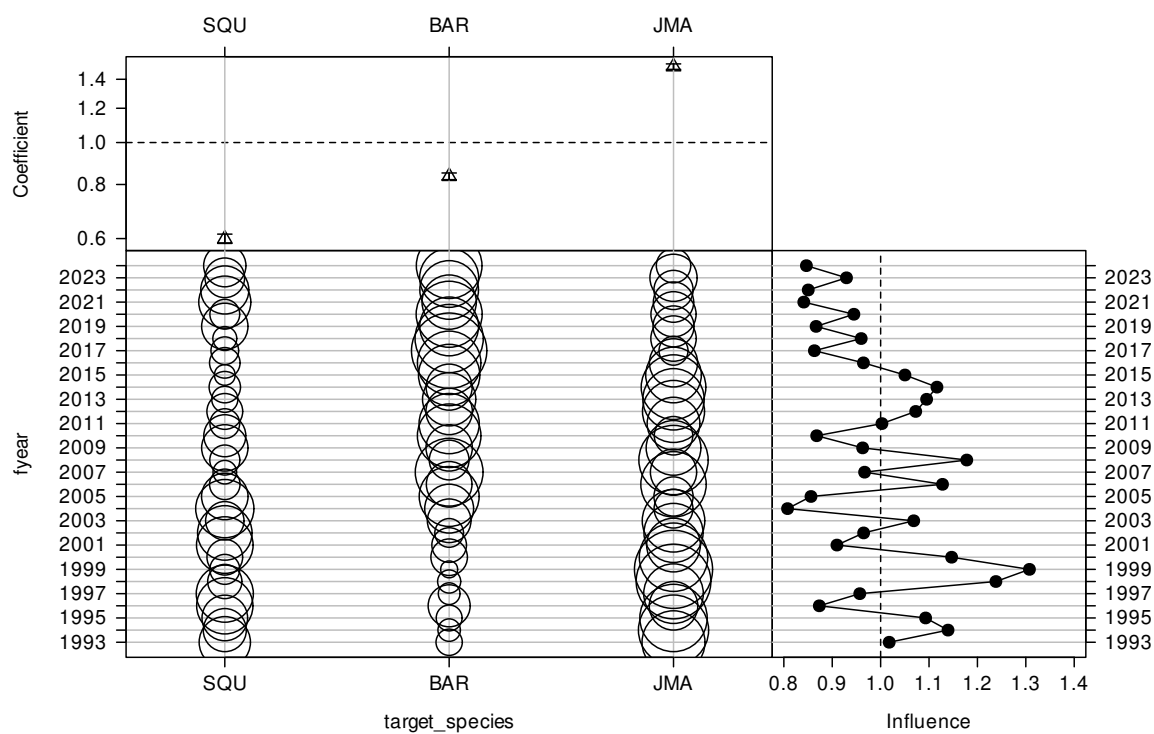


Figure 91: CDI plot for target species for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

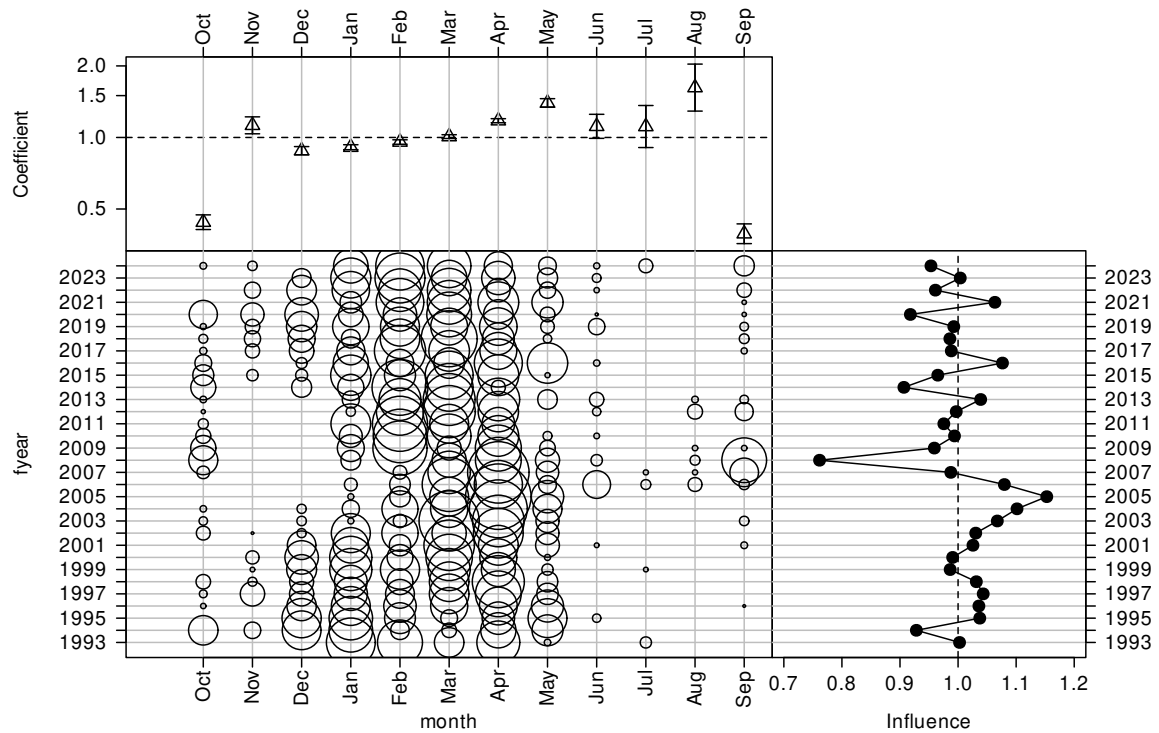


Figure 92: CDI plot for month for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

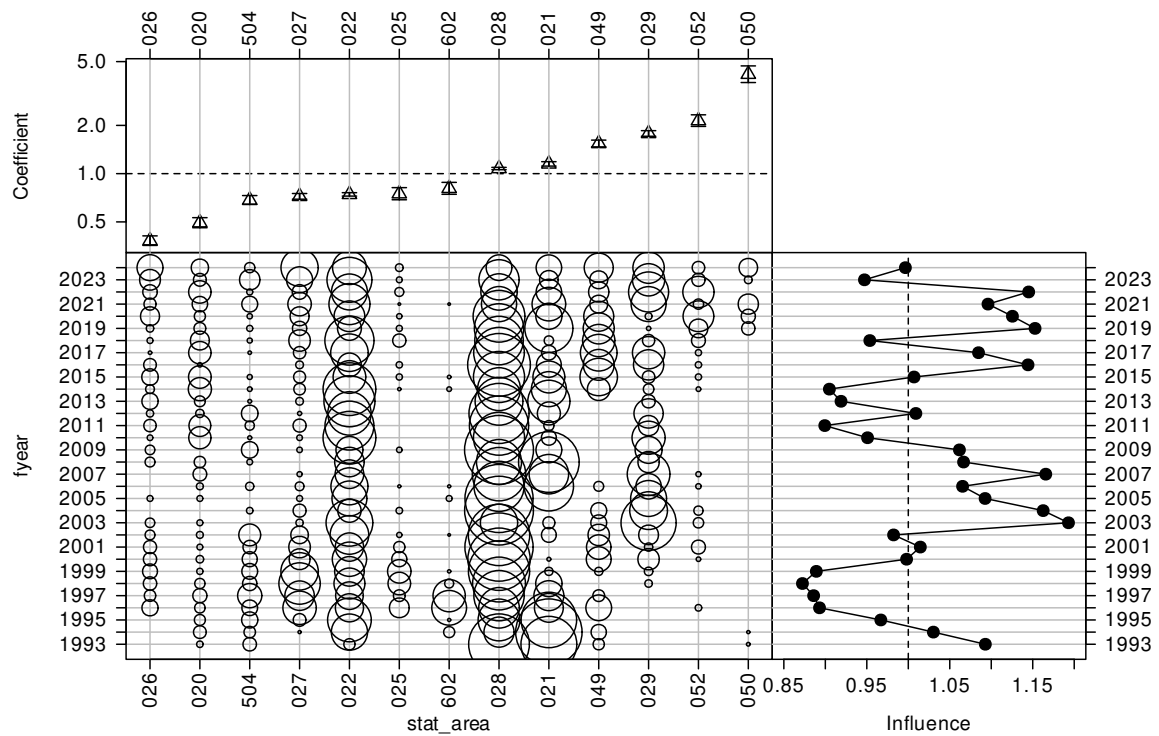


Figure 93: CDI plot for statistical area for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

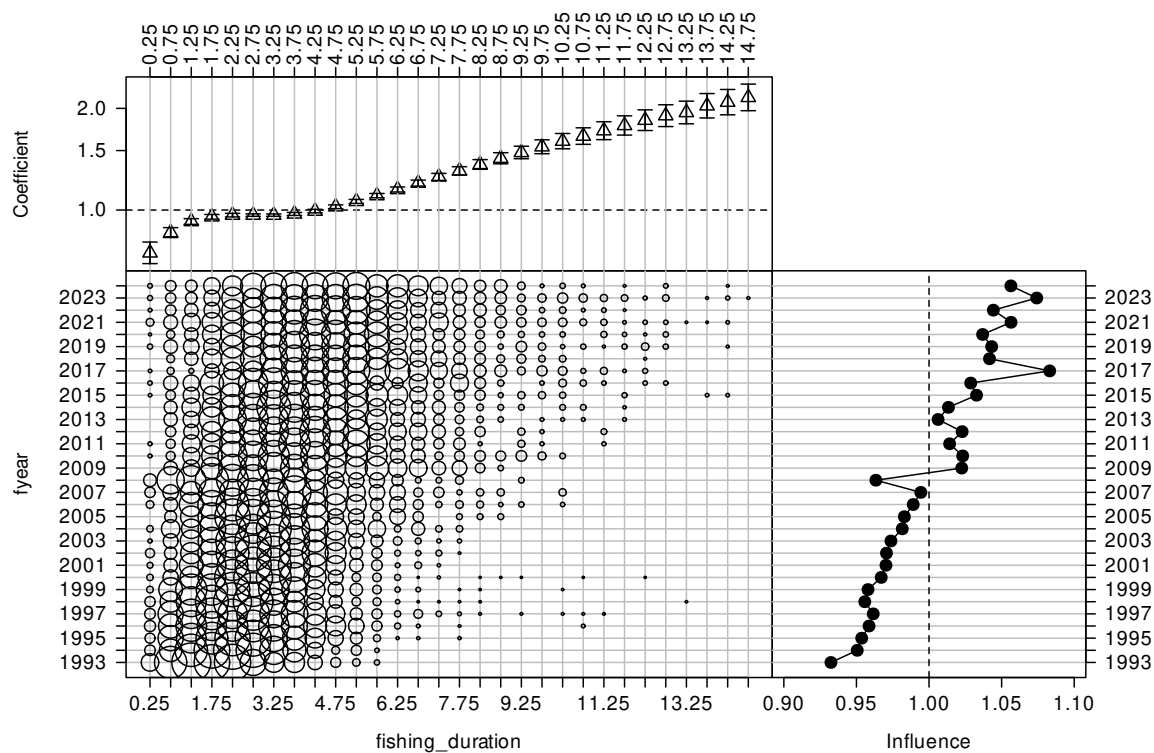


Figure 94: CDI plot for fishing duration (h) for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

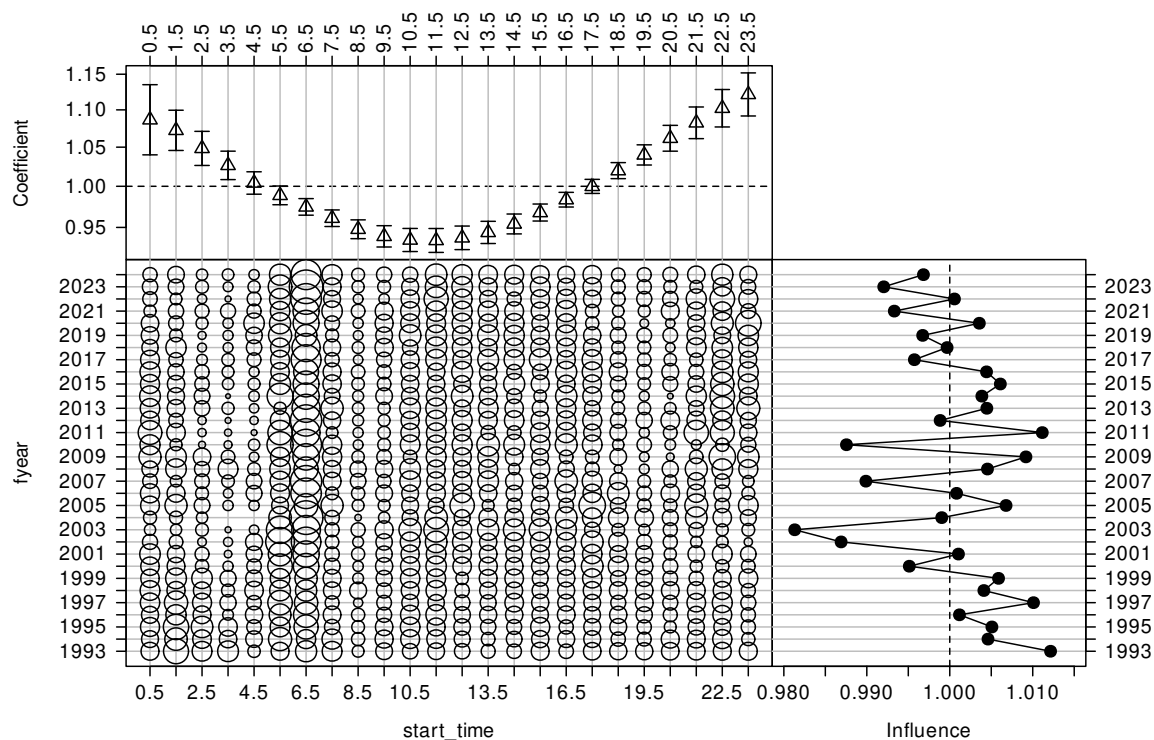


Figure 95: CDI plot for start time for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

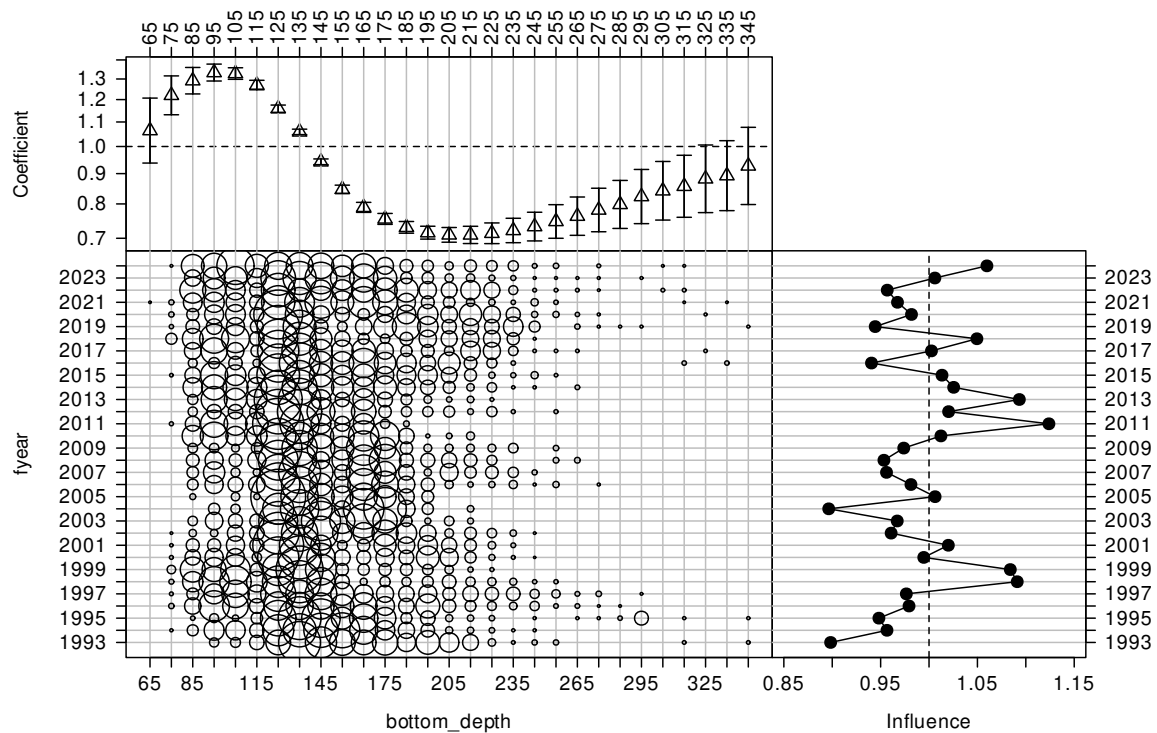


Figure 96: CDI plot for bottom depth (m) for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

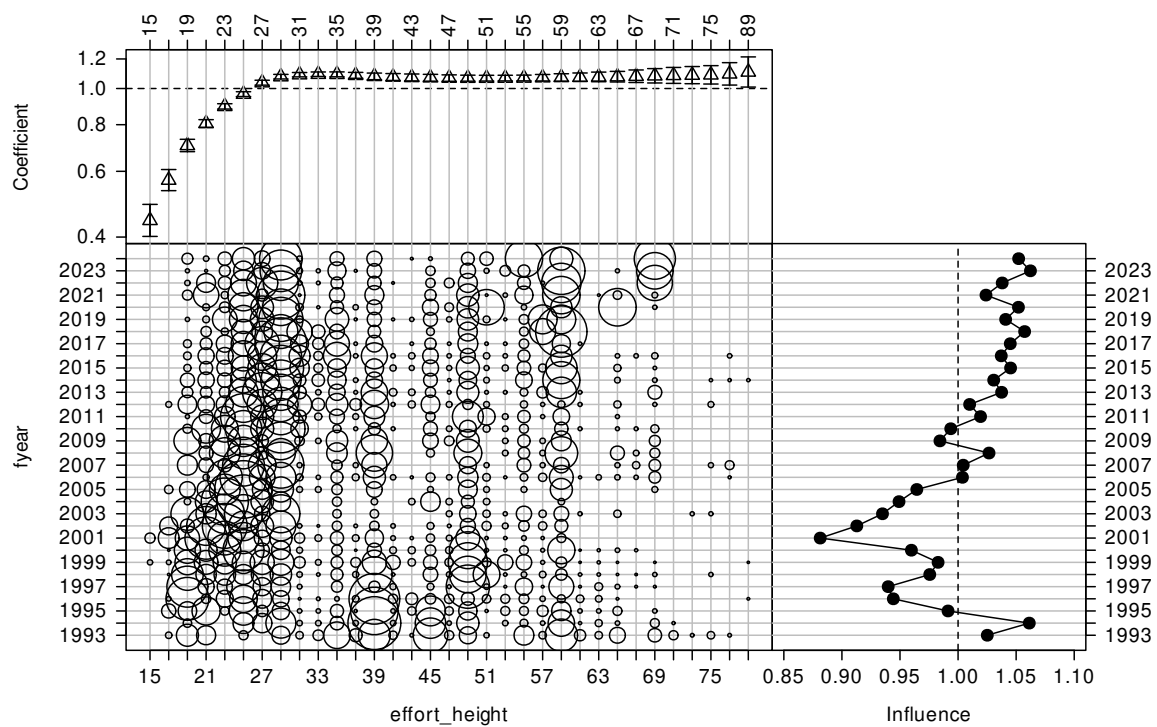


Figure 97: CDI plot for effort height (m) for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

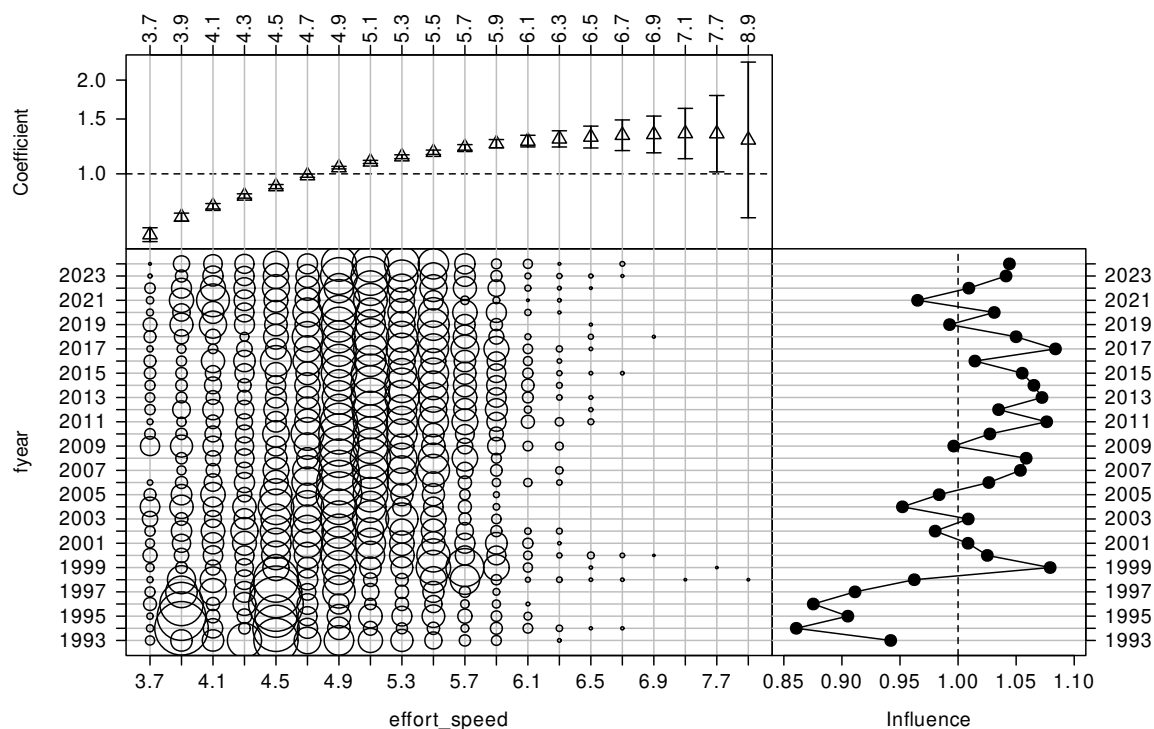


Figure 98: CDI plot for effort speed for the lognormal model of positive catches in the JMA3 MW event catch-per-unit-effort dataset.

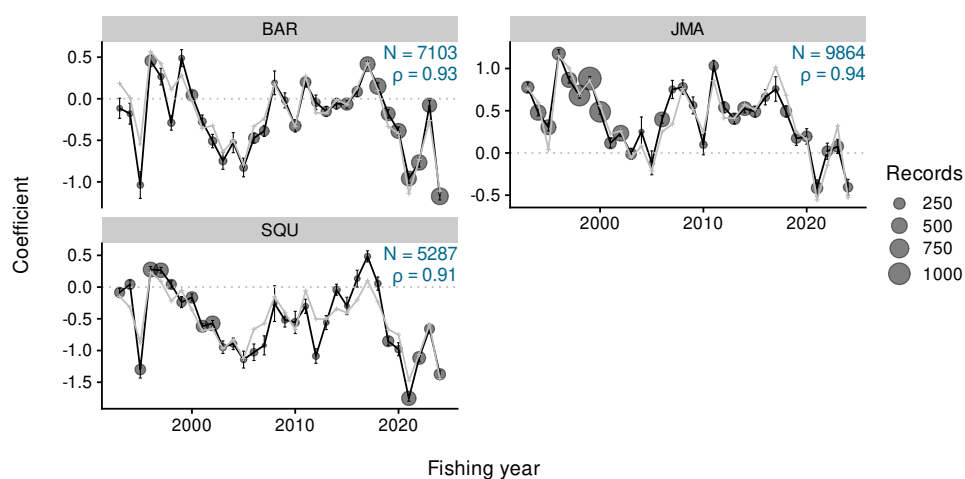


Figure 99: Residual implied coefficients for target-year in the lognormal positive catch model for the JMA3 MW event dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

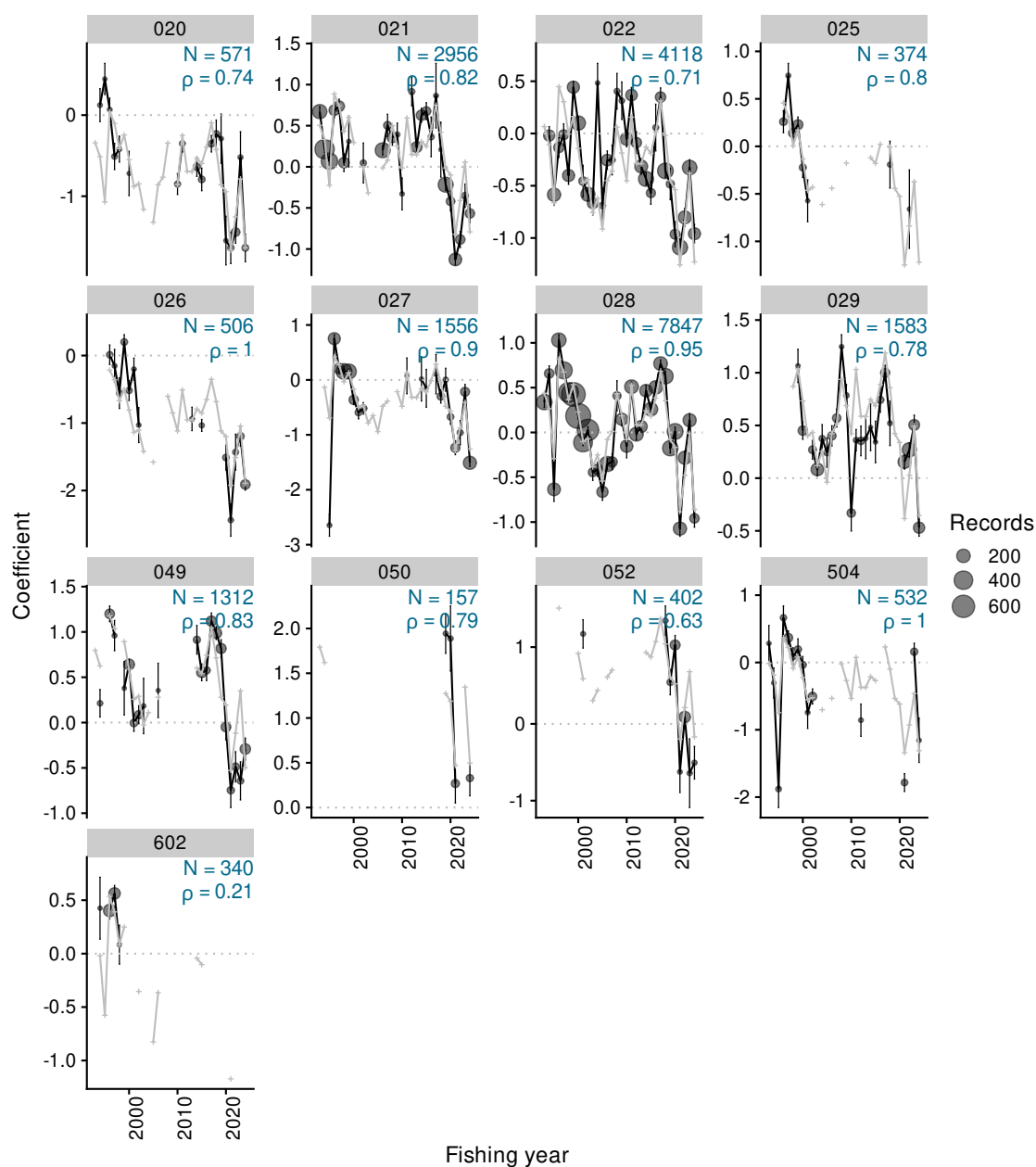


Figure 100: Residual implied coefficients for area-year in the lognormal positive catch model for the JMA3 MW event dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

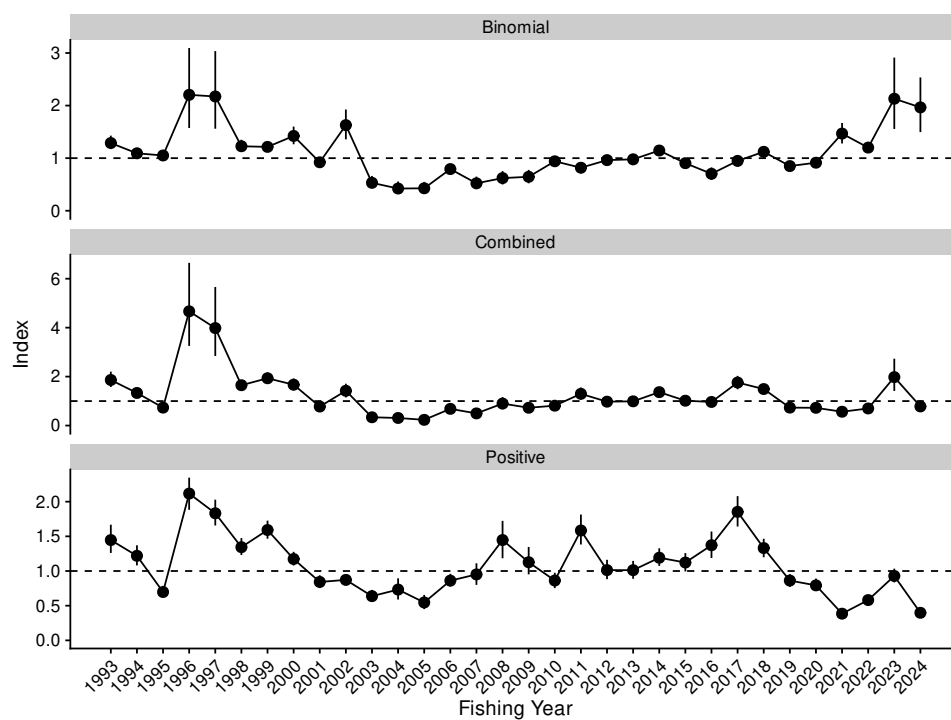


Figure 101: Standardised indices and 95% confidence intervals for the JMA3 MW event dataset.

Table 14: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW event series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.288	0.065	1.172	1.428	1.862	0.160	1.575	2.202	1.446	0.104	1.260	1.668
1994	1.092	0.051	0.998	1.197	1.332	0.104	1.132	1.539	1.219	0.074	1.081	1.371
1995	1.051	0.047	0.957	1.141	0.733	0.052	0.632	0.836	0.697	0.041	0.627	0.786
1996	2.204	0.388	1.573	3.094	4.667	0.866	3.254	6.648	2.117	0.118	1.883	2.346
1997	2.173	0.377	1.560	3.036	3.983	0.719	2.841	5.661	1.833	0.095	1.656	2.029
1998	1.226	0.056	1.131	1.350	1.648	0.104	1.451	1.859	1.344	0.062	1.231	1.474
1999	1.214	0.048	1.126	1.313	1.932	0.114	1.726	2.173	1.591	0.066	1.466	1.726
2000	1.422	0.086	1.264	1.600	1.669	0.124	1.437	1.923	1.173	0.050	1.079	1.277
2001	0.922	0.043	0.832	0.999	0.777	0.056	0.664	0.884	0.842	0.047	0.754	0.939
2002	1.628	0.145	1.358	1.925	1.420	0.143	1.150	1.709	0.872	0.041	0.792	0.954
2003	0.531	0.060	0.428	0.661	0.338	0.043	0.259	0.429	0.638	0.044	0.554	0.728
2004	0.422	0.060	0.320	0.556	0.309	0.057	0.215	0.437	0.732	0.078	0.589	0.894
2005	0.427	0.056	0.329	0.548	0.233	0.038	0.165	0.316	0.547	0.052	0.451	0.655
2006	0.792	0.055	0.682	0.897	0.682	0.059	0.568	0.799	0.861	0.047	0.777	0.959
2007	0.522	0.061	0.411	0.649	0.496	0.075	0.361	0.655	0.951	0.079	0.800	1.111
2008	0.621	0.065	0.499	0.754	0.898	0.126	0.665	1.159	1.447	0.137	1.184	1.723
2009	0.645	0.065	0.522	0.776	0.727	0.098	0.565	0.949	1.127	0.101	0.952	1.347
2010	0.941	0.052	0.834	1.037	0.811	0.067	0.688	0.950	0.863	0.056	0.754	0.975
2011	0.818	0.054	0.709	0.920	1.296	0.126	1.059	1.554	1.584	0.110	1.382	1.814
2012	0.963	0.052	0.861	1.063	0.975	0.085	0.819	1.152	1.013	0.071	0.883	1.162
2013	0.978	0.055	0.868	1.084	0.990	0.083	0.831	1.155	1.012	0.066	0.888	1.146
2014	1.145	0.050	1.055	1.250	1.365	0.092	1.190	1.551	1.192	0.065	1.074	1.328
2015	0.904	0.049	0.800	0.993	1.015	0.080	0.864	1.178	1.122	0.068	0.994	1.259
2016	0.703	0.061	0.585	0.824	0.964	0.109	0.761	1.188	1.372	0.097	1.188	1.570
2017	0.948	0.052	0.835	1.039	1.757	0.139	1.484	2.030	1.853	0.112	1.641	2.080
2018	1.121	0.048	1.032	1.220	1.492	0.101	1.303	1.697	1.331	0.068	1.198	1.465
2019	0.850	0.048	0.753	0.942	0.733	0.059	0.622	0.854	0.862	0.047	0.771	0.954
2020	0.913	0.045	0.818	0.993	0.724	0.056	0.613	0.831	0.793	0.046	0.712	0.891
2021	1.467	0.100	1.279	1.669	0.565	0.048	0.477	0.664	0.385	0.019	0.350	0.425
2022	1.200	0.051	1.108	1.310	0.698	0.047	0.611	0.797	0.581	0.031	0.522	0.643
2023	2.130	0.346	1.556	2.913	1.978	0.336	1.413	2.731	0.928	0.051	0.836	1.034
2024	1.966	0.265	1.496	2.535	0.781	0.110	0.588	1.020	0.397	0.020	0.358	0.438

8.2 JMA3 MW pred JMD event

The JMA3 MW pred JMD event series (Table 15) was similar to the JMA3 MW event model, except that the predicted catch of *T. declivis* (JMD), assigned using the species composition modelling, is the response variable. In addition, Fisheries Management Area (FMA; rather than Statistical Area) was used as the spatial covariate (following the species composition modelling), and the model for positive catches was fitted using weights representing the predictive power of the species composition model. We assigned the observer FMA using the recorded latitude and longitude of a tow; in practice, the datasets for the predicted catch models lost a few tows that were present in the aggregated catch model dataset due to missing or erroneous positions.

As with the JMA3 MW event model, vessels were retained in the core fleet if they had carried out five trips in at least five years; this retained 84.6% of the catch while reducing the core fleet in the modelling dataset to 12 vessels (Figure 102).

The core fleet (Figure 103) was identical to that of the JMA3 MW event model. The same data filters were applied (Table 16), although the impact on retained catch differs. The core fleet dataset (Table 17) differed from that of the JMA3 MW event model primarily in the annual catches. The proportion of records with a catch of JMD closely matched that with a catch of JMA, because a catch of JMA was a prerequisite for a catch of JMD to be estimated and it was rare for all draws from the species composition model to predict no catch of JMD for a tow. In common with the approach adopted for the JMA3 MW event model, tows were retained in the CPUE dataset only if catches were allocated on the basis of estimated catch (Figure 104).

Target species and year were responsible for most of the deviance explained in the model for the occurrence of jack mackerel catches (Table 18), with Fisheries Management Area explaining a lower proportion of the deviance than Statistical Area in the JMA model. The impacts of standardisation were especially apparent during the late 1990s (Figure 105), with target species and FMA responsible for most of the standardisation effect (Figure 106).

Vessel coefficients differed somewhat in comparison to the JMA3 MW event model, but there was a similar pattern in the influence on the occurrence of catches (Figure 107). The effect of target species (Figure 108) matched that in the JMA catch model, and the effect of month (Figure 109) was also similar.

Catches were estimated to be most likely on the eastern Chatham Rise (SOE/FMA 4), and lowest around the Auckland Islands (observer FMA SOI; Figure 110), a pattern that was generally consistent with the effect of Statistical Area in the JMA3 MW event series. Effects of fishing duration (Figure 111), time of day (Figure 112), depth (Figure 113), net opening (Figure 114), and fishing speed (Figure 115) were also similar to those in the aggregated catch model.

Fishing year and target species were also responsible for most of the deviance explained by the positive catch model (Table 19), with a Weibull error distribution (Figure 116) providing a somewhat better fit than either a lognormal or gamma model (Figure 117). Impacts of standardisation were apparent throughout the series, largely flattening the series prior to the mid 2010s, but with standardised catch rates lifted in the 2020s (Figure 118). Target species was responsible for most of the standardisation effect (Figure 119).

The influence of vessel on positive catch rates (Figure 120) was essentially the inverse of the influence on the occurrence of catches, with vessels that were more likely to catch jack mackerels tending to have lower catch rates of JMD. Catch rate was highest in tows targeting jack mackerels (Figure 121), with little monthly effect (Figure 122). Catch rates of JMD were estimated to be lowest on the east coast of the South Island (SEC/FMA 3) and highest off Southland (SOU/FMA 5; Figure 123).

The effect of tow duration (Figure 124) was almost the inverse of that in the occurrence model, but the time of day (Figure 125) effect was similar. Catch rates of JMD were estimated to be highest in 100 m to 160 m depths (Figure 126).

As was the case in the JMA catch model, net heights appeared to influence catch rates only when this was less than about 25 m (Figure 127), while catch rates were generally lower at towing speeds less than 5 kn (Figure 128).

Residual implied coefficients by target species (Figure 129) did not show substantial differences from the overall trend, but the recent (2020s) trend in catch rates off the South Island east coast (SOE/FMA 3) was flatter than off Southland (SOU/FMA 5), where effort was greatest and most consistent over the series (Figure 130).

The binomial model, as expected, showed the same trends as the JMA3 MW event model, with increased probability of catches in the 1990s and early 2000s, and again in the 2020s (Figure 131). The positive catch index for JMD was generally below the series average until the mid 2000s, and above the average thereafter, with peaks in 2017 and 2023. Unlike the JMA3 MW event model, the binomial and positive models for JMD did not diverge and, as a result, the interannual variation was reinforced in the combined series (Figure 132). Based on the combined series, the abundance of JMD gradually declined from the mid 1990s to the mid 2000s, and increased thereafter (Table 20). However, the series shows considerable interannual variability with notable ‘spikes’ in 1996 and 2002, and in 2017 and 2023.

Table 15: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW pred JMD event CPUE series.

Series	JMA3 MW pred JMD event
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	pred_catch_JMD ~ fyear + vessel_key + target_species + month + start_obs_fma + ns(log(fishing_duration), 3) + ns(log(start_time), 3) + ns(log(bottom_depth), 3) + ns(log(effort_height), 3) + ns(effort_speed, 3)
Stepwise selection	No
Positive catch distribution	Weibull

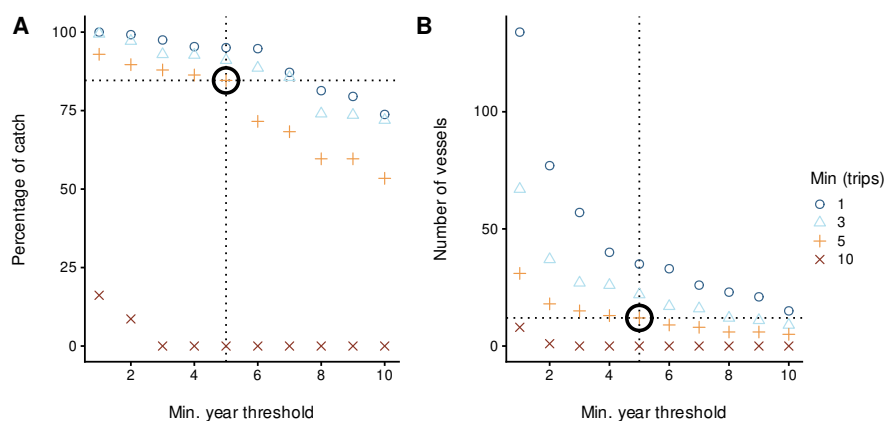


Figure 102: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW pred JMD event CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

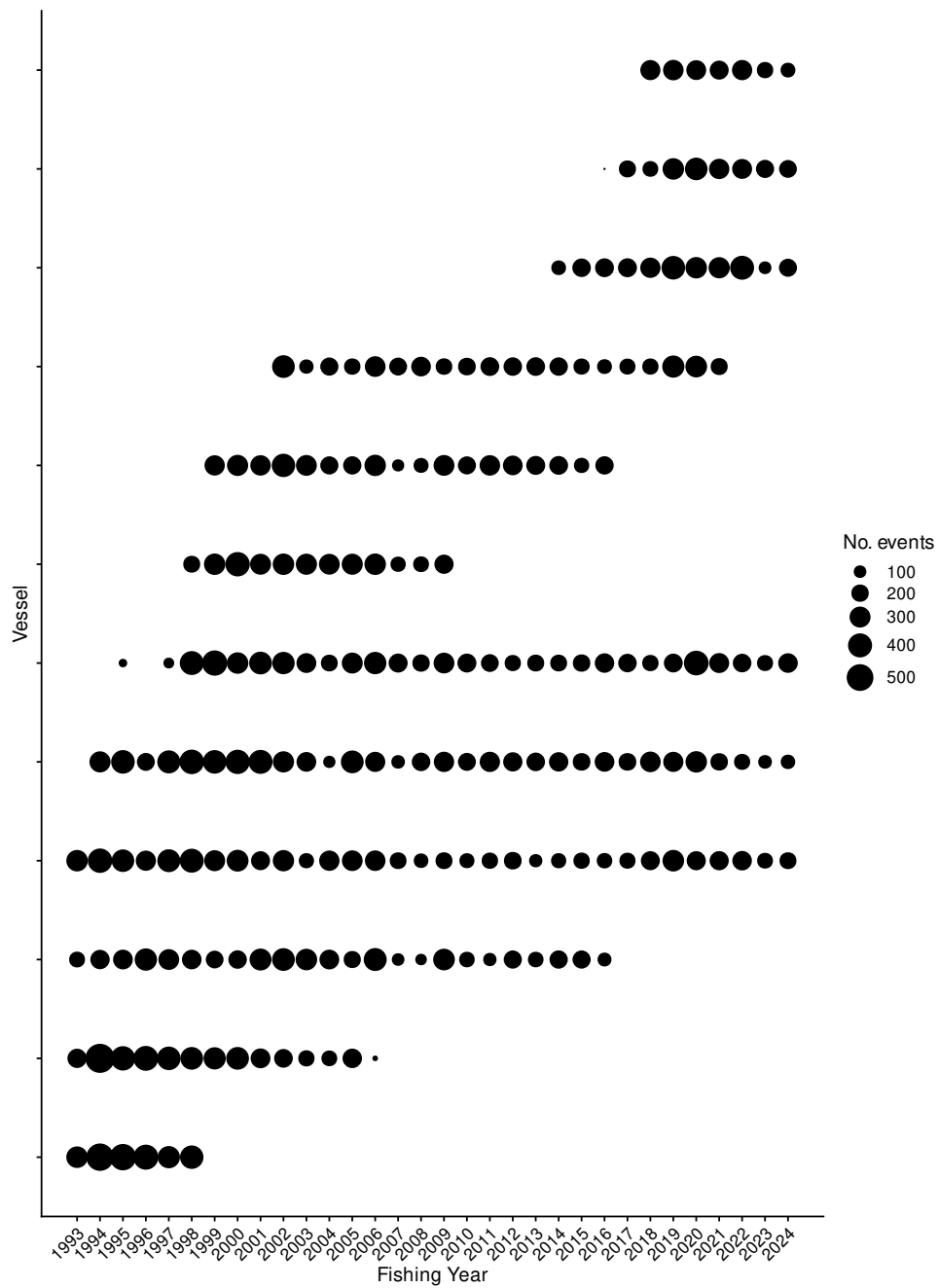


Figure 103: Number of events by fishing year for core vessels in the JMA3 MW pred JMD event series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table 16: Summary of the JMA3 MW pred JMD event dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	2303 (100%) n: 7113	834 (100%) n: 6413	1647 (100%) n: 7617	2692 (100%) n: 7993	1573 (100%) n: 5763	2340 (100%) n: 5648	3583 (100%) n: 5256	2528 (100%) n: 3758	459 (100%) n: 3011
Fishing speed not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2691 (100%) n: 7985	1571 (100%) n: 5757	2340 (100%) n: 5644	3583 (100%) n: 5252	2528 (100%) n: 3758	459 (100%) n: 3010
Fishing speed lt 10kts	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2682 (100%) n: 7953	1568 (100%) n: 5745	2340 (100%) n: 5639	3583 (100%) n: 5251	2528 (100%) n: 3758	459 (100%) n: 3010
Start date not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2682 (100%) n: 7953	1568 (100%) n: 5745	2340 (100%) n: 5639	3583 (100%) n: 5251	2528 (100%) n: 3758	459 (100%) n: 3010
End date not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2682 (100%) n: 7953	1568 (100%) n: 5745	2340 (100%) n: 5639	3583 (100%) n: 5251	2528 (100%) n: 3758	459 (100%) n: 3010
Start depth not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2682 (100%) n: 7946	1568 (100%) n: 5729	2272 (97%) n: 5626	3579 (100%) n: 5240	2527 (100%) n: 3755	459 (100%) n: 3000
Headline height not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2681 (100%) n: 7797	1567 (100%) n: 5721	2272 (97%) n: 5615	3574 (100%) n: 5233	2524 (100%) n: 3751	459 (100%) n: 2999
Fishing speed >3.5kn	2163 (94%) n: 6832	829 (99%) n: 6125	1631 (99%) n: 7473	2669 (99%) n: 7506	1558 (99%) n: 5470	2266 (97%) n: 5391	3548 (99%) n: 5118	2505 (99%) n: 3698	455 (99%) n: 2985
Headline height >15m	2157 (94%) n: 6811	823 (99%) n: 6075	1622 (99%) n: 7430	2610 (97%) n: 7400	1547 (98%) n: 5384	2254 (96%) n: 5366	3533 (99%) n: 5022	2503 (99%) n: 3688	455 (99%) n: 2978
Headline height <90m	1883 (82%) n: 6659	815 (98%) n: 6073	1622 (99%) n: 7430	2608 (97%) n: 7389	1376 (87%) n: 5181	2079 (89%) n: 4978	3522 (98%) n: 5008	2501 (99%) n: 3678	455 (99%) n: 2977
Fishing duration >15mins	1833 (80%) n: 6627	812 (97%) n: 6056	1617 (98%) n: 7413	2579 (96%) n: 7360	1364 (87%) n: 5165	2077 (89%) n: 4964	3519 (98%) n: 4997	2501 (99%) n: 3675	455 (99%) n: 2970
Fishing duration <15h	1827 (79%) n: 6609	810 (97%) n: 6040	1607 (98%) n: 7404	2571 (96%) n: 7342	1344 (85%) n: 5134	2071 (89%) n: 4949	3508 (98%) n: 4988	2482 (98%) n: 3656	455 (99%) n: 2970
Seabed depth >50m	1827 (79%) n: 6609	810 (97%) n: 6040	1607 (98%) n: 7403	2571 (96%) n: 7342	1344 (85%) n: 5134	2068 (88%) n: 4946	3508 (98%) n: 4987	2482 (98%) n: 3655	455 (99%) n: 2970
Seabed depth <350m	1825 (79%) n: 6570	807 (97%) n: 6000	1605 (97%) n: 7227	2567 (95%) n: 7313	1339 (85%) n: 5121	2067 (88%) n: 4942	3502 (98%) n: 4964	2481 (98%) n: 3645	454 (99%) n: 2967
Start time >0	1766 (77%) n: 6508	791 (95%) n: 5958	1576 (96%) n: 7156	2467 (92%) n: 7221	1290 (82%) n: 5067	2025 (87%) n: 4901	3365 (94%) n: 4916	2456 (97%) n: 3623	446 (97%) n: 2956
SA subset	1766 (77%) n: 6508	791 (95%) n: 5958	1576 (96%) n: 7156	2467 (92%) n: 7221	1290 (82%) n: 5067	2025 (87%) n: 4901	3365 (94%) n: 4916	2456 (97%) n: 3623	446 (97%) n: 2956
No effort allocation	1765 (77%) n: 6462	781 (94%) n: 5829	1574 (96%) n: 7023	2467 (92%) n: 7221	1290 (82%) n: 5066	2025 (87%) n: 4901	3365 (94%) n: 4916	2456 (97%) n: 3619	446 (97%) n: 2956
Core fleet selection	1000 (43%) n: 1050	513 (62%) n: 2090	1053 (64%) n: 1937	1368 (51%) n: 1698	788 (50%) n: 1813	1420 (61%) n: 2393	2166 (60%) n: 2269	2007 (79%) n: 2351	396 (86%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
Fishing speed not null	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
Fishing speed lt 10kts	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
Start date not null	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
End date not null	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
Start depth not null	1373 (100%) n: 3306	424 (100%) n: 3106	172 (100%) n: 3278	137 (100%) n: 3635	1491 (100%) n: 2831	502 (100%) n: 2412	488 (100%) n: 2246	388 (100%) n: 2187	697 (100%) n: 1313
Headline height not null	1373 (100%) n: 3306	424 (100%) n: 3106	172 (100%) n: 3278	137 (100%) n: 3635	1491 (100%) n: 2831	502 (100%) n: 2412	488 (100%) n: 2246	388 (100%) n: 2187	697 (100%) n: 1313
Fishing speed >3.5kn	1372 (100%) n: 3266	422 (99%) n: 3061	171 (100%) n: 3167	137 (100%) n: 3520	1490 (100%) n: 2794	501 (100%) n: 2380	483 (99%) n: 2222	377 (97%) n: 2132	697 (100%) n: 1300
Headline height >15m	1363 (99%) n: 3243	422 (99%) n: 3043	170 (99%) n: 3150	137 (100%) n: 3512	1490 (100%) n: 2790	501 (100%) n: 2359	483 (99%) n: 2205	374 (97%) n: 2128	697 (100%) n: 1297
Headline height <90m	1363 (99%) n: 3243	422 (99%) n: 3043	169 (98%) n: 3149	137 (100%) n: 3512	1490 (100%) n: 2789	501 (100%) n: 2359	483 (99%) n: 2204	374 (97%) n: 2128	697 (100%) n: 1297
Fishing duration >15mins	1361 (99%) n: 3229	422 (99%) n: 3038	169 (98%) n: 3140	137 (100%) n: 3501	1489 (100%) n: 2782	501 (100%) n: 2354	482 (99%) n: 2198	374 (97%) n: 2126	697 (100%) n: 1295
Fishing duration <15h	1361 (99%) n: 3226	420 (99%) n: 3037	169 (98%) n: 3138	137 (100%) n: 3501	1489 (100%) n: 2780	501 (100%) n: 2353	482 (99%) n: 2195	374 (97%) n: 2122	697 (100%) n: 1294
Seabed depth >50m	1358 (99%) n: 3224	420 (99%) n: 3037	169 (98%) n: 3138	137 (100%) n: 3501	1489 (100%) n: 2780	501 (100%) n: 2353	482 (99%) n: 2195	374 (97%) n: 2122	697 (100%) n: 1294
Seabed depth <350m	1356 (99%) n: 3222	420 (99%) n: 3033	169 (98%) n: 3134	137 (100%) n: 3500	1489 (100%) n: 2779	501 (100%) n: 2351	482 (99%) n: 2193	371 (96%) n: 2120	697 (100%) n: 1293
Start time >0	1317 (96%) n: 3198	411 (97%) n: 3025	167 (97%) n: 3119	134 (98%) n: 3458	1456 (98%) n: 2766	484 (96%) n: 2334	477 (98%) n: 2182	358 (92%) n: 2108	688 (99%) n: 1280
SA subset	1317 (96%) n: 3198	411 (97%) n: 3025	167 (97%) n: 3119	134 (98%) n: 3458	1456 (98%) n: 2766	484 (96%) n: 2334	477 (98%) n: 2182	358 (92%) n: 2108	688 (99%) n: 1280
No effort allocation	1317 (96%) n: 3196	411 (97%) n: 2486	166 (97%) n: 2363	134 (98%) n: 2581	1456 (98%) n: 2593	484 (96%) n: 1705	475 (97%) n: 1587	357 (92%) n: 1990	687 (99%) n: 1260
Core fleet selection	1232 (90%) n: 2598	383 (90%) n: 1904	163 (95%) n: 1725	133 (97%) n: 2103	1444 (97%) n: 2204	443 (88%) n: 1109	446 (91%) n: 1223	252 (65%) n: 1809	664 (95%) n: 1191

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2232 (100%) n: 1678	1041 (100%) n: 2307
Fishing speed not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2232 (100%) n: 1678	1041 (100%) n: 2307
Fishing speed lt 10kts	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
Start date not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
End date not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
Start depth not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
Headline height not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
Fishing speed >3.5kn	1143 (100%) n: 1412	1104 (99%) n: 1465	1626 (100%) n: 1229	1626 (100%) n: 1454	892 (100%) n: 1381	625 (100%) n: 1503	1638 (100%) n: 1357	2222 (100%) n: 1625	1039 (100%) n: 2269
Headline height >15m	1130 (99%) n: 1395	1104 (99%) n: 1464	1626 (100%) n: 1229	1626 (100%) n: 1454	892 (100%) n: 1379	625 (100%) n: 1503	1624 (99%) n: 1354	2222 (100%) n: 1625	1039 (100%) n: 2263
Headline height <90m	1130 (99%) n: 1395	1104 (99%) n: 1463	1626 (100%) n: 1229	1626 (100%) n: 1454	892 (100%) n: 1379	625 (100%) n: 1503	1624 (99%) n: 1354	2222 (100%) n: 1624	1039 (100%) n: 2263
Fishing duration >15mins	1130 (99%) n: 1394	1104 (99%) n: 1459	1624 (100%) n: 1224	1626 (100%) n: 1449	892 (100%) n: 1378	625 (100%) n: 1498	1624 (99%) n: 1352	2222 (100%) n: 1624	1039 (100%) n: 2260
Fishing duration <15h	1130 (99%) n: 1392	1103 (99%) n: 1457	1624 (100%) n: 1224	1626 (100%) n: 1448	892 (100%) n: 1378	625 (100%) n: 1497	1624 (99%) n: 1352	2222 (100%) n: 1624	1036 (100%) n: 2257
Seabed depth >50m	1130 (99%) n: 1392	1103 (99%) n: 1457	1624 (100%) n: 1224	1626 (100%) n: 1448	892 (100%) n: 1378	625 (100%) n: 1497	1624 (99%) n: 1352	2222 (100%) n: 1624	1036 (100%) n: 2257
Seabed depth <350m	1130 (99%) n: 1390	1103 (99%) n: 1457	1624 (100%) n: 1224	1626 (100%) n: 1448	892 (100%) n: 1378	625 (100%) n: 1491	1624 (99%) n: 1352	2222 (100%) n: 1623	1036 (100%) n: 2256
Start time >0	1120 (98%) n: 1382	1100 (99%) n: 1453	1611 (99%) n: 1217	1579 (97%) n: 1438	883 (99%) n: 1370	616 (98%) n: 1483	1622 (99%) n: 1349	2213 (99%) n: 1617	1036 (100%) n: 2252
SA subset	1120 (98%) n: 1382	1100 (99%) n: 1453	1611 (99%) n: 1217	1579 (97%) n: 1438	883 (99%) n: 1370	616 (98%) n: 1483	1622 (99%) n: 1349	2213 (99%) n: 1617	1036 (100%) n: 2252
No effort allocation	1120 (98%) n: 1382	1100 (99%) n: 1390	1611 (99%) n: 1216	1579 (97%) n: 1436	883 (99%) n: 1370	613 (98%) n: 1447	1622 (99%) n: 1336	2213 (99%) n: 1616	1036 (100%) n: 2252
Core fleet selection	1111 (97%) n: 1301	1061 (96%) n: 1344	1593 (98%) n: 1169	1576 (97%) n: 1420	881 (98%) n: 1362	602 (96%) n: 1409	1608 (98%) n: 1212	2207 (99%) n: 1599	976 (94%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1330 (100%) n: 1343
Fishing speed not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1330 (100%) n: 1343
Fishing speed lt 10kts	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1330 (100%) n: 1343
Start date not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1330 (100%) n: 1343
End date not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1327 (100%) n: 1342
Start depth not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1327 (100%) n: 1342
Headline height not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1327 (100%) n: 1342
Fishing speed >3.5kn	922 (100%) n: 2430	2669 (100%) n: 1919	2153 (100%) n: 1794	2676 (100%) n: 1037	1327 (100%) n: 1342
Headline height >15m	920 (100%) n: 2426	2669 (100%) n: 1917	2153 (100%) n: 1792	2676 (100%) n: 1035	1319 (99%) n: 1336
Headline height <90m	920 (100%) n: 2426	2669 (100%) n: 1917	2153 (100%) n: 1792	2676 (100%) n: 1035	1319 (99%) n: 1336
Fishing duration >15mins	920 (100%) n: 2421	2656 (100%) n: 1912	2153 (100%) n: 1785	2676 (100%) n: 1032	1319 (99%) n: 1331
Fishing duration <15h	920 (100%) n: 2421	2653 (99%) n: 1910	2153 (100%) n: 1785	2673 (100%) n: 1031	1319 (99%) n: 1330
Seabed depth >50m	920 (100%) n: 2421	2653 (99%) n: 1910	2153 (100%) n: 1784	2673 (100%) n: 1031	1319 (99%) n: 1330
Seabed depth <350m	920 (100%) n: 2419	2653 (99%) n: 1910	2153 (100%) n: 1783	2673 (100%) n: 1030	1319 (99%) n: 1329
Start time >0	920 (100%) n: 2415	2571 (96%) n: 1902	2139 (99%) n: 1781	2666 (100%) n: 1029	1319 (99%) n: 1326
SA subset	920 (100%) n: 2415	2571 (96%) n: 1902	2139 (99%) n: 1781	2666 (100%) n: 1029	1319 (99%) n: 1326
No effort allocation	920 (100%) n: 2414	2571 (96%) n: 1898	2139 (99%) n: 1775	2666 (100%) n: 1029	1319 (99%) n: 1306
Core fleet selection	787 (85%) n: 2235	2467 (92%) n: 1744	1866 (87%) n: 1603	2622 (98%) n: 953	1202 (90%) n: 1157

Table 17: Summary of the JMA3 MW pred JMD event dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	996.13	50.00
1994	5	40	2 090	5 313.80	512.98	34.55
1995	6	38	1 937	5 281.88	1 053.16	37.43
1996	5	31	1 698	4 946.23	1 368.23	59.60
1997	6	23	1 813	5 486.45	788.35	52.84
1998	7	36	2 393	6 500.45	1 420.22	49.44
1999	7	29	2 269	6 680.20	2 166.15	58.35
2000	7	34	2 351	7 026.89	2 007.22	60.57
2001	7	29	2 174	7 230.32	395.61	29.62
2002	8	32	2 598	8 281.02	1 231.81	40.57
2003	8	33	1 904	6 719.12	383.48	21.48
2004	8	23	1 725	6 488.50	163.05	10.09
2005	8	28	2 103	7 303.95	133.39	9.94
2006	8	33	2 204	8 642.28	1 443.61	34.48
2007	7	27	1 109	4 762.03	443.37	24.89
2008	7	27	1 223	5 763.20	446.30	18.23
2009	7	37	1 809	8 957.70	251.73	13.27
2010	6	25	1 191	5 181.56	664.44	38.04
2011	6	21	1 301	5 811.68	1 111.23	32.97
2012	6	27	1 344	5 844.70	1 061.15	31.70
2013	6	25	1 169	4 960.32	1 593.29	42.86
2014	7	36	1 420	6 220.82	1 575.73	46.76
2015	7	37	1 362	6 240.75	880.87	41.56
2016	8	48	1 409	6 312.63	602.02	25.83
2017	6	29	1 212	6 426.48	1 607.59	47.77
2018	7	33	1 599	7 557.02	2 206.59	52.47
2019	7	36	2 156	9 997.48	976.42	36.83
2020	7	44	2 235	10 344.52	787.14	34.54
2021	7	32	1 744	7 955.15	2 466.83	63.65
2022	6	35	1 603	7 543.75	1 866.15	63.32
2023	6	25	953	4 692.92	2 621.64	88.98
2024	6	34	1 157	5 419.63	1 201.65	85.13

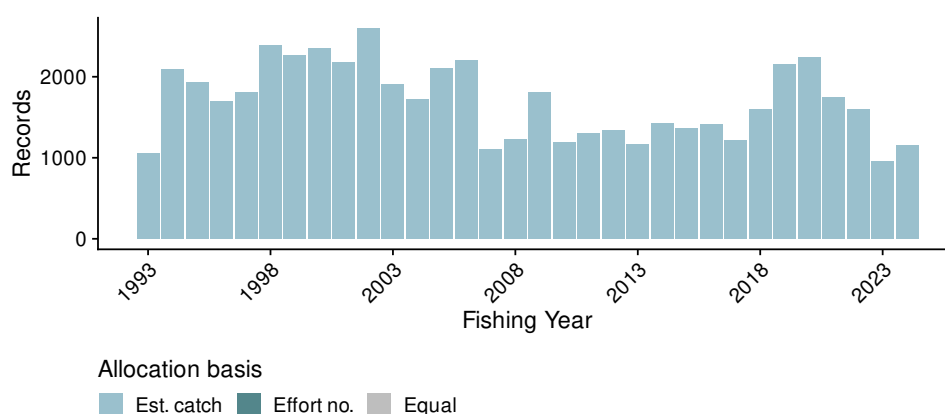


Figure 104: The allocation approach used for attributing catches to records in the JMA3 MW pred JMD event catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table 18: Summary table for occurrence of positive catch in the JMA3 MW pred JMD event series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	21 892.20	0.00	0.00	*
fyear	31	17 415.62	13.67	13.67	*
vessel_key	11	17 394.03	14.02	0.34	*
target_species	2	17 953.04	26.82	12.80	*
month	11	17 789.90	27.69	0.87	*
start_obs_fma	3	17 379.23	30.99	3.30	*
ns(log(fishing_duration), 3)	3	17 371.73	31.06	0.07	*
ns(log(start_time), 3)	3	17 322.90	31.27	0.22	*
ns(log(bottom_depth), 3)	3	17 222.68	31.60	0.33	*
ns(log(effort_height), 3)	3	17 211.75	31.67	0.06	*
ns(effort_speed, 3)	3	17 078.68	32.21	0.54	*

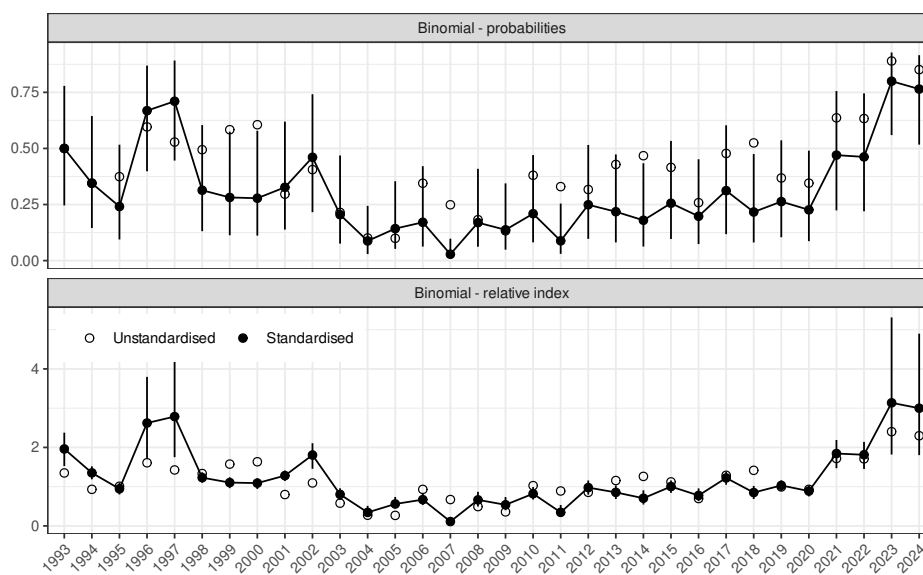


Figure 105: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW pred JMD event dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

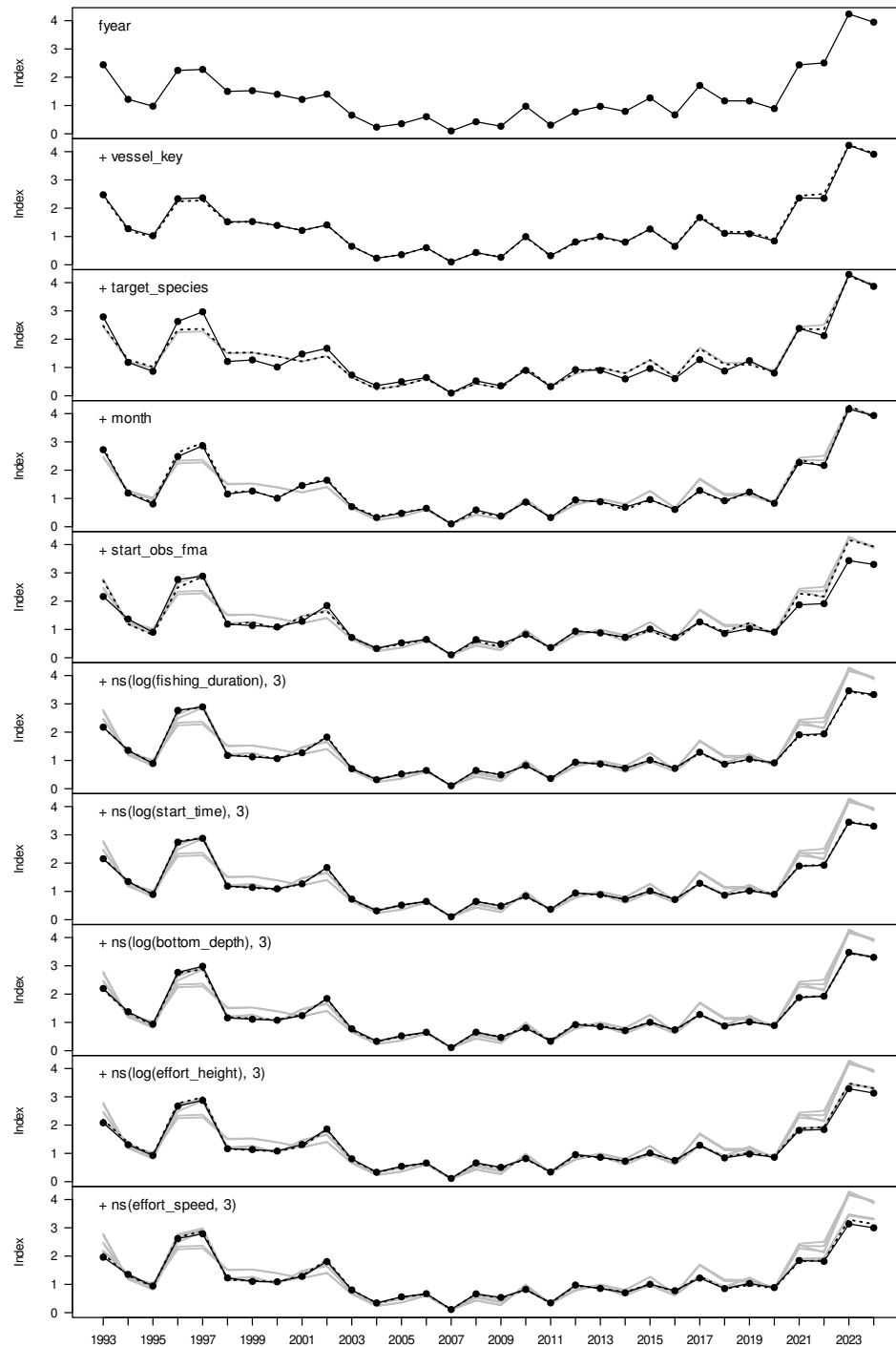


Figure 106: Step plot for occurrence of catch in the JMA3 MW pred JMD event dataset.

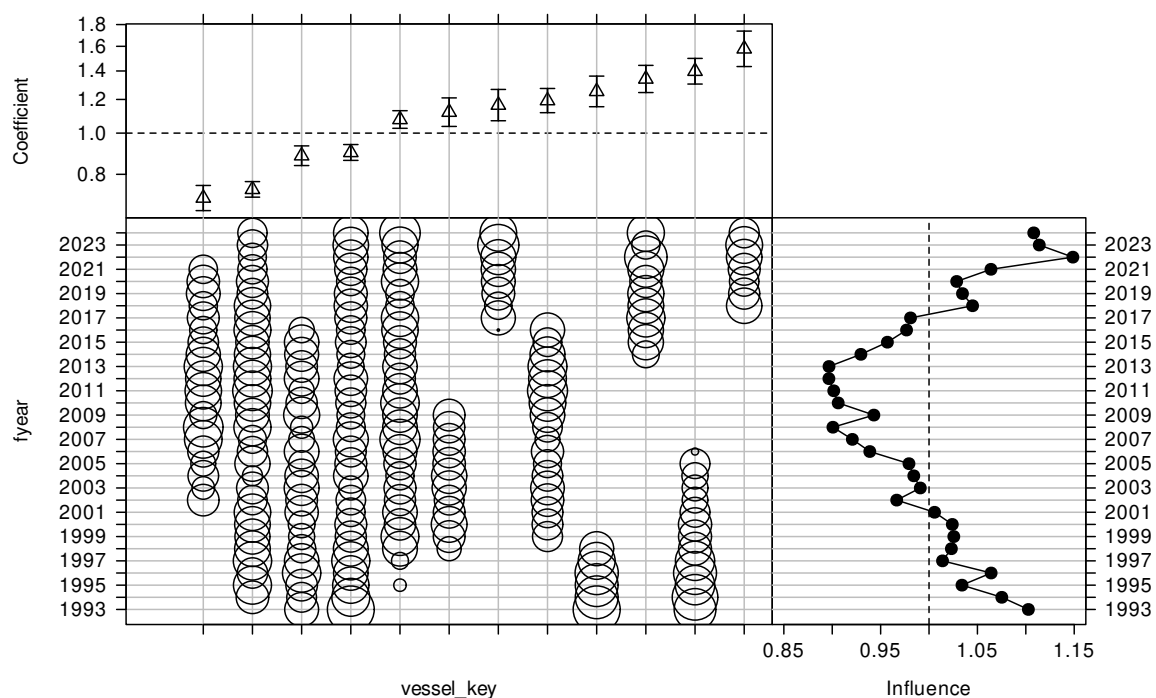


Figure 107: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

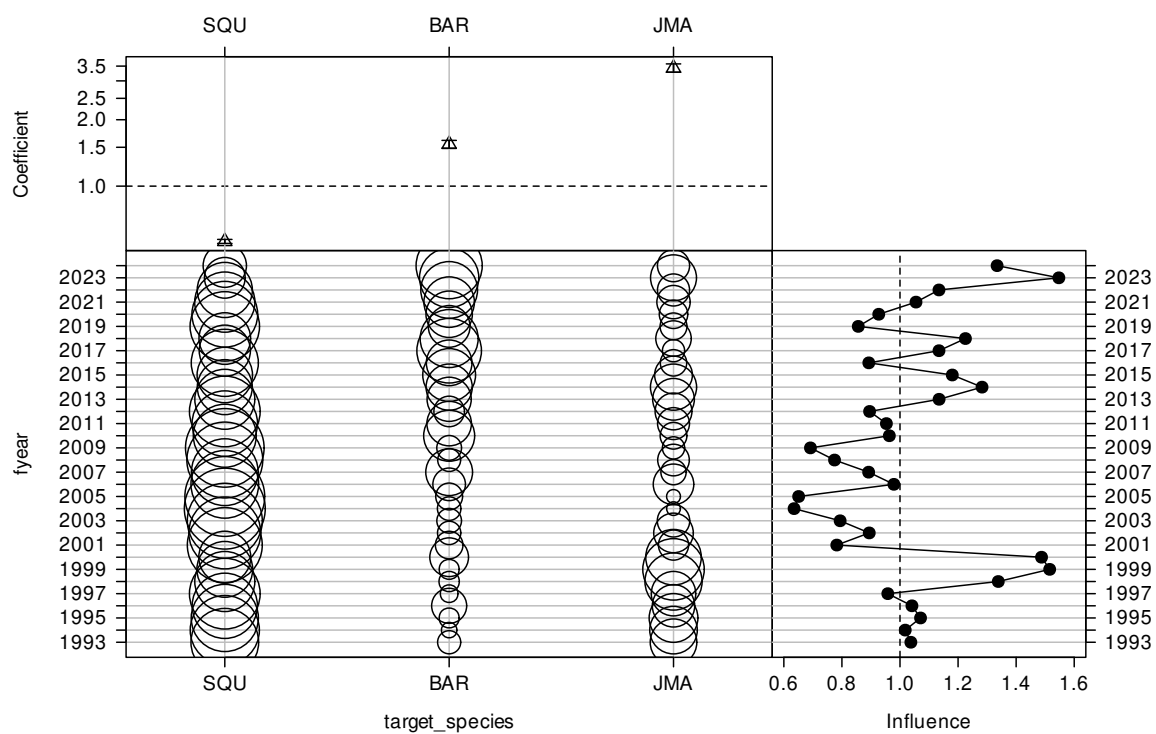


Figure 108: CDI plot for target species for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

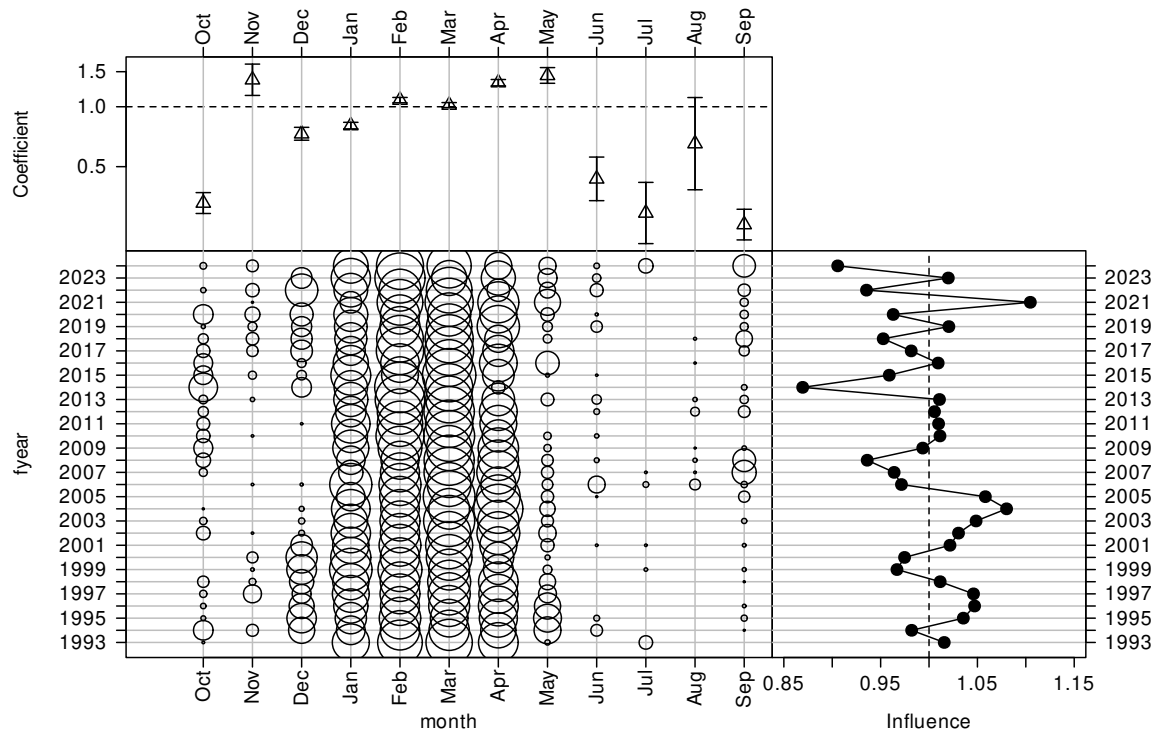


Figure 109: CDI plot for month for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

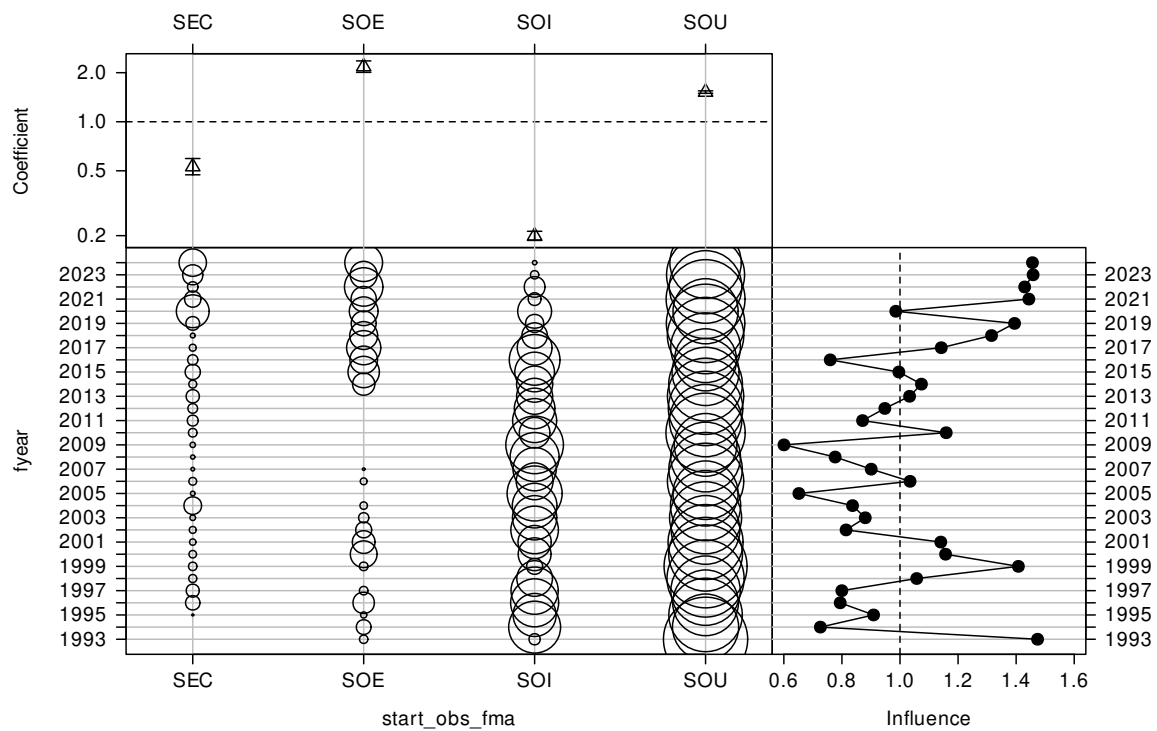


Figure 110: CDI plot for start obs fma for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

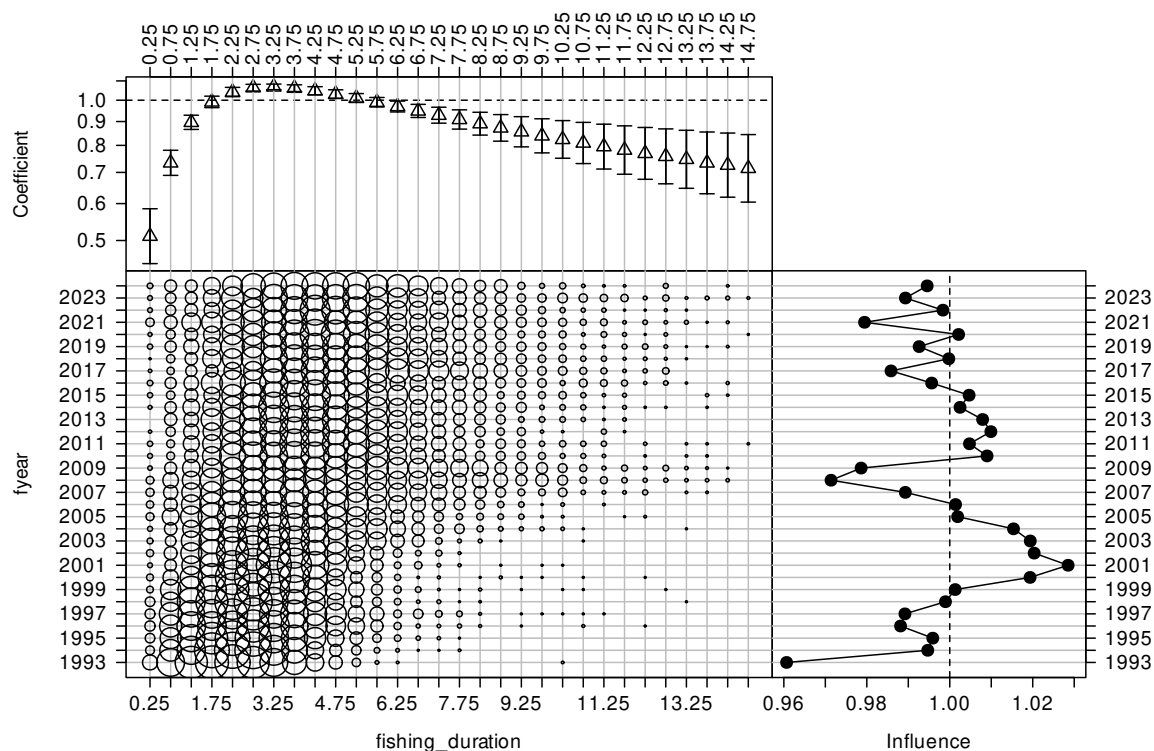


Figure 111: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

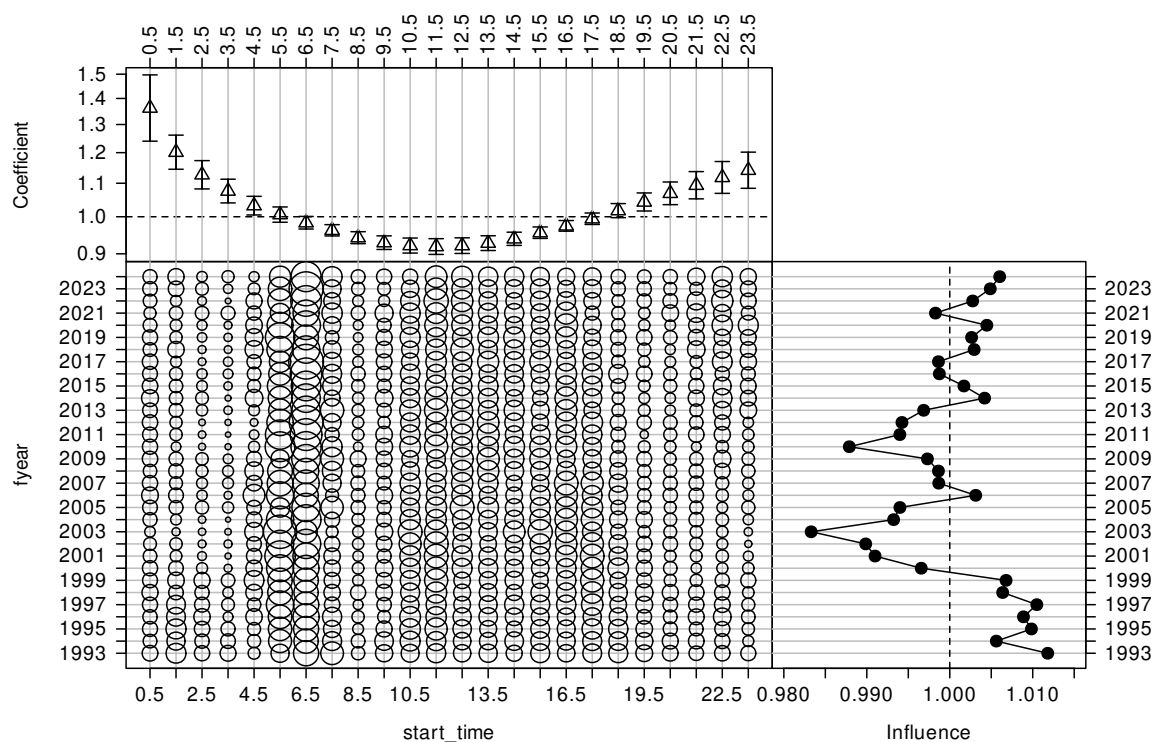


Figure 112: CDI plot for start time for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

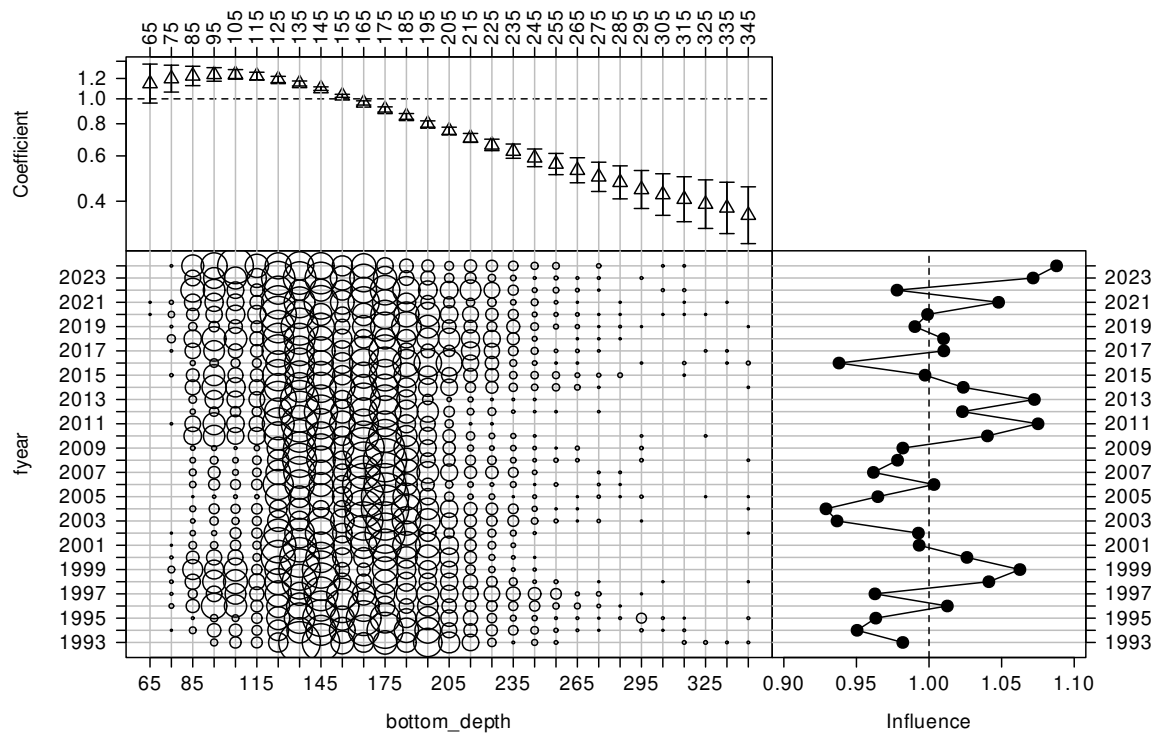


Figure 113: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

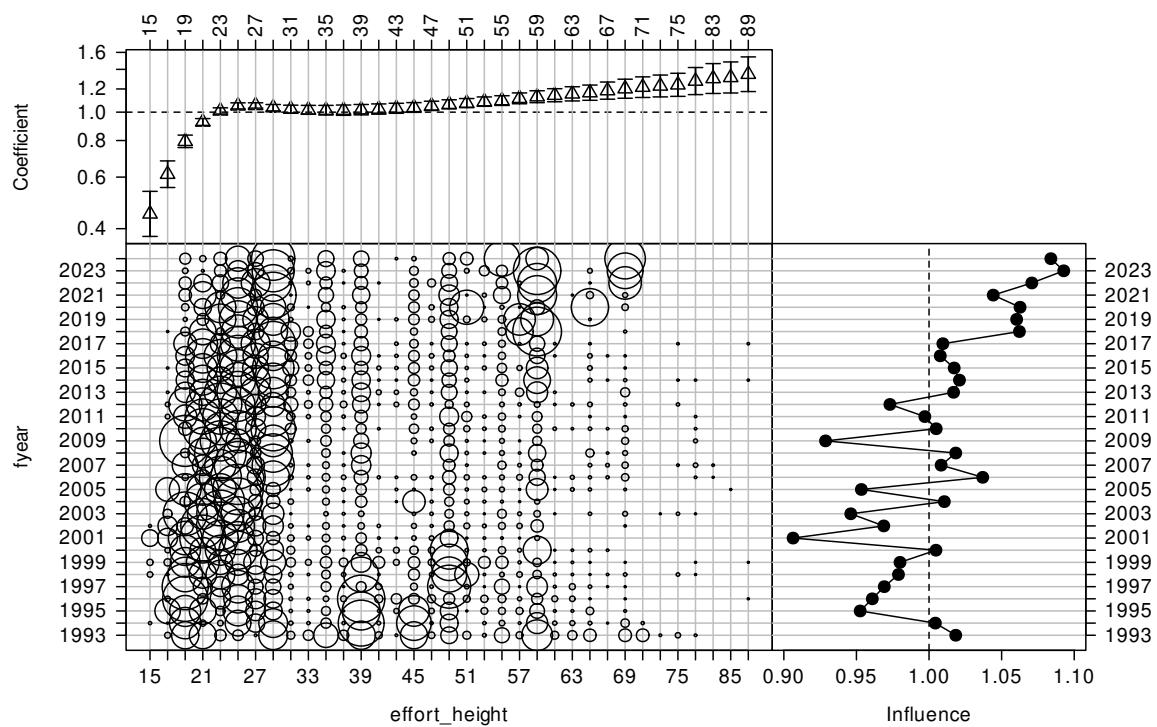


Figure 114: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

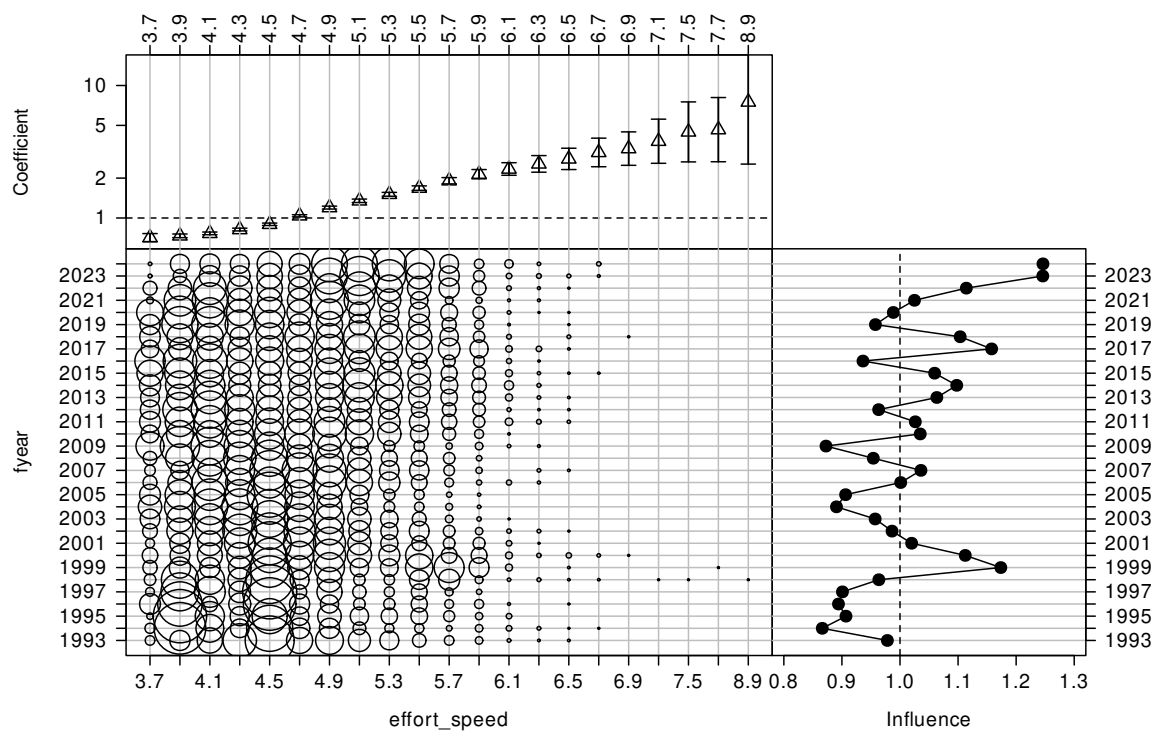


Figure 115: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

Table 19: Summary table for the Weibull model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	103431.1	0.00	0.00	*
fyear	31	103020.9	8.02	8.02	*
vessel_key	11	102894.1	10.55	2.53	*
target_species	2	101750.3	30.05	19.50	*
month	11	101605.8	32.87	2.83	*
start_obs_fma	3	101545.7	34.00	1.12	*
ns(log(fishing_duration), 3)	3	101514.5	34.63	0.63	*
ns(log(start_time), 3)	3	101463.6	35.60	0.97	*
ns(log(bottom_depth), 3)	3	101449.4	35.94	0.34	*
ns(log(effort_height), 3)	3	101417.6	36.58	0.64	*
ns(effort_speed, 3)	3	101392.0	37.12	0.54	*

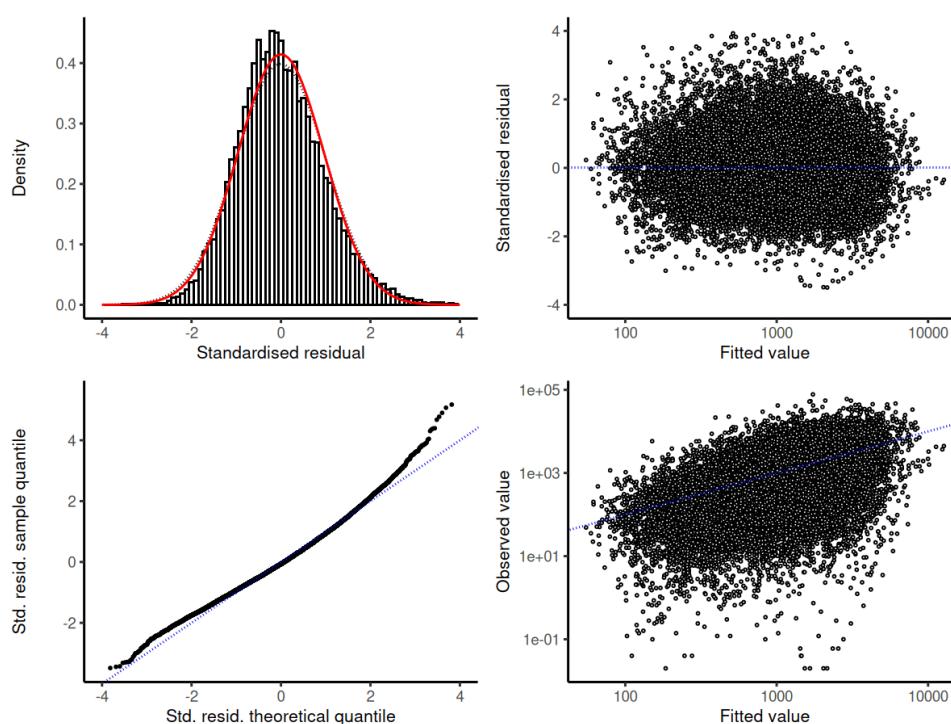


Figure 116: Diagnostic plots for the selected Weibull model for positive catches in the JMA3 MW pred JMD event dataset.

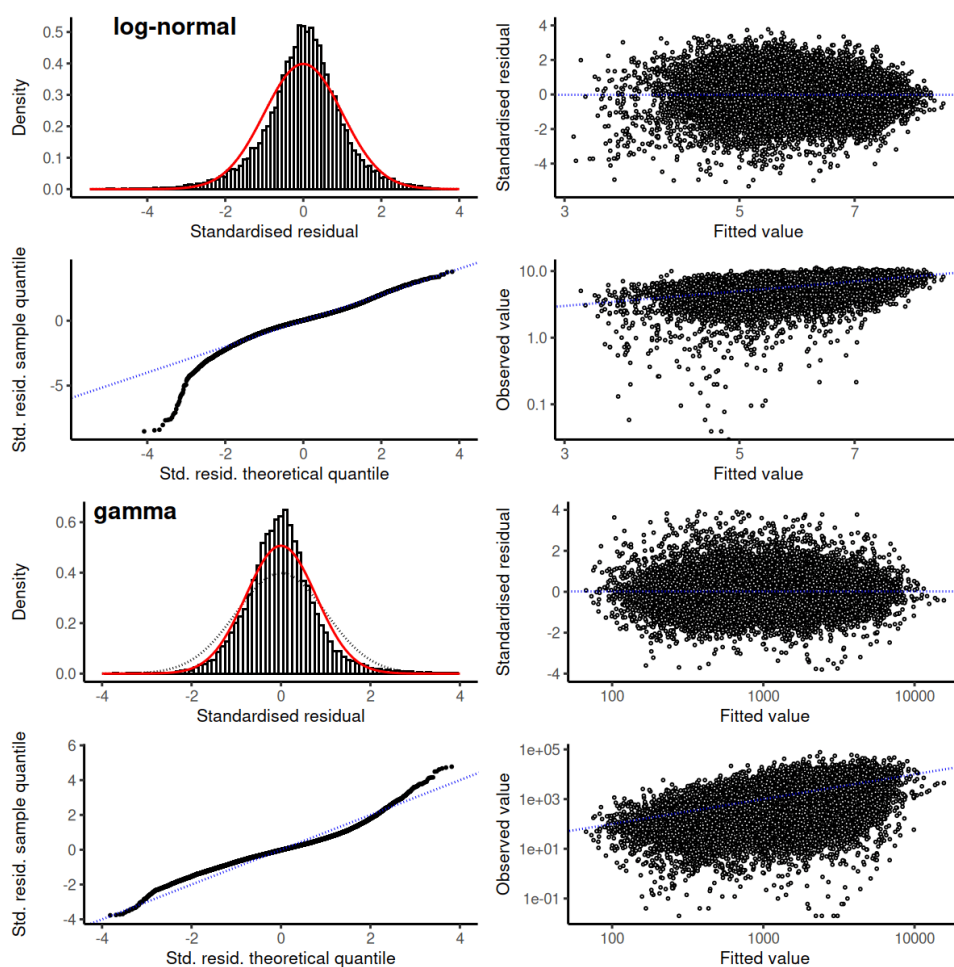


Figure 117: Diagnostic plots for the alternative log-normal and gamma models considered for positive catches in the JMA3 MW pred JMD event dataset.

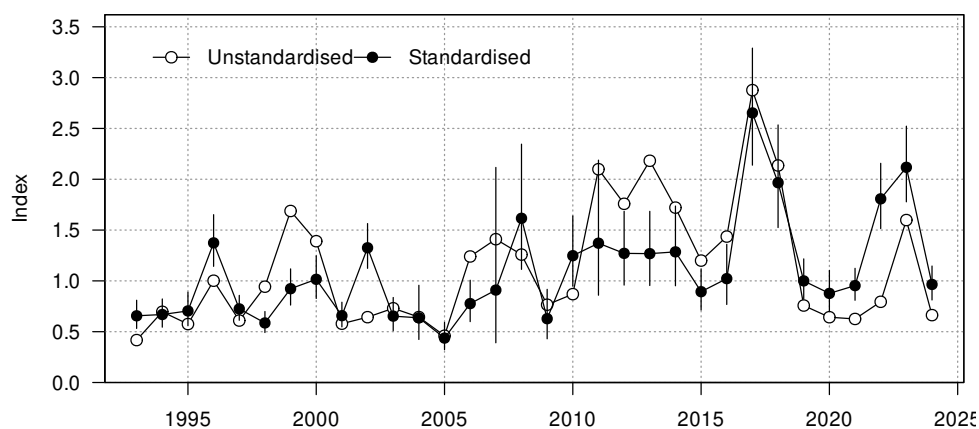


Figure 118: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the Weibull model for the JMA3 MW pred JMD event dataset.

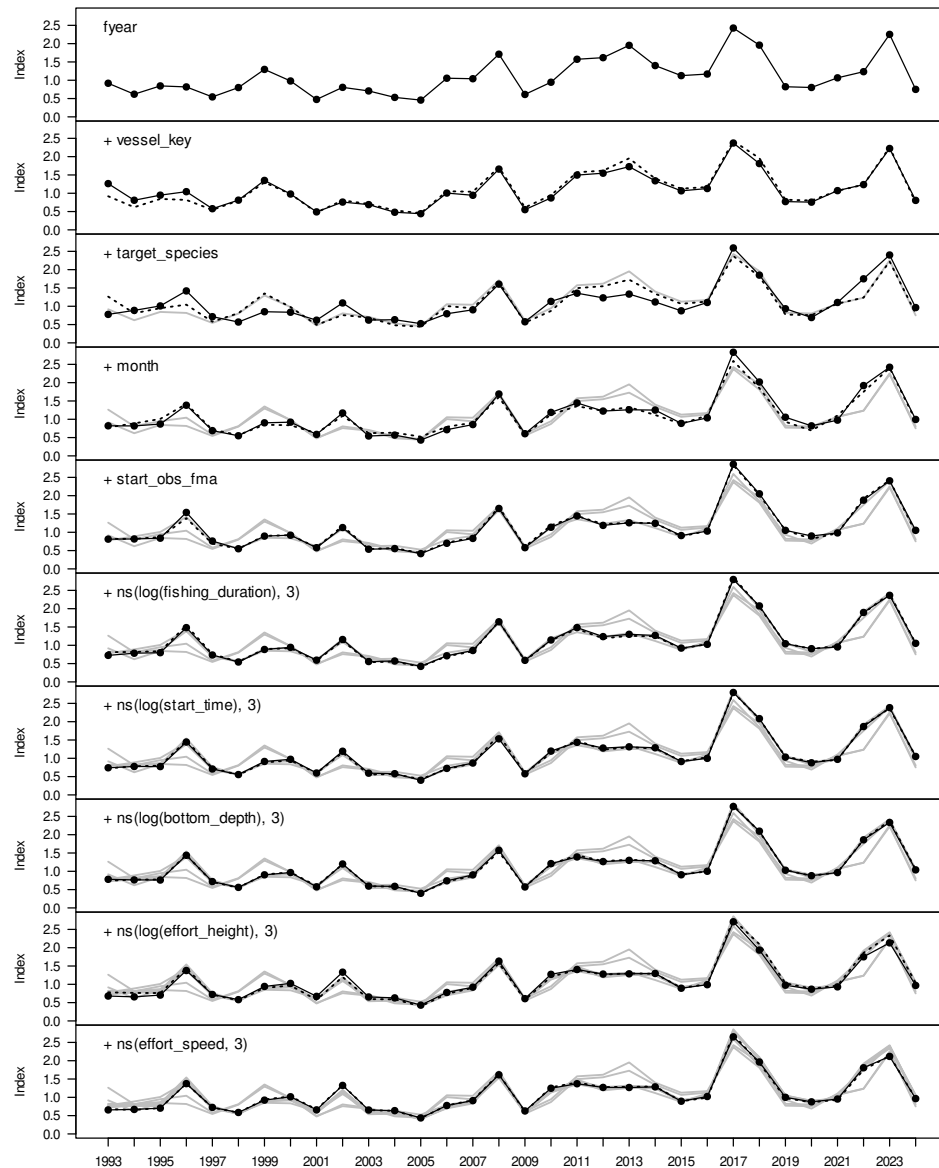


Figure 119: Changes to the JMA3 MW pred JMD event positive catch index as terms are successively entered into the Weibull model.

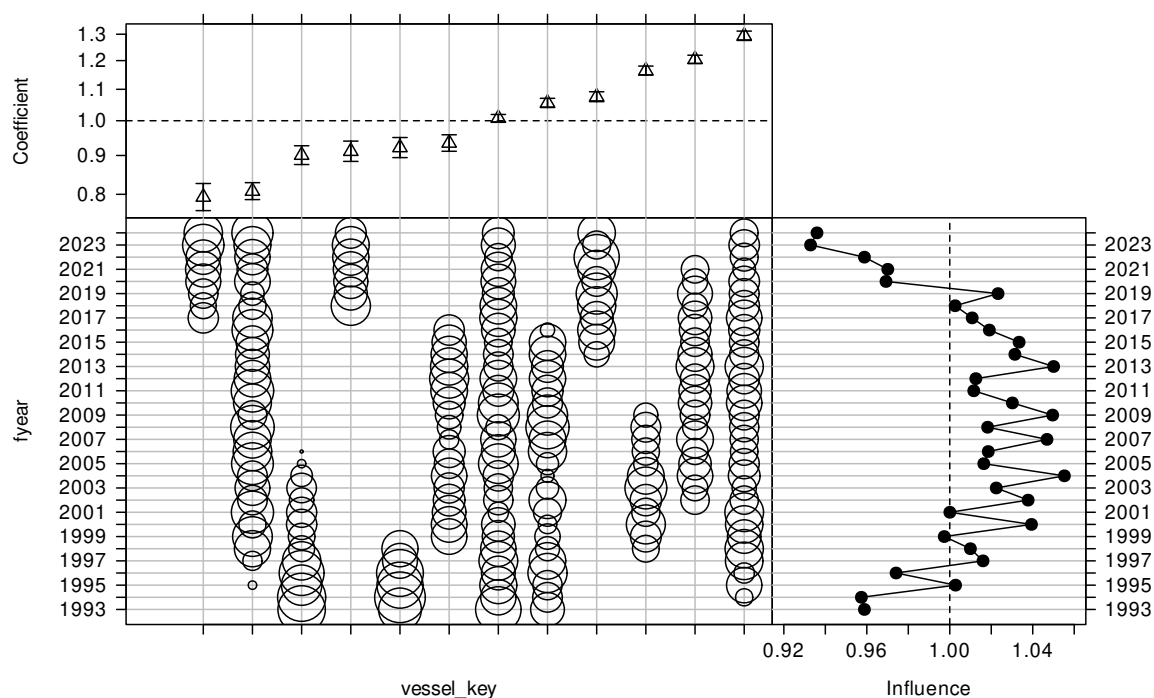


Figure 120: CDI plot for vessel key for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

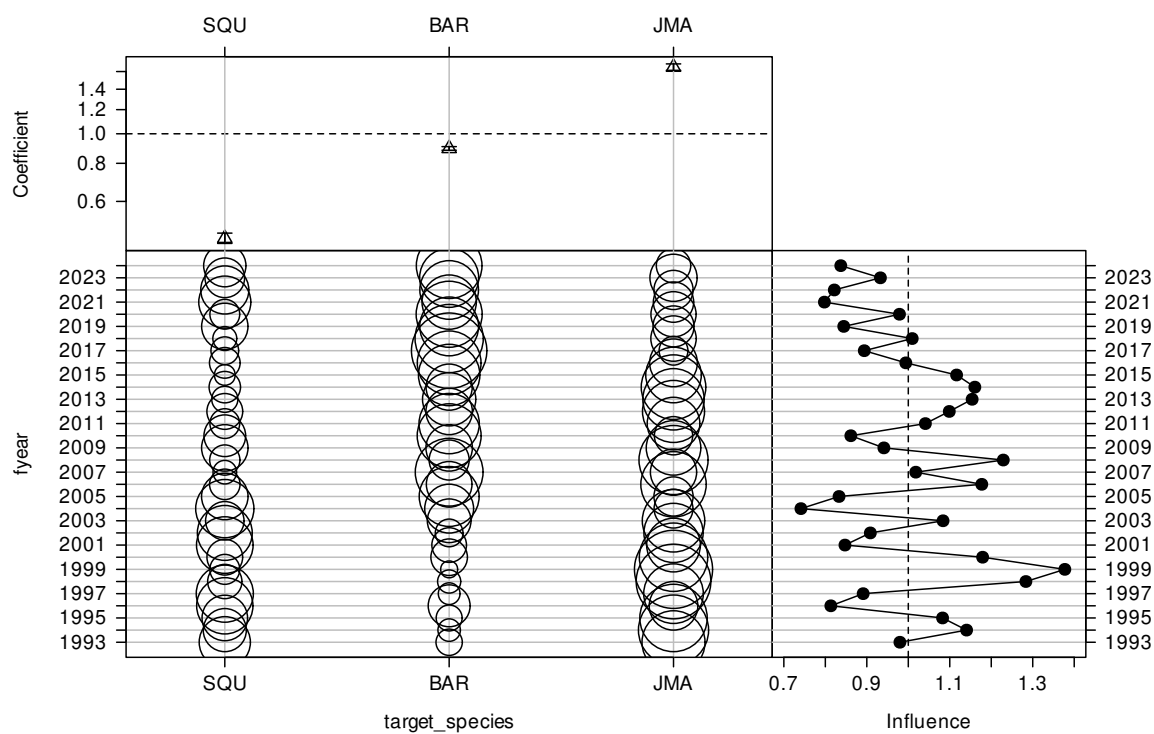


Figure 121: CDI plot for target species for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

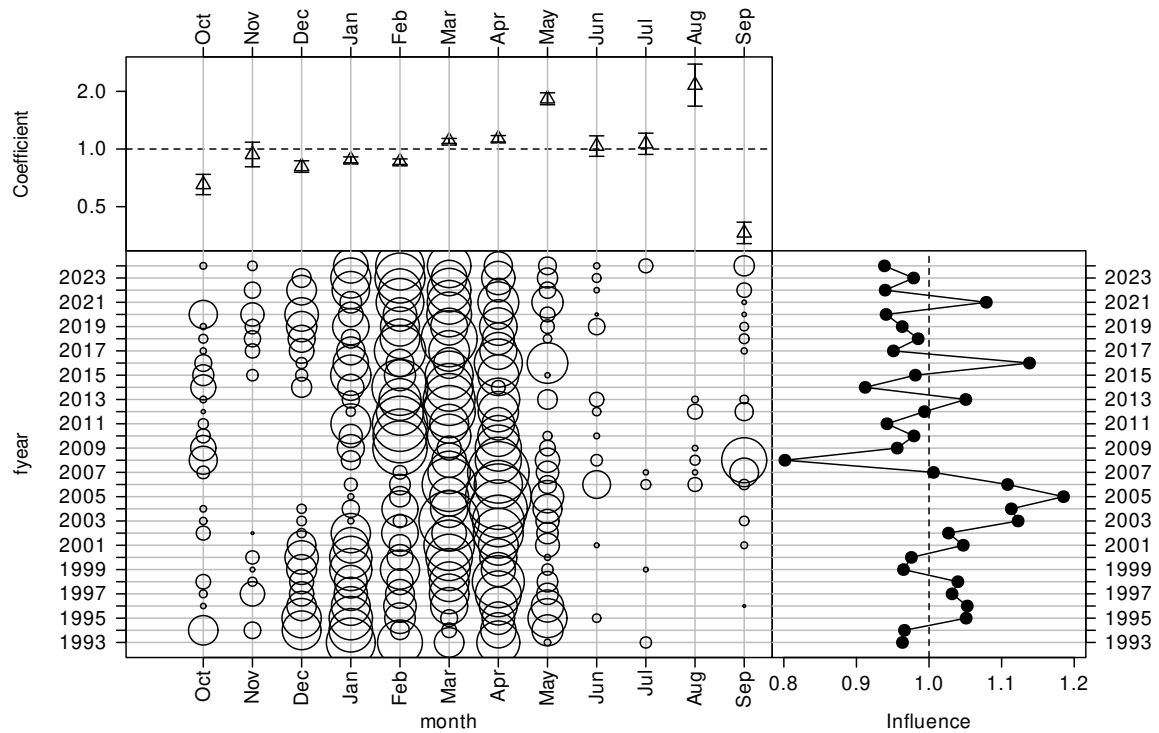


Figure 122: CDI plot for month for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

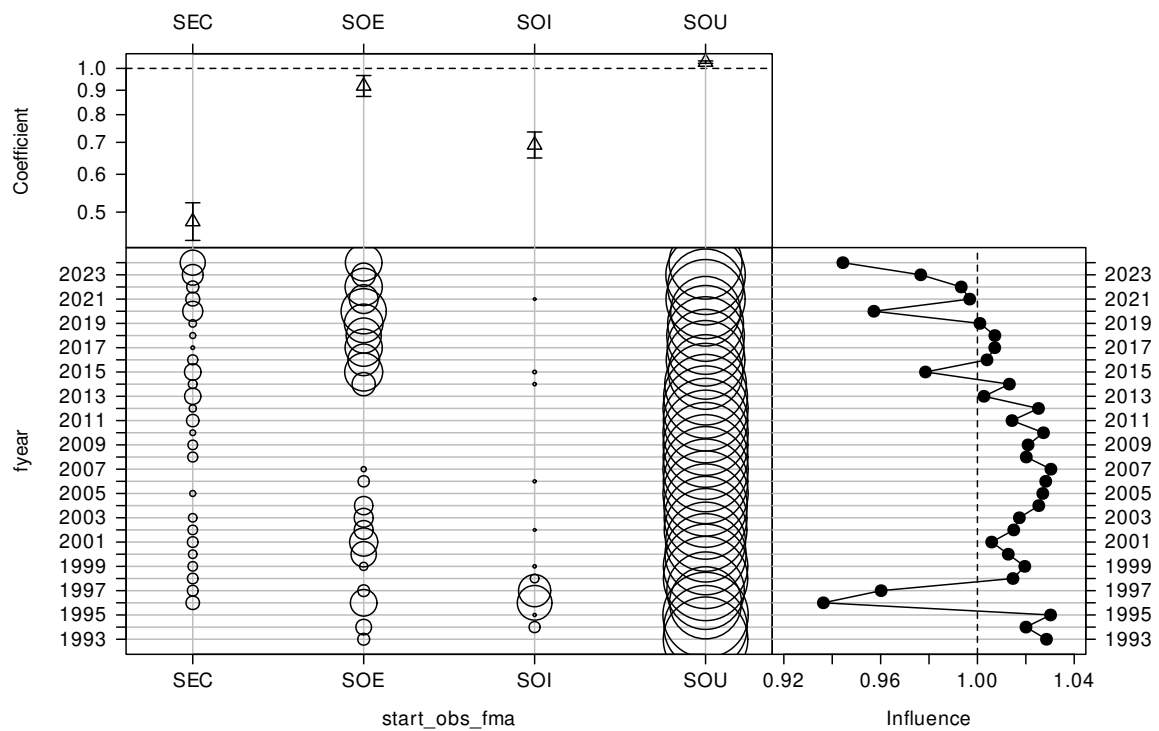


Figure 123: CDI plot for start obs fma for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

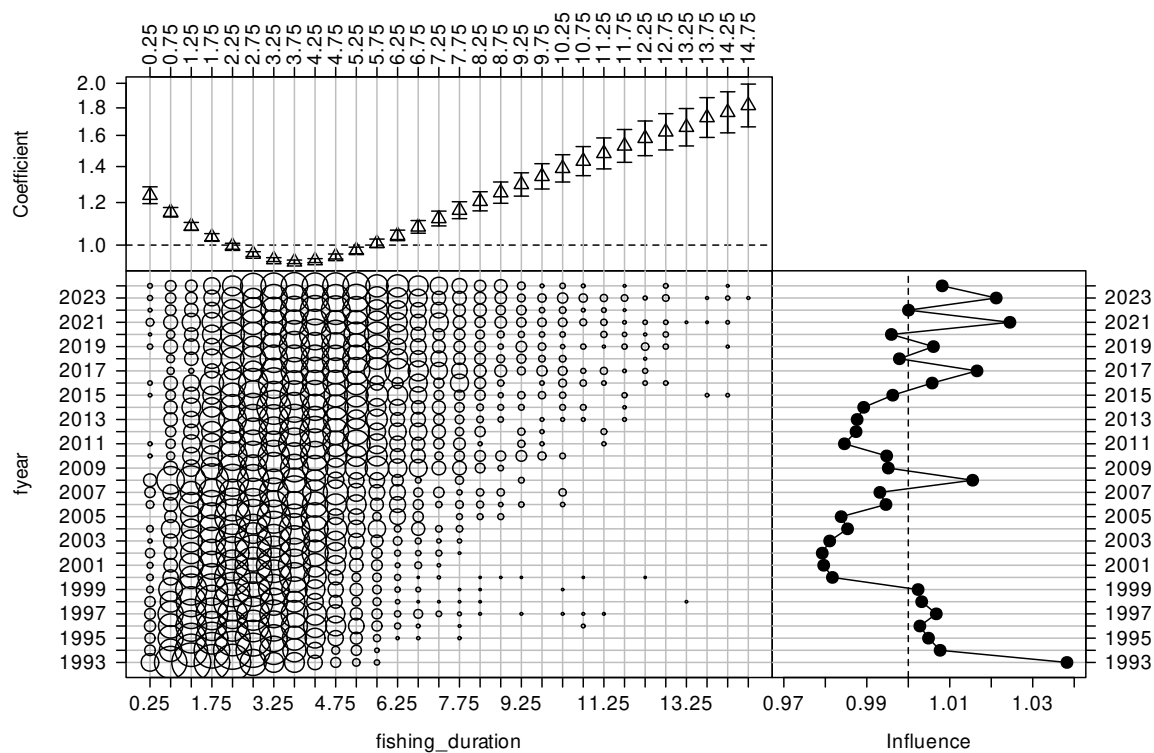


Figure 124: CDI plot for fishing duration (h) for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

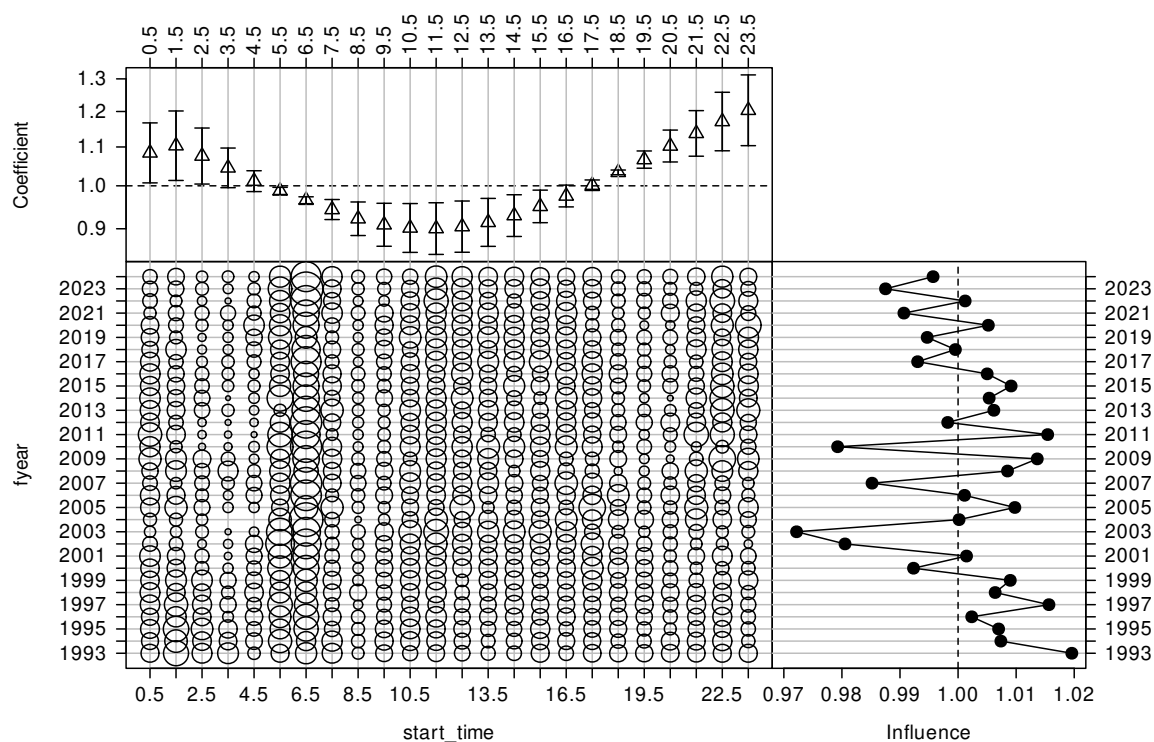


Figure 125: CDI plot for start time for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

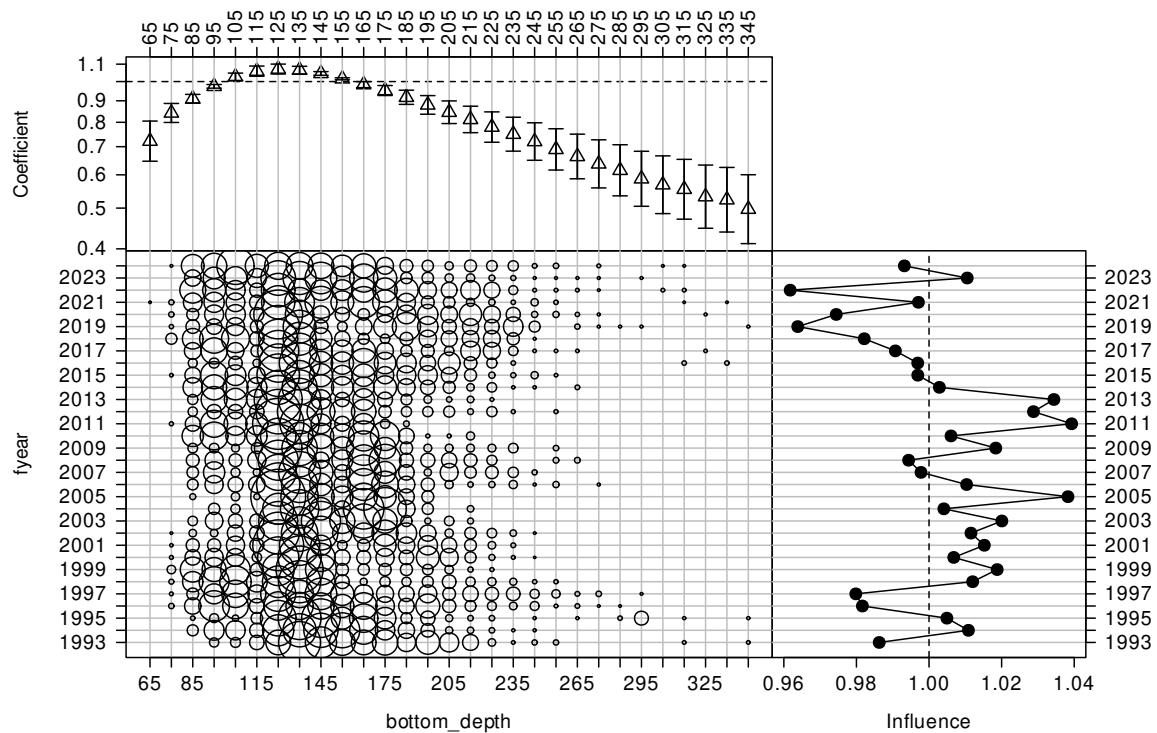


Figure 126: CDI plot for bottom depth (m) for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

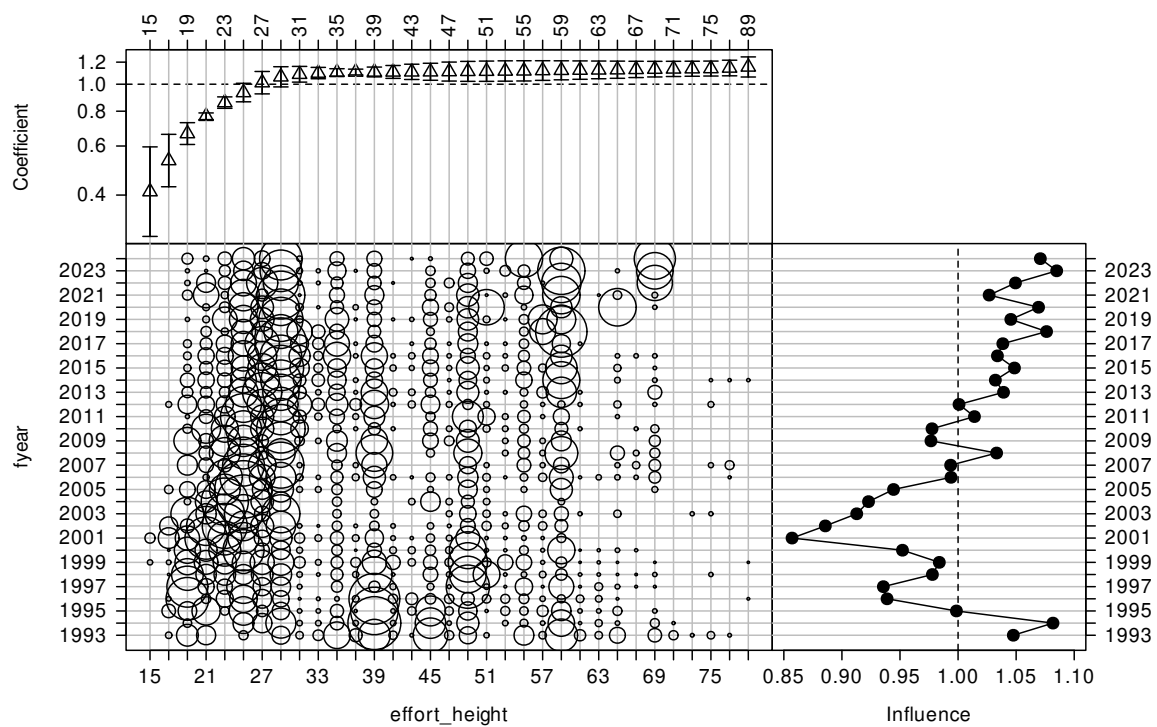


Figure 127: CDI plot for effort height (m) for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

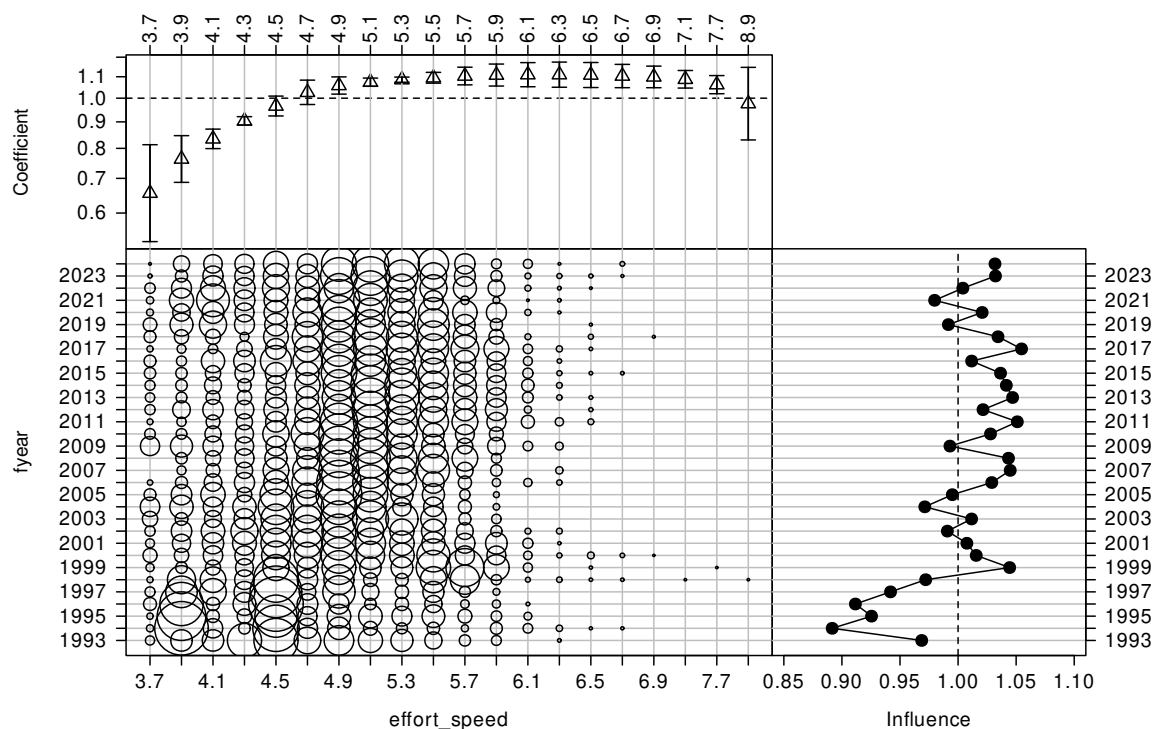


Figure 128: CDI plot for effort speed for the Weibull model of positive catches in the JMA3 MW pred JMD event catch-per-unit-effort dataset.

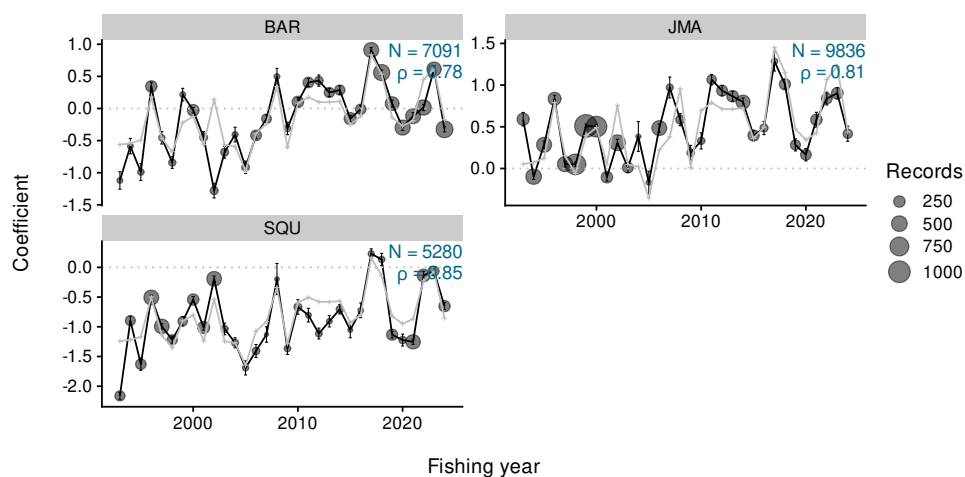


Figure 129: Residual implied coefficients for target-year in the Weibull positive catch model for the JMA3 MW pred JMD event dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

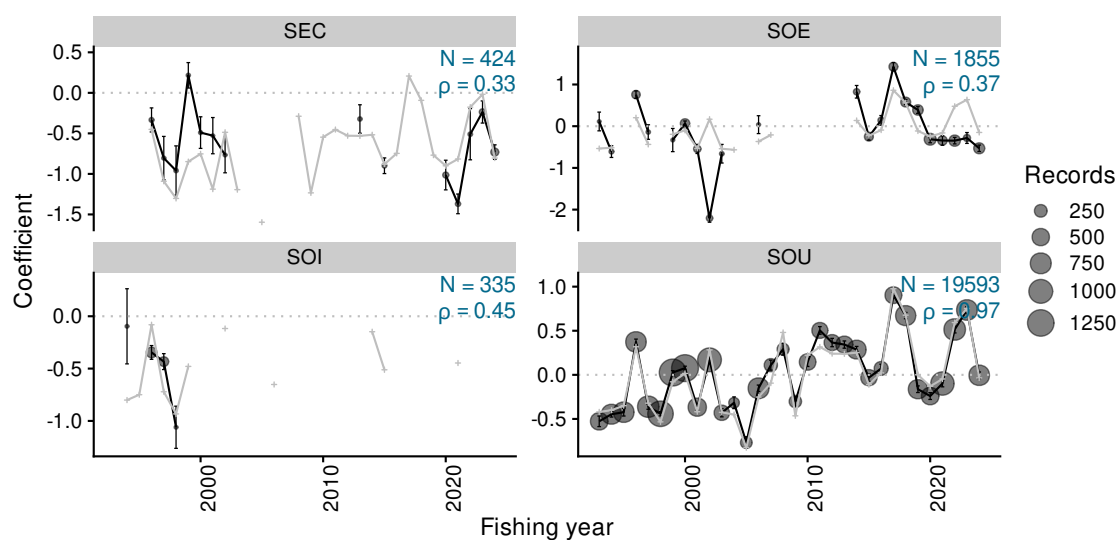


Figure 130: Residual implied coefficients for area-year in the Weibull positive catch model for the JMA3 MW pred JMD event dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

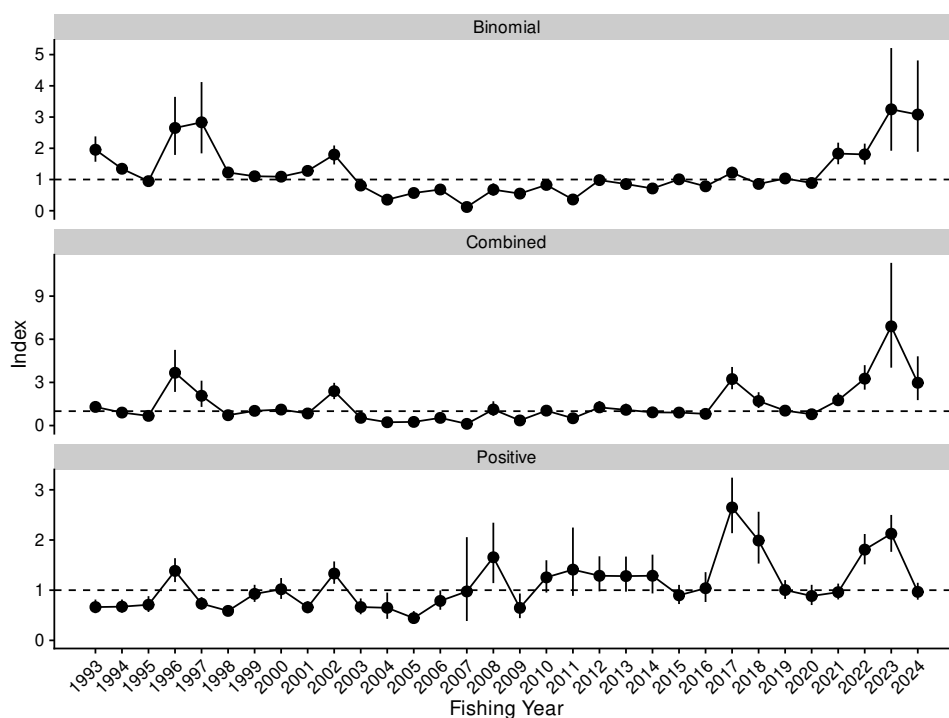


Figure 131: Standardised indices and 95% confidence intervals for the JMA3 MW pred JMD event dataset.

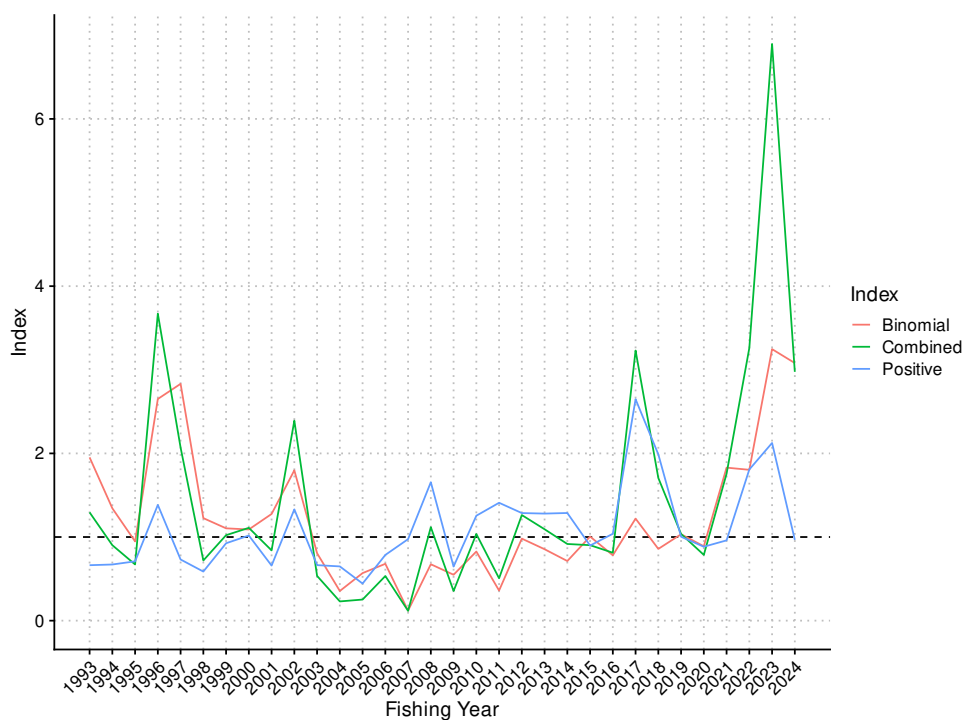


Figure 132: Standardised indices for the JMA3 MW pred JMD event dataset.

Table 20: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW pred JMD event series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.953	0.207	1.569	2.380	1.295	0.194	0.950	1.709	0.663	0.069	0.541	0.813
1994	1.344	0.088	1.184	1.531	0.902	0.112	0.705	1.142	0.672	0.067	0.552	0.814
1995	0.948	0.076	0.797	1.094	0.672	0.095	0.507	0.879	0.709	0.080	0.566	0.881
1996	2.651	0.474	1.787	3.646	3.670	0.746	2.338	5.262	1.384	0.121	1.161	1.637
1997	2.832	0.582	1.837	4.121	2.070	0.465	1.296	3.120	0.731	0.063	0.613	0.861
1998	1.226	0.071	1.085	1.363	0.720	0.074	0.585	0.875	0.587	0.052	0.491	0.696
1999	1.104	0.071	0.965	1.244	1.022	0.113	0.816	1.258	0.926	0.087	0.766	1.107
2000	1.090	0.072	0.943	1.226	1.110	0.130	0.880	1.389	1.018	0.106	0.826	1.242
2001	1.276	0.066	1.156	1.416	0.840	0.089	0.678	1.027	0.658	0.061	0.541	0.780
2002	1.797	0.155	1.482	2.090	2.391	0.289	1.837	2.970	1.331	0.114	1.127	1.573
2003	0.806	0.075	0.656	0.950	0.535	0.081	0.385	0.703	0.664	0.080	0.520	0.835
2004	0.355	0.069	0.246	0.515	0.230	0.065	0.129	0.381	0.649	0.133	0.429	0.952
2005	0.569	0.074	0.430	0.722	0.252	0.050	0.167	0.362	0.444	0.065	0.328	0.583
2006	0.680	0.077	0.533	0.836	0.534	0.089	0.382	0.730	0.786	0.098	0.610	0.995
2007	0.120	0.044	0.057	0.230	0.117	0.068	0.036	0.300	0.975	0.426	0.386	2.056
2008	0.675	0.100	0.483	0.877	1.117	0.258	0.675	1.688	1.656	0.307	1.141	2.345
2009	0.549	0.080	0.409	0.723	0.355	0.087	0.217	0.559	0.647	0.125	0.442	0.933
2010	0.826	0.082	0.670	0.992	1.036	0.174	0.727	1.410	1.255	0.164	0.952	1.596
2011	0.360	0.074	0.239	0.527	0.507	0.153	0.269	0.869	1.410	0.347	0.887	2.248
2012	0.981	0.088	0.807	1.154	1.263	0.208	0.893	1.709	1.287	0.178	0.977	1.675
2013	0.854	0.090	0.677	1.030	1.093	0.192	0.766	1.518	1.280	0.178	0.970	1.669
2014	0.713	0.082	0.560	0.882	0.917	0.175	0.612	1.299	1.287	0.197	0.935	1.708
2015	1.006	0.079	0.852	1.163	0.903	0.123	0.696	1.179	0.898	0.097	0.724	1.106
2016	0.782	0.081	0.629	0.946	0.812	0.144	0.561	1.127	1.039	0.152	0.764	1.359
2017	1.220	0.087	1.065	1.405	3.230	0.395	2.525	4.073	2.648	0.282	2.136	3.242
2018	0.858	0.081	0.699	1.016	1.706	0.280	1.220	2.318	1.989	0.263	1.530	2.562
2019	1.033	0.065	0.905	1.158	1.037	0.121	0.818	1.293	1.003	0.096	0.825	1.200
2020	0.889	0.067	0.760	1.022	0.786	0.112	0.591	1.030	0.884	0.103	0.704	1.107
2021	1.830	0.176	1.489	2.180	1.757	0.235	1.357	2.279	0.960	0.081	0.815	1.131
2022	1.804	0.170	1.480	2.149	3.261	0.435	2.495	4.200	1.808	0.154	1.515	2.119
2023	3.247	0.839	1.922	5.210	6.897	1.859	4.024	11.313	2.125	0.187	1.764	2.499
2024	3.080	0.746	1.889	4.813	2.975	0.777	1.768	4.814	0.966	0.086	0.811	1.147

8.3 JMA3 MW pred JMM event

The JMA3 MW pred JMM event series (Table 21) had the same data and settings as the JMA3 MW pred JMD event series, except that the species composition modelling was used to estimate the catch of *T. murphyi* (JMM).

The core fleet selection retained 75.7% of the catch in the modelling dataset with the core fleet again reduced to 12 vessels (Figure 133). The same data filters were applied (Table 22), but the retained catch obviously differed somewhat (Table 23). Because catches of JMM were predicted for the same events that had catches of JMD, the occurrence model was essentially identical, and diagnostics were not repeated here.

As was the case for JMD, fishing year and target species were responsible for most of the deviance explained by the positive catch model, although FMA explained somewhat more deviance in the JMM model (Table 24). A Weibull error distribution (Figure 134) again provided a somewhat better fit than either a lognormal or gamma model (Figure 135). The impacts of standardisation were especially apparent during the late 1990s, shifting the year with peak catch rates, and in the 2010s, where standardisation generally reduced the indices (Figure 136). Target species was responsible for most of the standardisation effect in the 1990s (Figure 137).

Vessels largely fell into two groups, with higher or lower catch rates of JMM (Figure 138) and catch rate was highest in tows targeting jack mackerels (Figure 139). For JMM, catch rates were similarly low on SQU and BAR target tows, whereas BAR target tows had intermediate catch rates of JMD (Figure 121).

The effect of month (Figure 140) was similar to that in the JMD model, but catch rates of JMM were highest on the eastern Chatham Rise (Figure 141). Tow duration (Figure 142) and time of day (Figure 143), had similar effects to those in the JMD model. Catch rates of JMM were estimated to be highest in depths of 90 m to 140 m (Figure 144), slightly shallower than for JMD.

Net heights around 45 m were associated with somewhat higher catch rates of JMM than either smaller or larger opening nets (Figure 145), while catch rates generally increased with towing speed (Figure 146).

Residual implied coefficients by target species (Figure 147) and FMA (Figure 148) did not show substantial differences from the overall trend, although effort was patchy in areas other than Southland (SOU/FMA 5).

As was the case for the JMA3 MW event model, the binomial and positive models showed similar trends during the 1990s, reinforcing the increased abundance estimated in the combined series (Figure 149). Likewise, after the mid 2010s, there were diverging trends resulting in a flattening of the combined series (Figure 150). The combined series indicates a significant increase in abundance of JMM in the mid 1990s, followed by an equally rapid decline. Abundance declined further to the mid 2000s, but increased and stabilised during the 2010s (Table 25). While the likelihood of catching JMM appears to have increased in the 2020s, the magnitude of those catches has decreased.

Table 21: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW pred JMM event CPUE series.

Series	JMA3 MW pred JMM event
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	pred_catch_JMM ~ fyear + vessel_key + target_species + month + start_obs_fma + ns(log(fishing_duration), 3) + ns(log(start_time), 3) + ns(log(bottom_depth), 3) + ns(log(effort_height), 3) + ns(effort_speed, 3)
Stepwise selection	No
Positive catch distribution	Weibull

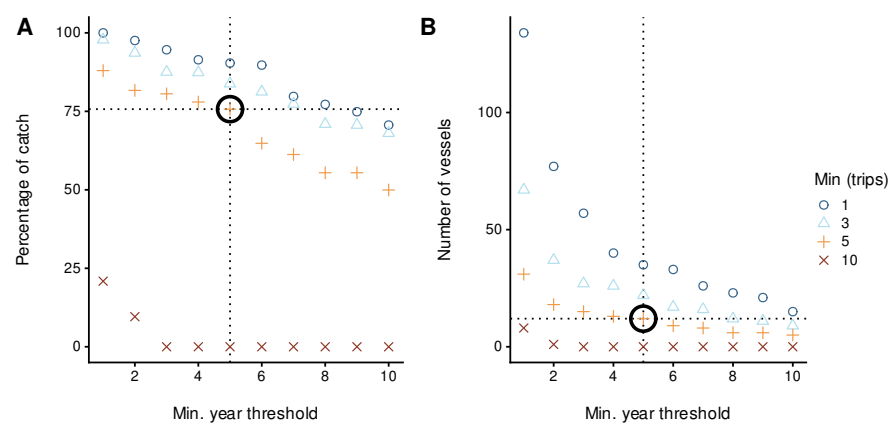


Figure 133: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW pred JMM event CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

Table 22: Summary of the JMA3 MW pred JMM event dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	7278 (100%) n: 7113	4154 (100%) n: 6413	5515 (100%) n: 7617	11101 (100%) n: 7993	10598 (100%) n: 5763	9731 (100%) n: 5648	10988 (100%) n: 5256	5715 (100%) n: 3758	1541 (100%) n: 3011
Fishing speed not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11096 (100%) n: 7985	10577 (100%) n: 5757	9731 (100%) n: 5644	10986 (100%) n: 5252	5715 (100%) n: 3758	1541 (100%) n: 3010
Fishing speed lt 10kts	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11052 (100%) n: 7953	10555 (100%) n: 5745	9731 (100%) n: 5639	10986 (100%) n: 5251	5715 (100%) n: 3758	1541 (100%) n: 3010
Start date not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11052 (100%) n: 7953	10555 (100%) n: 5745	9731 (100%) n: 5639	10986 (100%) n: 5251	5715 (100%) n: 3758	1541 (100%) n: 3010
End date not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11052 (100%) n: 7953	10555 (100%) n: 5745	9731 (100%) n: 5639	10986 (100%) n: 5251	5715 (100%) n: 3758	1541 (100%) n: 3010
Start depth not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11052 (100%) n: 7946	10552 (100%) n: 5729	9652 (99%) n: 5626	10967 (100%) n: 5240	5715 (100%) n: 3755	1539 (100%) n: 3000
Headline height not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11042 (99%) n: 7797	10551 (100%) n: 5721	9650 (99%) n: 5615	10955 (100%) n: 5233	5708 (100%) n: 3751	1539 (100%) n: 2999
Fishing speed >3.5kn	7039 (97%) n: 6832	4131 (99%) n: 6125	5478 (99%) n: 7473	10968 (99%) n: 7506	10479 (99%) n: 5470	9612 (99%) n: 5391	10869 (99%) n: 5118	5667 (99%) n: 3698	1533 (99%) n: 2985
Headline height >15m	7022 (96%) n: 6811	4099 (99%) n: 6075	5437 (99%) n: 7430	10755 (97%) n: 7400	10411 (98%) n: 5384	9585 (99%) n: 5366	10829 (99%) n: 5022	5663 (99%) n: 3688	1532 (99%) n: 2978
Headline height <90m	6651 (91%) n: 6659	4074 (98%) n: 6073	5437 (99%) n: 7430	10745 (97%) n: 7389	9306 (88%) n: 5181	8744 (90%) n: 4978	10789 (98%) n: 5008	5654 (99%) n: 3678	1532 (99%) n: 2977
Fishing duration >15mins	6564 (90%) n: 6627	4059 (98%) n: 6056	5409 (98%) n: 7413	10663 (96%) n: 7360	9243 (87%) n: 5165	8730 (90%) n: 4964	10782 (98%) n: 4997	5654 (99%) n: 3675	1532 (99%) n: 2970
Fishing duration <15h	6553 (90%) n: 6609	4051 (98%) n: 6040	5394 (98%) n: 7404	10630 (96%) n: 7342	9089 (86%) n: 5134	8692 (89%) n: 4949	10754 (98%) n: 4988	5613 (98%) n: 3656	1532 (99%) n: 2970
Seabed depth >50m	6553 (90%) n: 6609	4051 (98%) n: 6040	5394 (98%) n: 7403	10630 (96%) n: 7342	9089 (86%) n: 5134	8673 (89%) n: 4946	10754 (98%) n: 4987	5613 (98%) n: 3655	1532 (99%) n: 2970
Seabed depth <350m	6519 (90%) n: 6570	4041 (97%) n: 6000	5385 (98%) n: 7227	10607 (96%) n: 7313	9057 (85%) n: 5121	8663 (89%) n: 4942	10728 (98%) n: 4964	5611 (98%) n: 3645	1528 (99%) n: 2967
Start time >0	6238 (86%) n: 6508	3954 (95%) n: 5958	5211 (94%) n: 7156	10262 (92%) n: 7221	8758 (83%) n: 5067	8490 (87%) n: 4901	10370 (94%) n: 4916	5548 (97%) n: 3623	1512 (98%) n: 2956
SA subset	6238 (86%) n: 6508	3954 (95%) n: 5958	5211 (94%) n: 7156	10262 (92%) n: 7221	8758 (83%) n: 5067	8490 (87%) n: 4901	10370 (94%) n: 4916	5548 (97%) n: 3623	1512 (98%) n: 2956
No effort allocation	6225 (86%) n: 6462	3905 (94%) n: 5829	5191 (94%) n: 7023	10262 (92%) n: 7221	8758 (83%) n: 5066	8490 (87%) n: 4901	10370 (94%) n: 4916	5548 (97%) n: 3619	1512 (98%) n: 2956
Core fleet selection	2057 (28%) n: 1050	2574 (62%) n: 2090	3005 (54%) n: 1937	5111 (46%) n: 1698	5094 (48%) n: 1813	5887 (60%) n: 2393	6915 (63%) n: 2269	4502 (79%) n: 2351	1332 (86%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
Fishing speed not null	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
Fishing speed lt 10kts	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
Start date not null	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
End date not null	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
Start depth not null	2288 (100%) n: 3306	1224 (100%) n: 3106	357 (100%) n: 3278	433 (100%) n: 3635	3116 (100%) n: 2831	943 (100%) n: 2412	1688 (100%) n: 2246	1405 (100%) n: 2187	1524 (100%) n: 1313
Headline height not null	2288 (100%) n: 3306	1224 (100%) n: 3106	357 (100%) n: 3278	433 (100%) n: 3635	3116 (100%) n: 2831	943 (100%) n: 2412	1688 (100%) n: 2246	1405 (100%) n: 2187	1524 (100%) n: 1313
Fishing speed >3.5kn	2288 (100%) n: 3266	1216 (99%) n: 3061	355 (100%) n: 3167	433 (100%) n: 3520	3111 (100%) n: 2794	942 (100%) n: 2380	1664 (99%) n: 2222	1367 (97%) n: 2132	1524 (100%) n: 1300
Headline height >15m	2251 (98%) n: 3243	1214 (99%) n: 3043	349 (98%) n: 3150	433 (100%) n: 3512	3111 (100%) n: 2790	942 (100%) n: 2359	1664 (99%) n: 2205	1359 (97%) n: 2128	1523 (100%) n: 1297
Headline height <90m	2251 (98%) n: 3243	1214 (99%) n: 3043	347 (97%) n: 3149	433 (100%) n: 3512	3111 (100%) n: 2789	942 (100%) n: 2359	1664 (99%) n: 2204	1359 (97%) n: 2128	1523 (100%) n: 1297
Fishing duration >15mins	2213 (97%) n: 3229	1214 (99%) n: 3038	347 (97%) n: 3140	433 (100%) n: 3501	3109 (100%) n: 2782	941 (100%) n: 2354	1663 (99%) n: 2198	1359 (97%) n: 2126	1523 (100%) n: 1295
Fishing duration <15h	2213 (97%) n: 3226	1211 (99%) n: 3037	347 (97%) n: 3138	433 (100%) n: 3501	3109 (100%) n: 2780	941 (100%) n: 2353	1651 (98%) n: 2195	1359 (97%) n: 2122	1523 (100%) n: 1294
Seabed depth >50m	2211 (97%) n: 3224	1211 (99%) n: 3037	347 (97%) n: 3138	433 (100%) n: 3501	3109 (100%) n: 2780	941 (100%) n: 2353	1651 (98%) n: 2195	1359 (97%) n: 2122	1523 (100%) n: 1294
Seabed depth <350m	2209 (97%) n: 3222	1211 (99%) n: 3033	347 (97%) n: 3134	433 (100%) n: 3500	3109 (100%) n: 2779	941 (100%) n: 2351	1651 (98%) n: 2193	1343 (96%) n: 2120	1523 (100%) n: 1293
Start time >0	2183 (95%) n: 3198	1195 (98%) n: 3025	343 (96%) n: 3119	422 (97%) n: 3458	3052 (98%) n: 2766	918 (97%) n: 2334	1631 (97%) n: 2182	1294 (92%) n: 2108	1489 (98%) n: 1280
SA subset	2183 (95%) n: 3198	1195 (98%) n: 3025	343 (96%) n: 3119	422 (97%) n: 3458	3052 (98%) n: 2766	918 (97%) n: 2334	1631 (97%) n: 2182	1294 (92%) n: 2108	1489 (98%) n: 1280
No effort allocation	2183 (95%) n: 3196	1194 (98%) n: 2486	341 (96%) n: 2363	421 (97%) n: 2581	3052 (98%) n: 2593	916 (97%) n: 1705	1628 (96%) n: 1587	1289 (92%) n: 1990	1489 (98%) n: 1260
Core fleet selection	2090 (91%) n: 2598	1072 (88%) n: 1904	332 (93%) n: 1725	418 (97%) n: 2103	3002 (96%) n: 2204	802 (85%) n: 1109	1246 (74%) n: 1223	1000 (71%) n: 1809	1408 (92%) n: 1191

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2792 (100%) n: 1678	3260 (100%) n: 2307
Fishing speed not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2792 (100%) n: 1678	3260 (100%) n: 2307
Fishing speed lt 10kts	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
Start date not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
End date not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
Start depth not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
Headline height not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
Fishing speed >3.5kn	2224 (100%) n: 1412	1564 (100%) n: 1465	1860 (100%) n: 1229	2688 (100%) n: 1454	2720 (100%) n: 1381	1826 (100%) n: 1503	2439 (100%) n: 1357	2772 (99%) n: 1625	3254 (100%) n: 2269
Headline height >15m	2188 (98%) n: 1395	1564 (100%) n: 1464	1860 (100%) n: 1229	2688 (100%) n: 1454	2719 (100%) n: 1379	1826 (100%) n: 1503	2414 (99%) n: 1354	2772 (99%) n: 1625	3254 (100%) n: 2263
Headline height <90m	2188 (98%) n: 1395	1564 (100%) n: 1463	1860 (100%) n: 1229	2688 (100%) n: 1454	2719 (100%) n: 1379	1826 (100%) n: 1503	2414 (99%) n: 1354	2772 (99%) n: 1624	3254 (100%) n: 2263
Fishing duration >15mins	2186 (98%) n: 1394	1564 (100%) n: 1459	1858 (100%) n: 1224	2688 (100%) n: 1449	2719 (100%) n: 1378	1826 (100%) n: 1498	2414 (99%) n: 1352	2772 (99%) n: 1624	3254 (100%) n: 2260
Fishing duration <15h	2186 (98%) n: 1392	1564 (100%) n: 1457	1858 (100%) n: 1224	2688 (100%) n: 1448	2719 (100%) n: 1378	1826 (100%) n: 1497	2414 (99%) n: 1352	2772 (99%) n: 1624	3242 (99%) n: 2257
Seabed depth >50m	2186 (98%) n: 1392	1564 (100%) n: 1457	1858 (100%) n: 1224	2688 (100%) n: 1448	2719 (100%) n: 1378	1826 (100%) n: 1497	2414 (99%) n: 1352	2772 (99%) n: 1624	3242 (99%) n: 2257
Seabed depth <350m	2186 (98%) n: 1390	1564 (100%) n: 1457	1858 (100%) n: 1224	2688 (100%) n: 1448	2719 (100%) n: 1378	1826 (100%) n: 1491	2414 (99%) n: 1352	2772 (99%) n: 1623	3242 (99%) n: 2256
Start time >0	2154 (97%) n: 1382	1558 (99%) n: 1453	1827 (98%) n: 1217	2570 (96%) n: 1438	2664 (98%) n: 1370	1782 (97%) n: 1483	2412 (99%) n: 1349	2766 (99%) n: 1617	3242 (99%) n: 2252
SA subset	2154 (97%) n: 1382	1558 (99%) n: 1453	1827 (98%) n: 1217	2570 (96%) n: 1438	2664 (98%) n: 1370	1782 (97%) n: 1483	2412 (99%) n: 1349	2766 (99%) n: 1617	3242 (99%) n: 2252
No effort allocation	2154 (97%) n: 1382	1558 (99%) n: 1390	1827 (98%) n: 1216	2570 (96%) n: 1436	2664 (98%) n: 1370	1762 (96%) n: 1447	2412 (99%) n: 1336	2766 (99%) n: 1616	3242 (99%) n: 2252
Core fleet selection	2139 (96%) n: 1301	1512 (96%) n: 1344	1782 (96%) n: 1169	2563 (95%) n: 1420	2655 (97%) n: 1362	1727 (94%) n: 1409	2388 (98%) n: 1212	2759 (99%) n: 1599	3150 (97%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1711 (100%) n: 1343
Fishing speed not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1711 (100%) n: 1343
Fishing speed lt 10kts	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1711 (100%) n: 1343
Start date not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1711 (100%) n: 1343
End date not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1698 (99%) n: 1342
Start depth not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1698 (99%) n: 1342
Headline height not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1698 (99%) n: 1342
Fishing speed >3.5kn	3536 (100%) n: 2430	2573 (100%) n: 1919	2471 (100%) n: 1794	2084 (100%) n: 1037	1698 (99%) n: 1342
Headline height >15m	3530 (100%) n: 2426	2573 (100%) n: 1917	2471 (100%) n: 1792	2084 (100%) n: 1035	1695 (99%) n: 1336
Headline height <90m	3530 (100%) n: 2426	2573 (100%) n: 1917	2471 (100%) n: 1792	2084 (100%) n: 1035	1695 (99%) n: 1336
Fishing duration >15mins	3530 (100%) n: 2421	2539 (99%) n: 1912	2471 (100%) n: 1785	2083 (100%) n: 1032	1695 (99%) n: 1331
Fishing duration <15h	3530 (100%) n: 2421	2537 (99%) n: 1910	2471 (100%) n: 1785	2083 (100%) n: 1031	1695 (99%) n: 1330
Seabed depth >50m	3530 (100%) n: 2421	2537 (99%) n: 1910	2471 (100%) n: 1784	2083 (100%) n: 1031	1695 (99%) n: 1330
Seabed depth <350m	3530 (100%) n: 2419	2537 (99%) n: 1910	2471 (100%) n: 1783	2083 (100%) n: 1030	1695 (99%) n: 1329
Start time >0	3529 (100%) n: 2415	2454 (95%) n: 1902	2469 (100%) n: 1781	2080 (100%) n: 1029	1695 (99%) n: 1326
SA subset	3529 (100%) n: 2415	2454 (95%) n: 1902	2469 (100%) n: 1781	2080 (100%) n: 1029	1695 (99%) n: 1326
No effort allocation	3529 (100%) n: 2414	2454 (95%) n: 1898	2469 (100%) n: 1775	2080 (100%) n: 1029	1695 (99%) n: 1306
Core fleet selection	3206 (91%) n: 2235	2386 (93%) n: 1744	2391 (97%) n: 1603	2042 (98%) n: 953	1660 (97%) n: 1157

Table 23: Summary of the JMA3 MW pred JMM event dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	2 057.14	50.10
1994	5	40	2 090	5 313.80	2 574.44	34.55
1995	6	38	1 937	5 281.88	3 004.77	37.43
1996	5	31	1 698	4 946.23	5 110.53	59.60
1997	6	23	1 813	5 486.45	5 094.05	52.84
1998	7	36	2 393	6 500.45	5 887.49	49.44
1999	7	29	2 269	6 680.20	6 914.54	58.35
2000	7	34	2 351	7 026.89	4 501.51	60.57
2001	7	29	2 174	7 230.32	1 332.08	29.62
2002	8	32	2 598	8 281.02	2 090.39	41.15
2003	8	33	1 904	6 719.12	1 071.63	21.48
2004	8	23	1 725	6 488.50	332.33	10.09
2005	8	28	2 103	7 303.95	418.02	9.94
2006	8	33	2 204	8 642.28	3 001.90	34.48
2007	7	27	1 109	4 762.03	801.83	24.89
2008	7	27	1 223	5 763.20	1 245.58	18.23
2009	7	37	1 809	8 957.70	996.80	13.27
2010	6	25	1 191	5 181.56	1 407.78	38.04
2011	6	21	1 301	5 811.68	2 138.62	32.97
2012	6	27	1 344	5 844.70	1 511.71	31.70
2013	6	25	1 169	4 960.32	1 781.64	42.86
2014	7	36	1 420	6 220.82	2 562.94	46.76
2015	7	37	1 362	6 240.75	2 655.39	41.56
2016	8	48	1 409	6 312.63	1 727.37	25.83
2017	6	29	1 212	6 426.48	2 388.20	47.77
2018	7	33	1 599	7 557.02	2 758.84	52.47
2019	7	36	2 156	9 997.48	3 149.66	36.83
2020	7	44	2 235	10 344.52	3 206.40	34.54
2021	7	32	1 744	7 955.15	2 385.58	63.65
2022	6	35	1 603	7 543.75	2 391.20	63.32
2023	6	25	953	4 692.92	2 042.41	88.98
2024	6	34	1 157	5 419.63	1 660.36	85.13

Table 24: Summary table for the Weibull model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	115 656.7	0.00	0.00	*
fyear	31	114 966.2	11.39	11.39	*
vessel_key	11	114 738.7	15.17	3.78	*
target_species	2	113 901.1	27.91	12.74	*
month	11	113 809.1	29.63	1.72	*
start_obs_fma	3	113 525.4	34.02	4.39	*
ns(log(fishing_duration), 3)	3	113 483.7	34.74	0.72	*
ns(log(start_time), 3)	3	113 400.4	36.09	1.35	*
ns(log(bottom_depth), 3)	3	113 344.9	37.02	0.93	*
ns(log(effort_height), 3)	3	113 339.9	37.19	0.17	*
ns(effort_speed, 3)	3	113 278.7	38.21	1.02	*

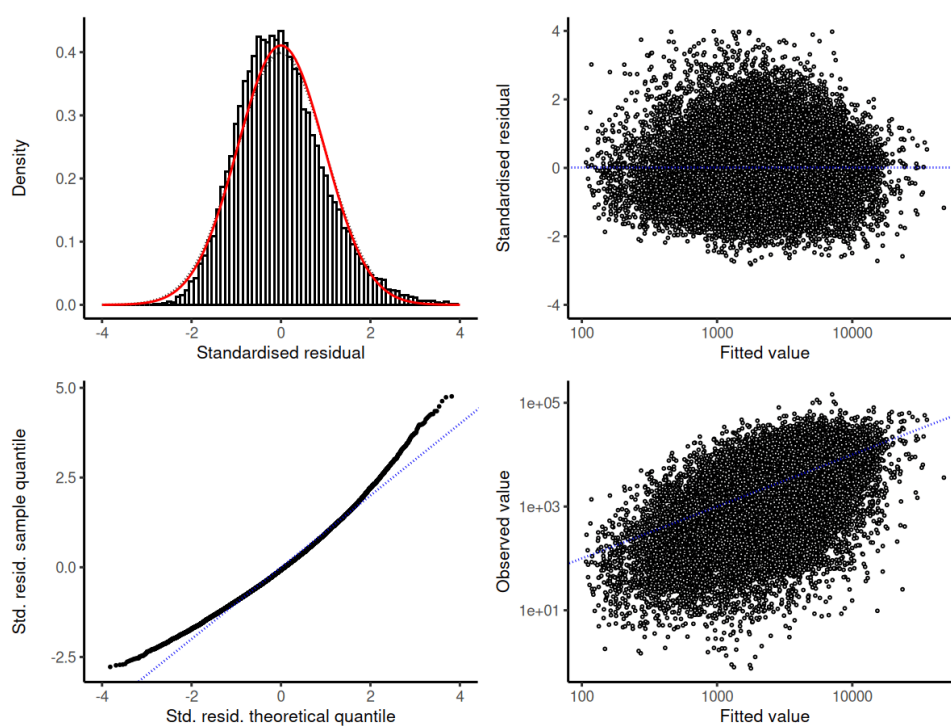


Figure 134: Diagnostic plots for the selected Weibull model for positive catches in the JMA3 MW pred JMM event dataset.

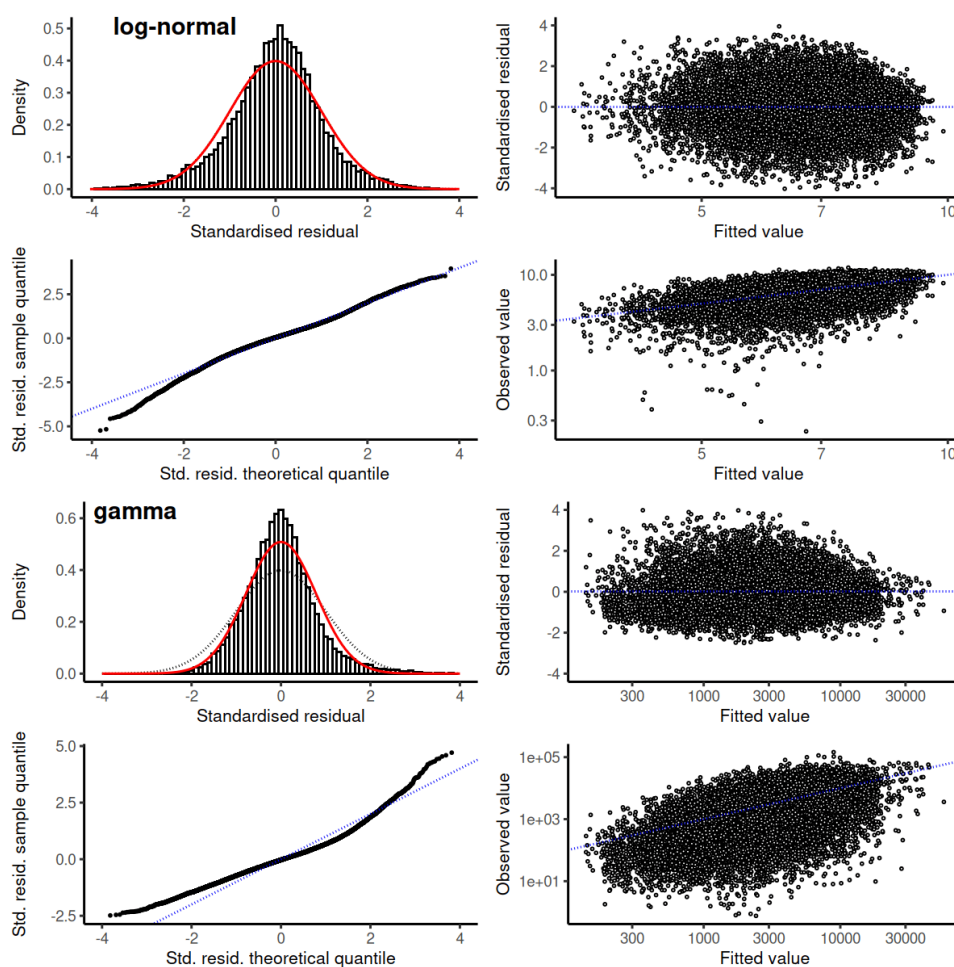


Figure 135: Diagnostic plots for the alternative log-normal and gamma models considered for positive catches in the JMA3 MW pred JMM event dataset.

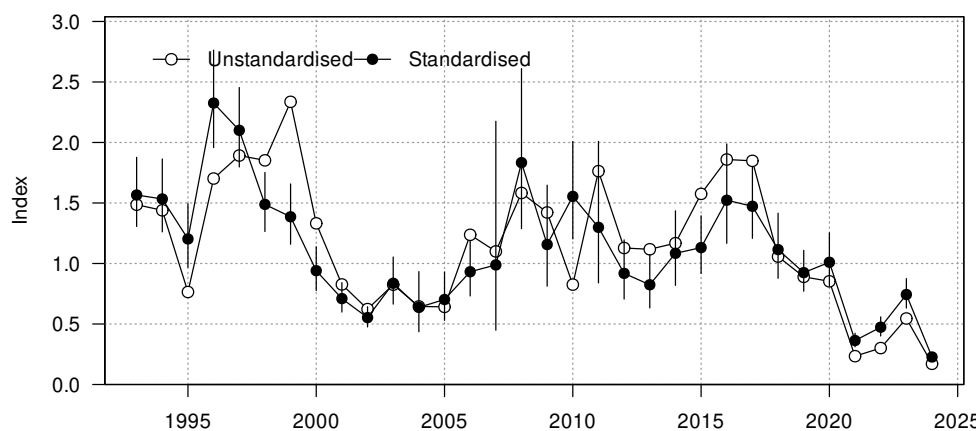


Figure 136: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the Weibull model for the JMA3 MW pred JMM event dataset.

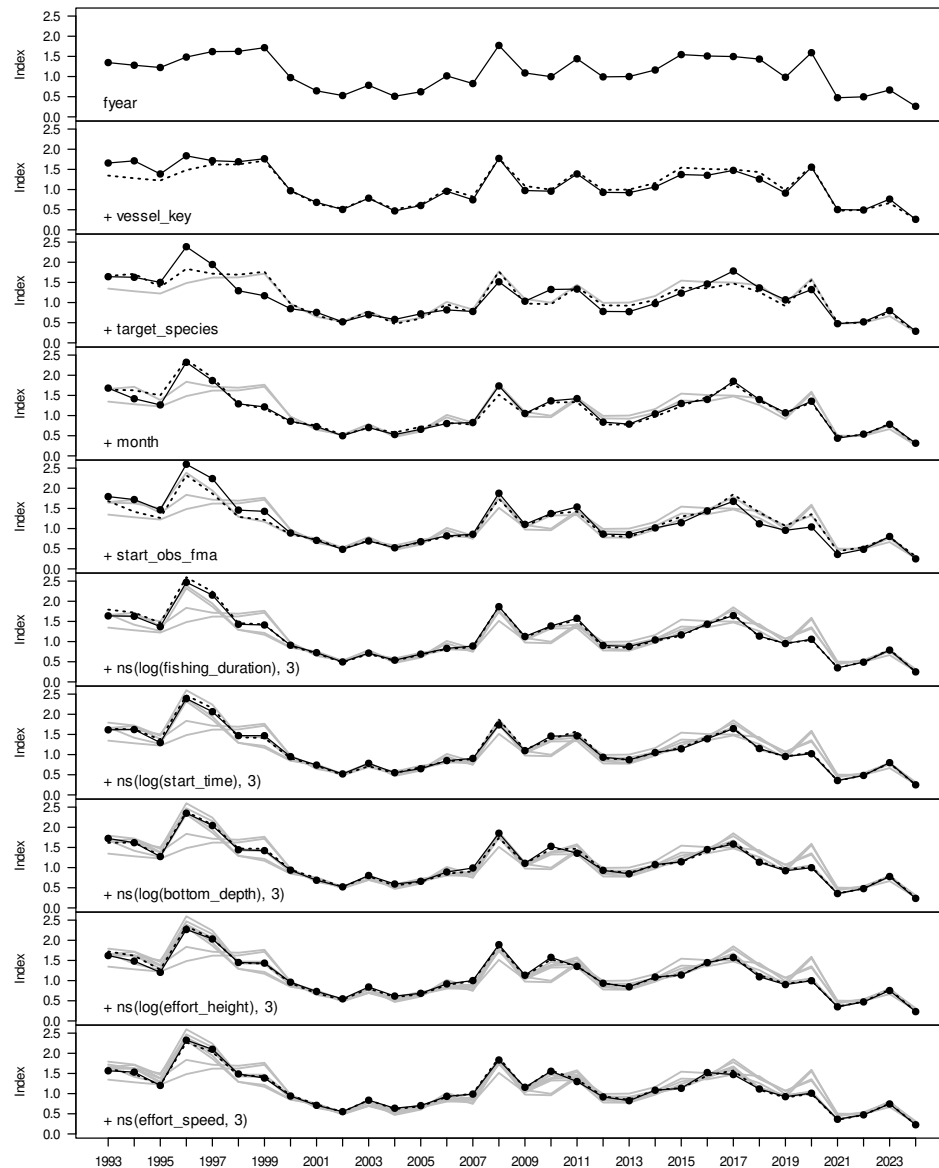


Figure 137: Changes to the JMA3 MW pred JMM event positive catch index as terms are successively entered into the Weibull model.

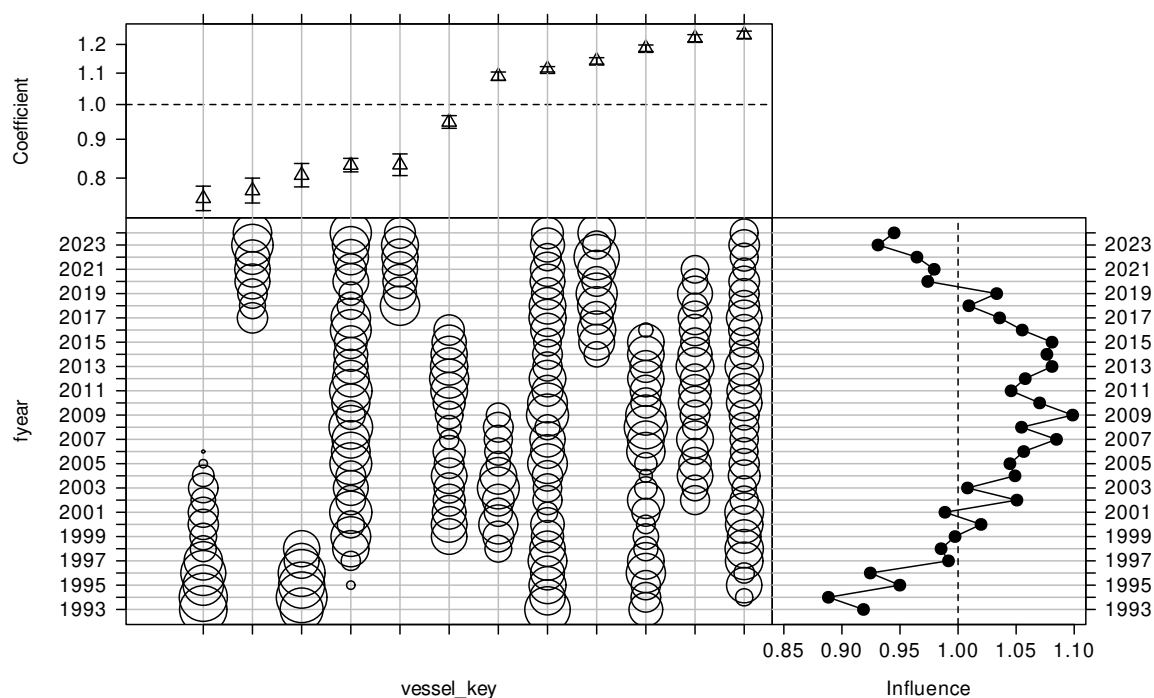


Figure 138: CDI plot for vessel key for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

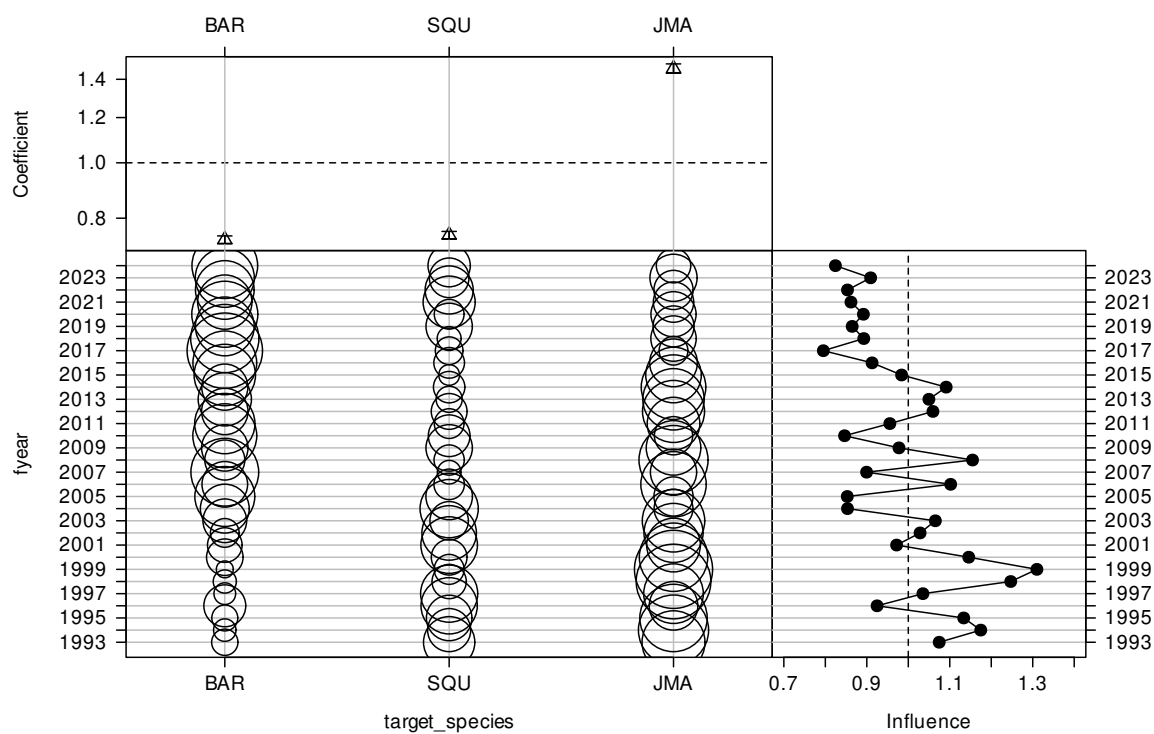


Figure 139: CDI plot for target species for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

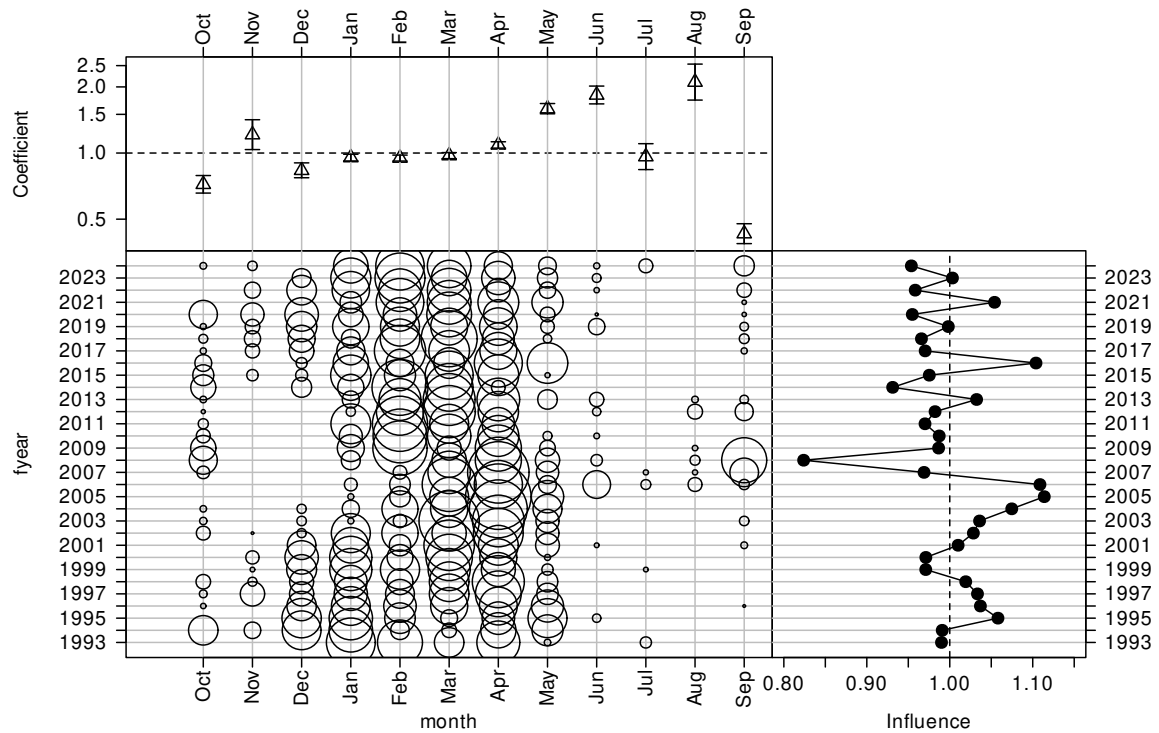


Figure 140: CDI plot for month for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

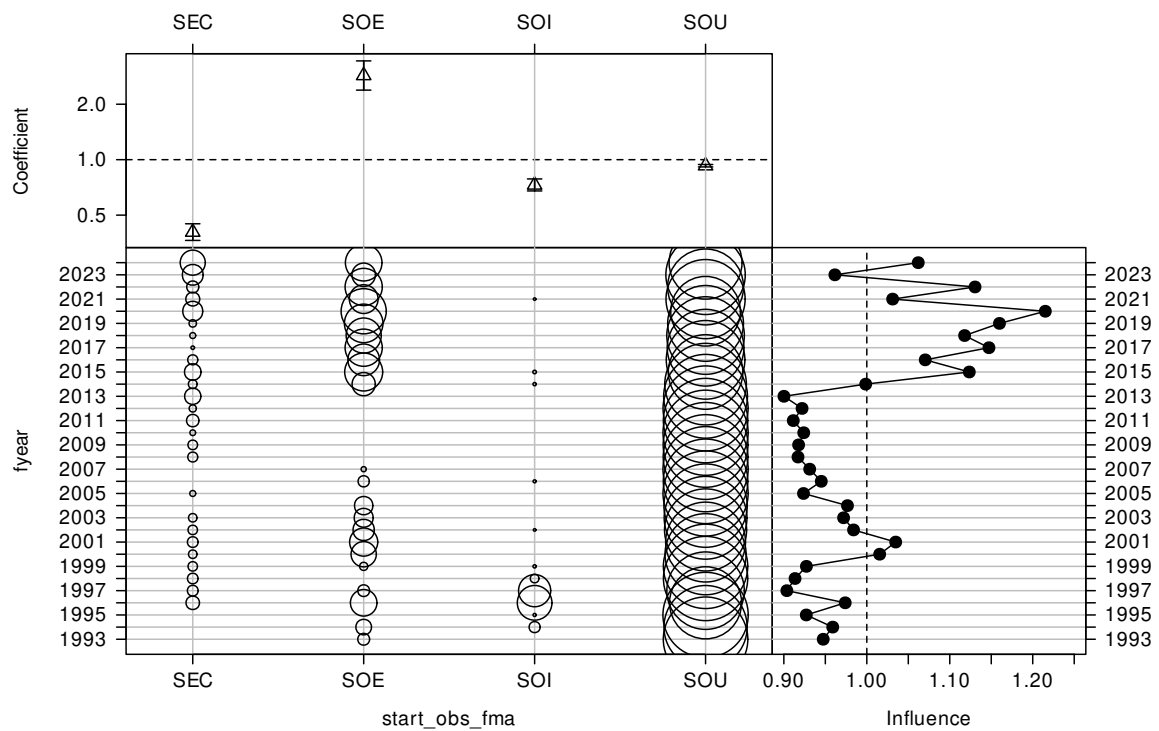


Figure 141: CDI plot for start obs fma for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

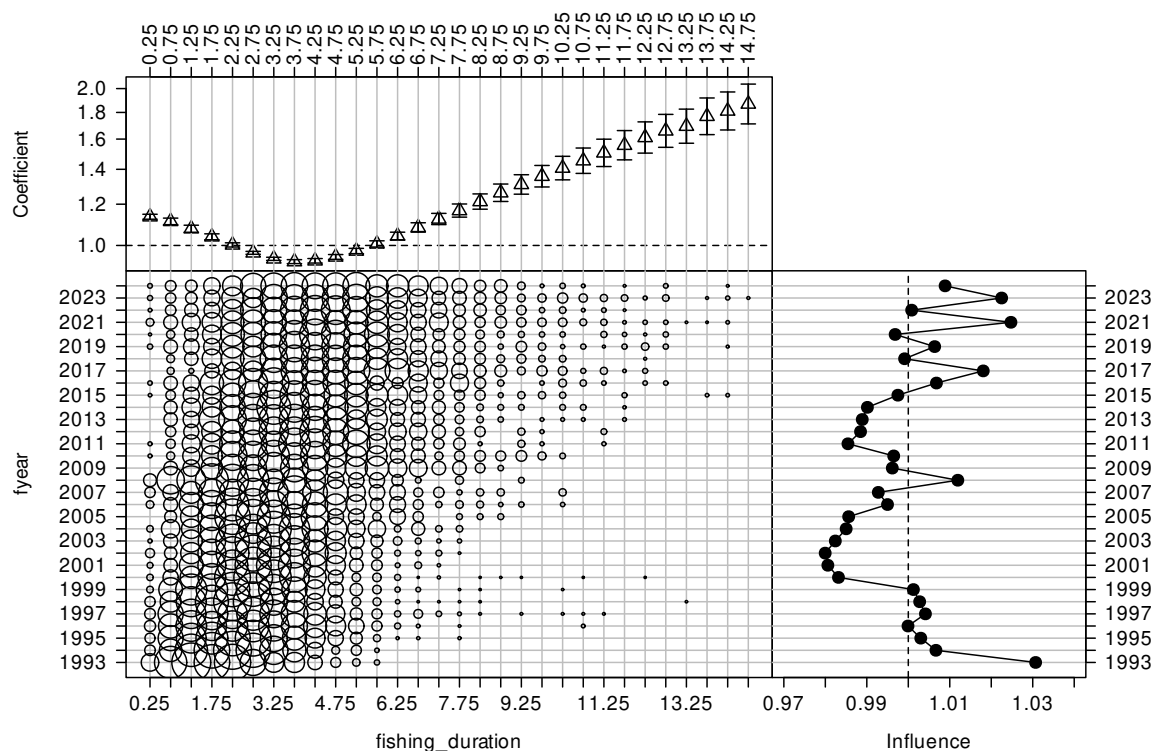


Figure 142: CDI plot for fishing duration (h) for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

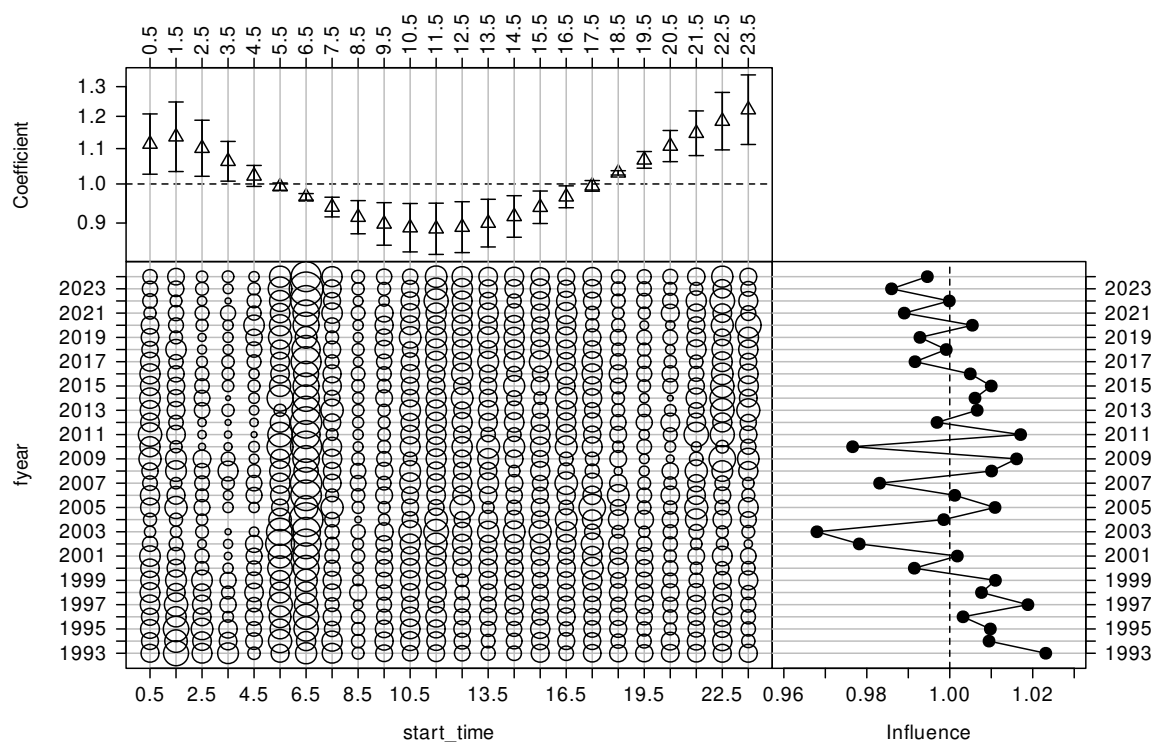


Figure 143: CDI plot for start time for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

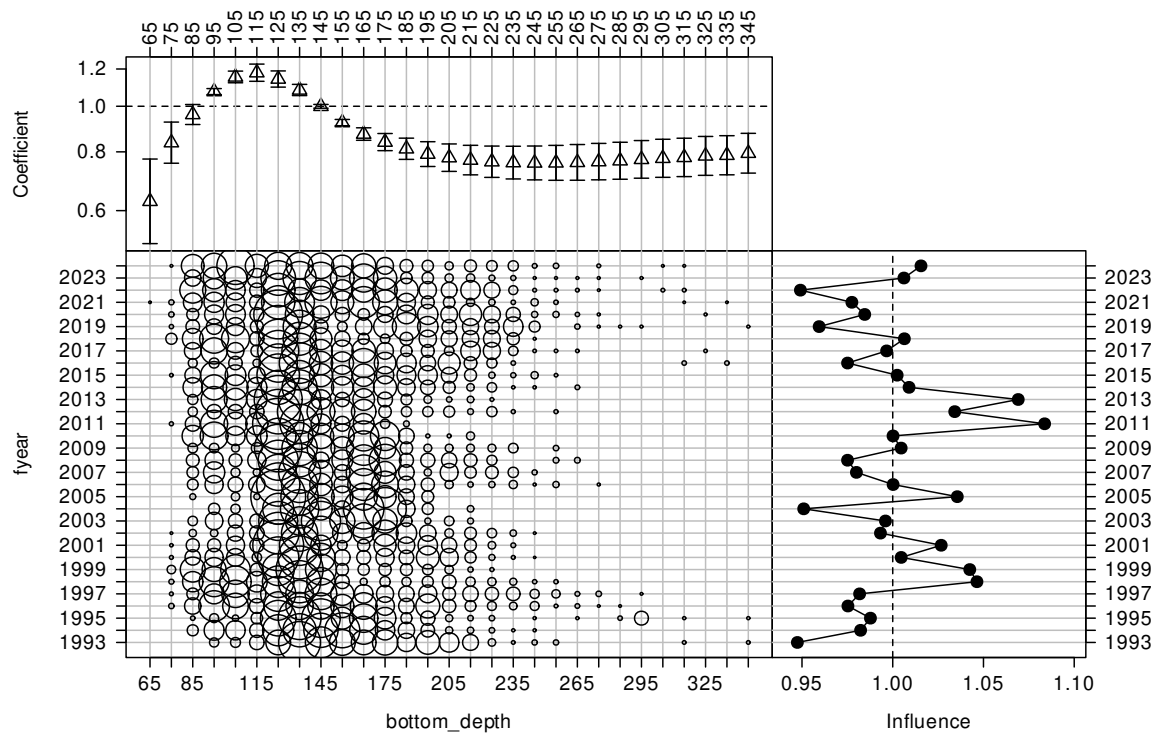


Figure 144: CDI plot for bottom depth (m) for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

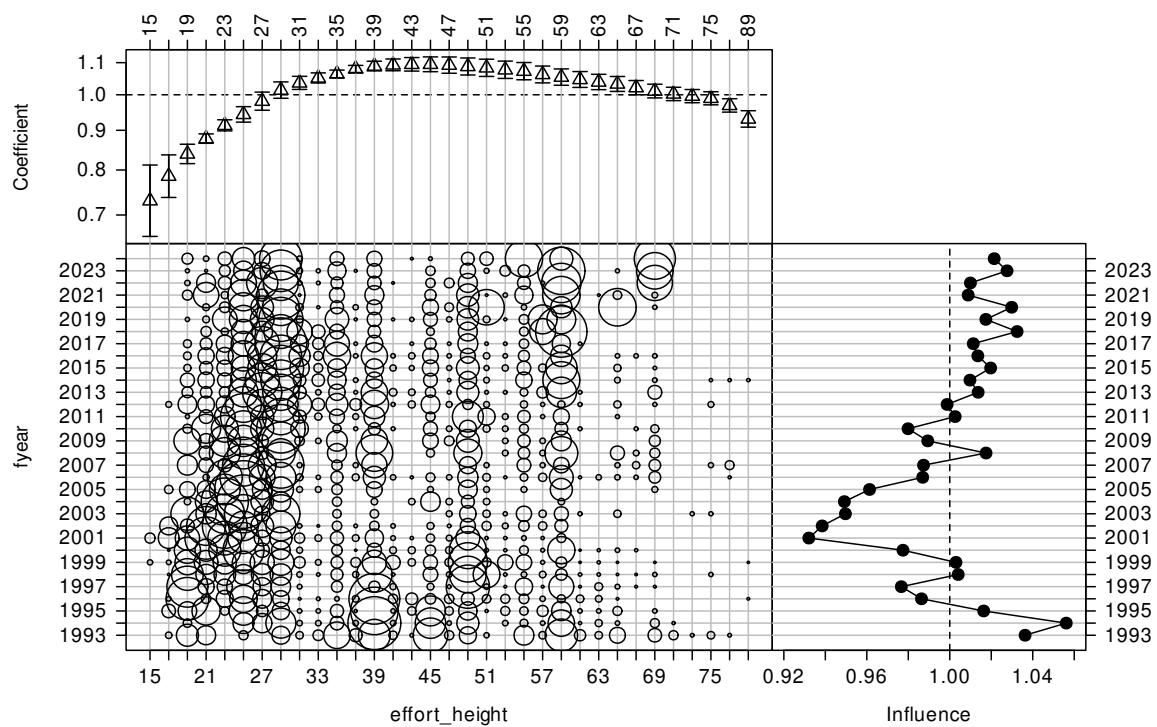


Figure 145: CDI plot for effort height (m) for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

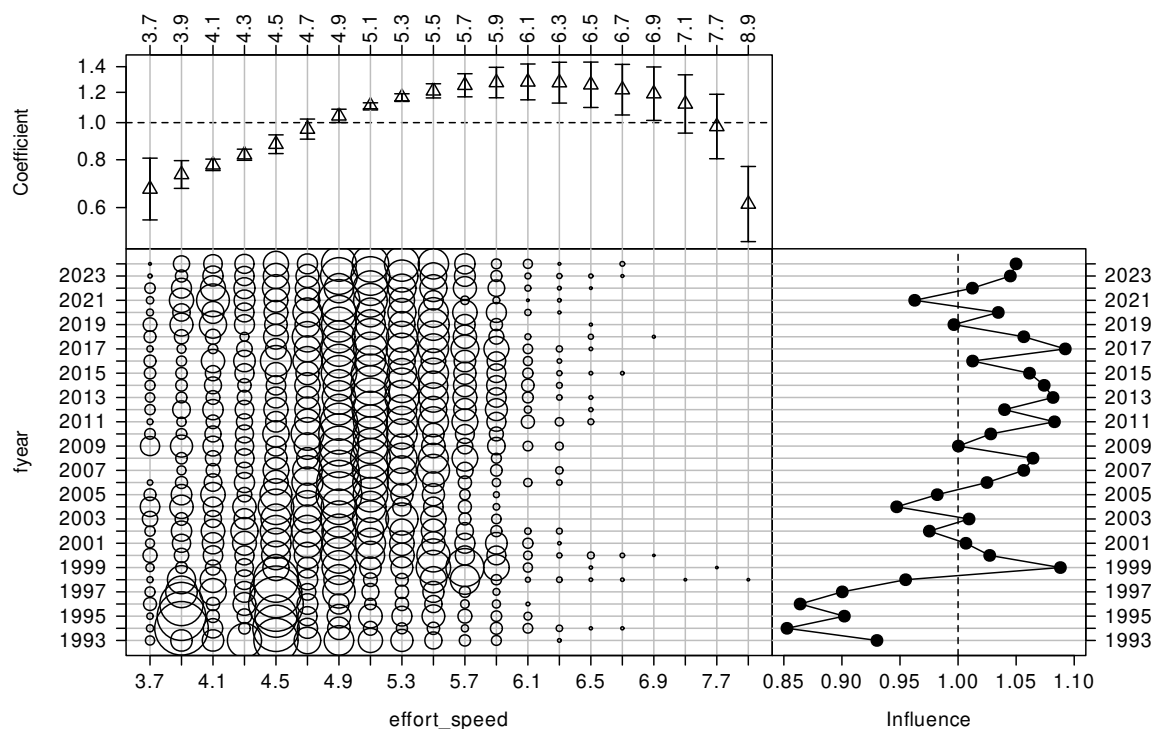


Figure 146: CDI plot for effort speed for the Weibull model of positive catches in the JMA3 MW pred JMM event catch-per-unit-effort dataset.

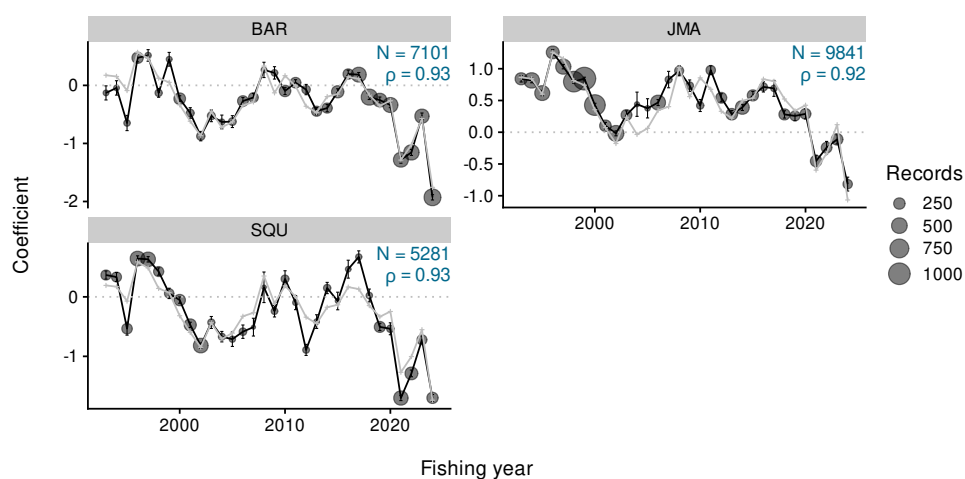


Figure 147: Residual implied coefficients for target-year in the Weibull positive catch model for the JMA3 MW pred JMM event dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

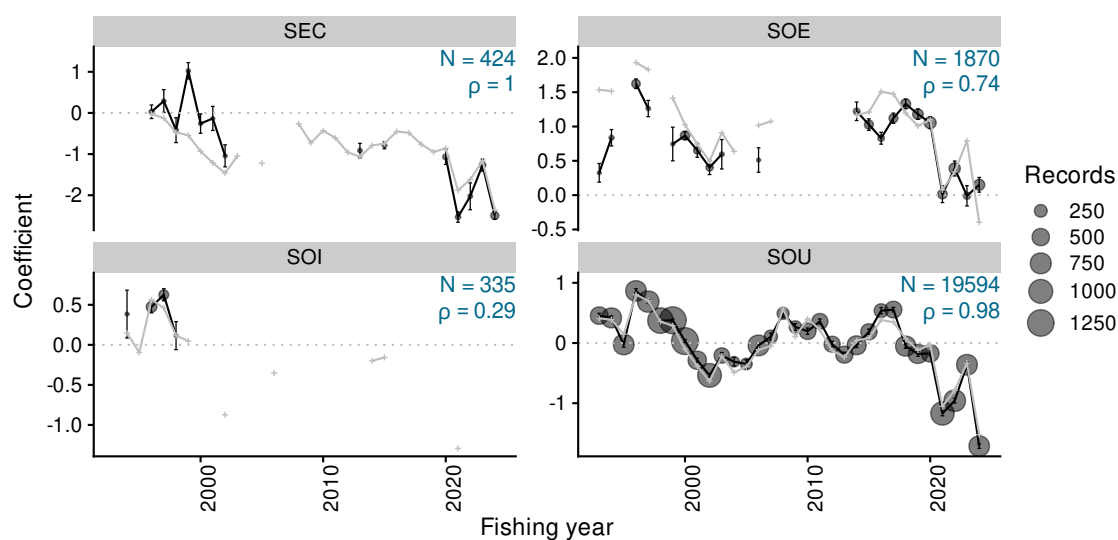


Figure 148: Residual implied coefficients for area-year in the Weibull positive catch model for the JMA3 MW pred JMM event dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

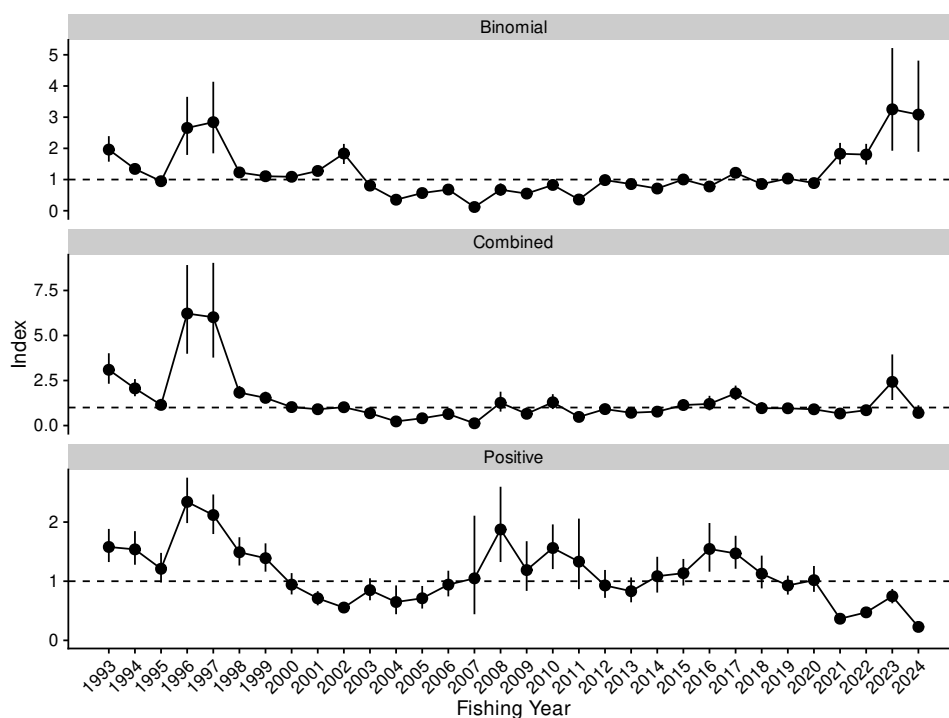


Figure 149: Standardised indices and 95% confidence intervals for the JMA3 MW pred JMM event dataset.

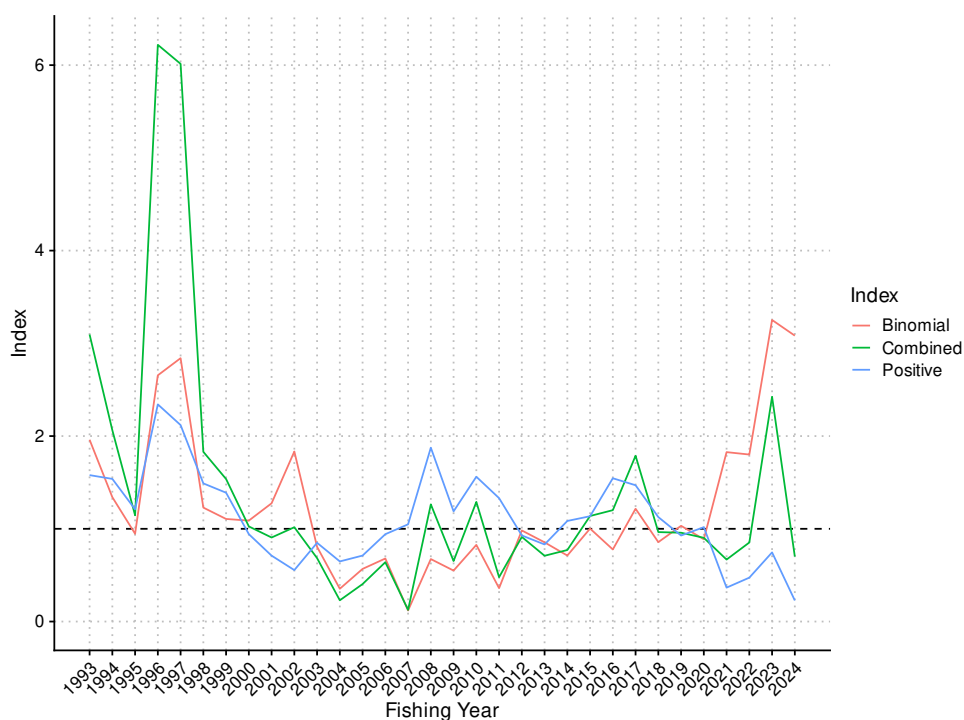


Figure 150: Standardised indices for the JMA3 MW pred JMM event dataset.

Table 25: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW pred JMM event series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.961	0.209	1.573	2.392	3.095	0.432	2.321	4.014	1.579	0.143	1.324	1.884
1994	1.341	0.088	1.182	1.528	2.063	0.243	1.628	2.580	1.538	0.145	1.279	1.846
1995	0.947	0.076	0.796	1.093	1.146	0.155	0.873	1.483	1.210	0.128	0.978	1.479
1996	2.655	0.475	1.790	3.652	6.219	1.256	3.987	8.911	2.342	0.196	1.983	2.751
1997	2.840	0.585	1.841	4.136	6.014	1.342	3.772	9.033	2.119	0.171	1.798	2.466
1998	1.229	0.071	1.087	1.367	1.830	0.177	1.506	2.199	1.490	0.122	1.265	1.743
1999	1.106	0.071	0.967	1.247	1.537	0.162	1.243	1.877	1.389	0.122	1.161	1.640
2000	1.089	0.072	0.942	1.224	1.026	0.113	0.825	1.269	0.942	0.092	0.776	1.137
2001	1.275	0.066	1.156	1.416	0.906	0.089	0.743	1.094	0.711	0.061	0.592	0.832
2002	1.834	0.164	1.499	2.143	1.017	0.121	0.788	1.260	0.555	0.043	0.478	0.647
2003	0.805	0.075	0.655	0.949	0.684	0.101	0.497	0.894	0.849	0.095	0.678	1.050
2004	0.354	0.069	0.245	0.514	0.229	0.063	0.131	0.377	0.648	0.124	0.442	0.929
2005	0.568	0.074	0.430	0.721	0.404	0.078	0.268	0.573	0.712	0.097	0.538	0.920
2006	0.680	0.077	0.533	0.836	0.640	0.103	0.463	0.866	0.942	0.111	0.743	1.177
2007	0.119	0.044	0.057	0.229	0.126	0.069	0.040	0.309	1.048	0.425	0.442	2.108
2008	0.674	0.100	0.482	0.876	1.264	0.282	0.773	1.879	1.875	0.325	1.324	2.597
2009	0.549	0.080	0.409	0.724	0.652	0.154	0.407	1.009	1.188	0.214	0.836	1.676
2010	0.827	0.082	0.670	0.993	1.290	0.211	0.915	1.742	1.562	0.193	1.205	1.960
2011	0.360	0.074	0.239	0.527	0.479	0.139	0.260	0.806	1.331	0.304	0.866	2.058
2012	0.982	0.089	0.808	1.156	0.913	0.142	0.656	1.213	0.928	0.120	0.719	1.190
2013	0.854	0.090	0.677	1.030	0.709	0.119	0.508	0.973	0.831	0.107	0.643	1.063
2014	0.712	0.082	0.559	0.881	0.771	0.142	0.525	1.082	1.085	0.154	0.808	1.413
2015	1.003	0.079	0.849	1.160	1.138	0.148	0.886	1.464	1.136	0.115	0.928	1.377
2016	0.777	0.081	0.625	0.941	1.201	0.206	0.842	1.651	1.545	0.210	1.161	1.984
2017	1.216	0.087	1.061	1.401	1.788	0.207	1.408	2.218	1.470	0.142	1.210	1.768
2018	0.856	0.081	0.698	1.015	0.965	0.151	0.699	1.292	1.127	0.141	0.878	1.432
2019	1.032	0.065	0.905	1.158	0.958	0.106	0.765	1.180	0.928	0.082	0.774	1.094
2020	0.887	0.067	0.757	1.021	0.903	0.125	0.683	1.172	1.018	0.112	0.820	1.257
2021	1.827	0.175	1.488	2.175	0.668	0.087	0.520	0.861	0.366	0.029	0.313	0.426
2022	1.801	0.169	1.480	2.144	0.852	0.109	0.660	1.088	0.473	0.038	0.402	0.552
2023	3.252	0.840	1.924	5.217	2.424	0.645	1.419	3.948	0.746	0.062	0.627	0.869
2024	3.083	0.745	1.891	4.813	0.701	0.180	0.420	1.127	0.227	0.019	0.193	0.266

8.4 CPUE comparisons

The combined (binomial and positive) event level CPUE series for JMD, JMM, and all JMA are compared in Figure 151. It is clear that the combined index is most similar to the species-specific index for JMM. All three series show increased abundance in the late 1990s, followed by a period of lower abundance in the 2000s. After 2010, the JMA and JMM indices fluctuate without trend around the long-term geometric mean, but the series for JMD has a generally increasing trend, albeit with two significant spikes.

As expected, the binomial indices for all three series are very similar (Figure 152), with the JMD and JMM binomial indices nearly identical. The aggregate JMA binomial index shows a similar trend, but with generally less variation, and a smaller increase in the 2020s. This difference is solely attributable to the slight differences in datasets, with the exclusion of a small number of tows that cannot be allocated to an observer FMA from the species-specific series.

The positive indices for the three series show greater differences (Figure 153). The JMA and JMM series have very similar trends, with both showing the greatest catch rates in the 1990s and a recent decline from the mid 2010s to 2024. In contrast, the catch rates for JMD have shown a generally increasing trend throughout the period from 1993 to 2024.

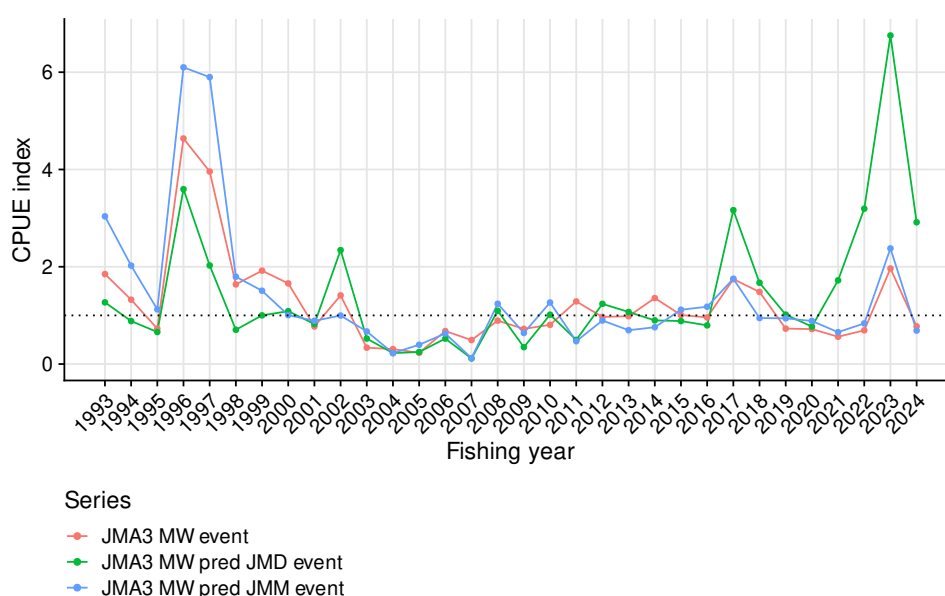


Figure 151: Comparison of the combined (binomial and positive) species group and species specific CPUE indices for JMA 3.

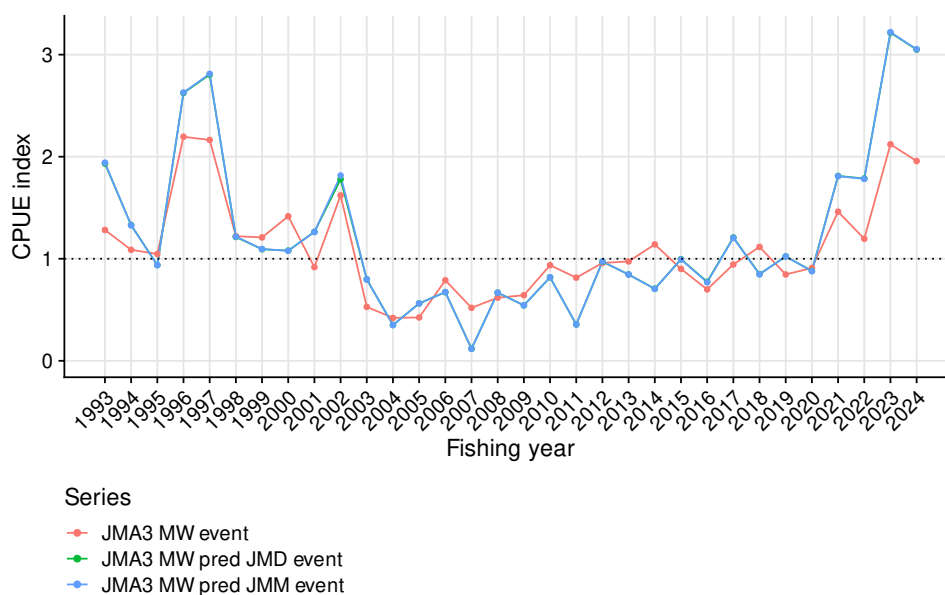


Figure 152: Comparison of the binomial species group and species specific CPUE indices for JMA 3.

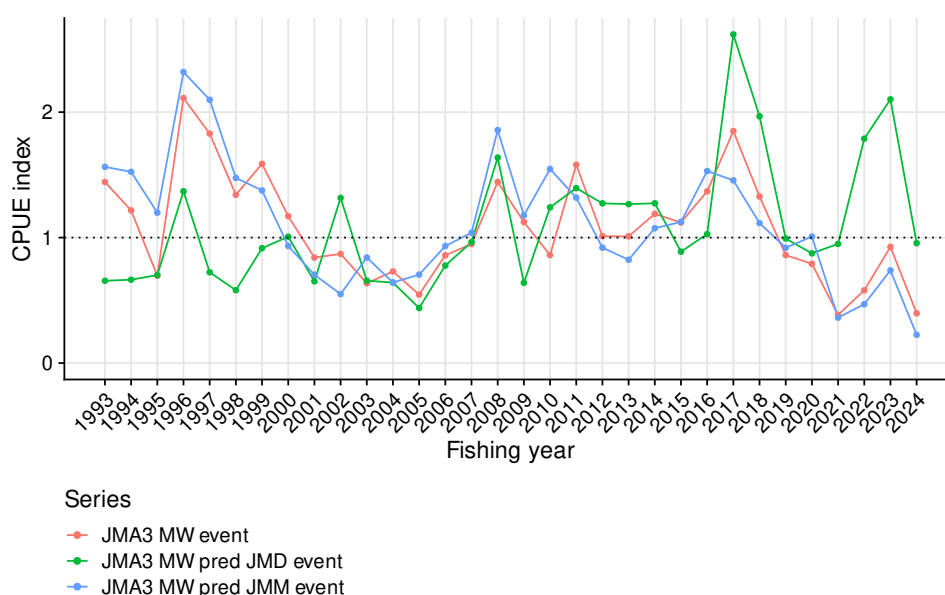


Figure 153: Comparison of the positive species group and species specific CPUE indices for JMA 3.

8.5 CPUE sensitivities

The sensitivity of the CPUE indices to data selection and modelling choices was primarily explored using the JMA3 MW event series for aggregate JMA catches.

In the primary JMA3 MW event series, tows were only included in the dataset if catches could be allocated to events proportionally to estimated catches. Any tows from trips that reported jack mackerel catches, but had no estimated catches at the event level, were dropped. In many CPUE analyses, including a small number of tows where catches are allocated proportionally to effort has little effect on the annual indices. However, in the case of JMA 3, there was a cluster of such tows in the 2000s (Figure D.3).

A model where these tows were included (JMA3 MW event (allow effort allocation); Appendix D.1) had the same general trends as the base (JMA3 MW event) series, but was considerably more dynamic (Figure 154), with a much larger peak in the 1990s, and declining to very low levels in the mid 2000s. Although the increased prevalence of tows using effort allocation is consistent with low abundance (small catches not appearing in the top 5 species on a tow), the wider impact of including these tows—especially on the scale of the abundance change in the 1990s—was not considered credible.

Our confidence in the decision to leave tows with effort-based allocation of catches out of the CPUE datasets was reinforced by a further sensitivity analyses where daily processed catches of jack mackerel was used as the response variable, with effort covariates aggregated to a daily resolution (JMA3 MW process daily; Appendix D.4). The annual indices from the daily processed model were very similar to those produced by the base, event-resolution model (Figure 155).

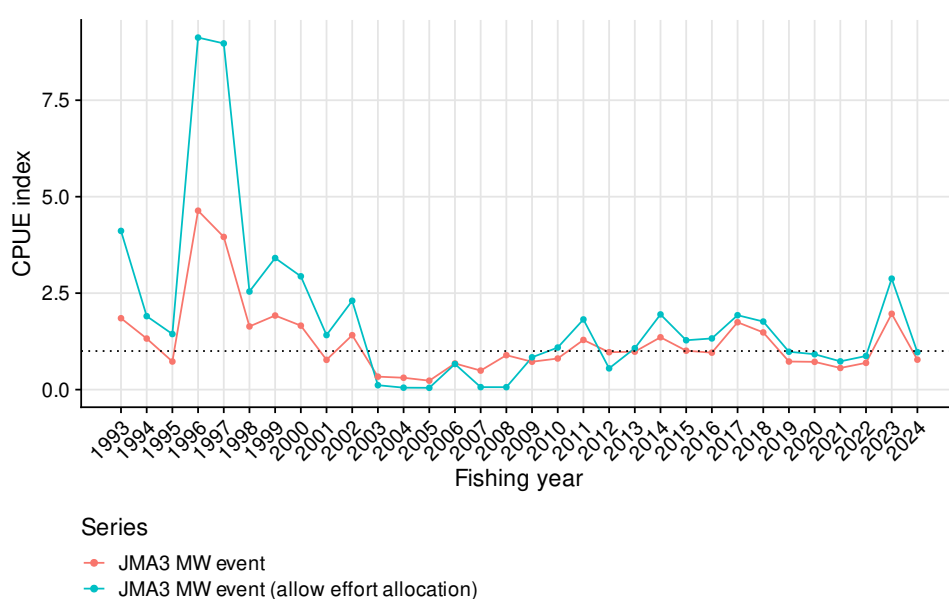


Figure 154: Comparison of the combined (binomial and positive) species group (JMA) CPUE indices for JMA 3 with and without the inclusion of tows where catches are allocated to events in proportion to effort.

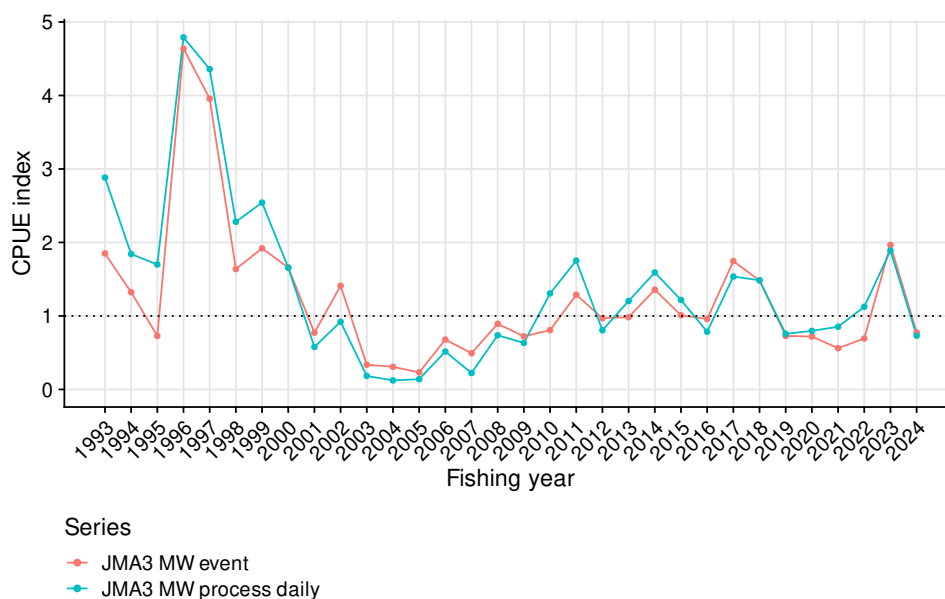


Figure 155: Comparison of the combined (binomial and positive) species group (JMA) CPUE indices for JMA 3 from event and daily resolution models. Processed catches of jack mackerel used as the response variable in the daily model, while the event resolution model included those tows where catches could be allocated proportionally to an estimated catch.

The possibility that the CPUE indices may be biased due to increasing catching efficiency of vessels in the fishery has been investigated by splitting the datasets for vessels with long term participation in the fishery, and estimating separate vessel effects for the vessel in different periods. A sensitivity model (JMA3 MW event (split long vessels); Appendix D.2) split vessels if they participated in the core fleet for more than 10 years. This produced a core fleet with 30 pseudo-vessels (Figure D.33); this had high vessel turnover, but retained good overlap. However, the resulting CPUE indices were very similar to those of the base model (Figure 156), and the issue was not pursued further.

As noted above, the JMA 3 fishery primarily takes place in January to April each year; as a result, monthly coefficients for the remainder of the year tend to be poorly estimated in CPUE models. A sensitivity model where the seasonal effect was defined as a three knot, natural spline on season-day (i.e., day of the fishing year) was fitted as a comparison (JMA3 MW event (season day); Appendix D.3). This model indicated that both the likelihood of catching jack mackerels (Figure D.71), and the catch rate in tows that caught jack mackerels (Figure D.84), peaked around April, towards the end of the normal fishery operating period.

The offset between the JMA 3 fishing season and the period of highest catch rates, suggests that the operation of the fishery is determined as much by the constraints of other fisheries as the efficiency of operating in JMA 3 (Middleton et al. 2024 discuss similar constraints in the context of the timing of the JMA 7 fishery). However, the parametrisation of the seasonal effect made little difference to the annual indices estimated in CPUE modelling (Figure 157).

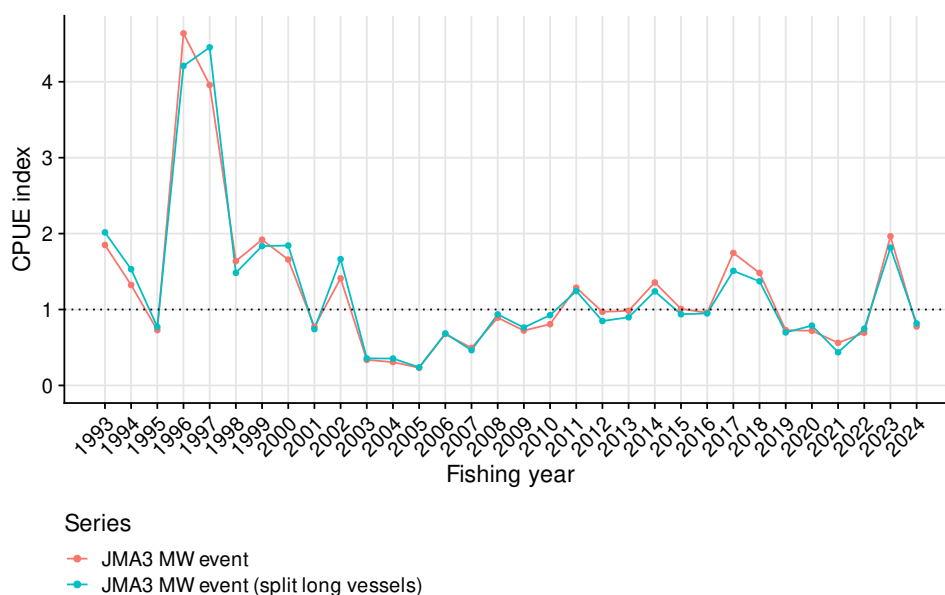


Figure 156: Comparison of the combined (binomial and positive) species group and (JMA) CPUE indices for JMA 3 in the base model and a model that split vessels that participated in the fishery for more than ten years.

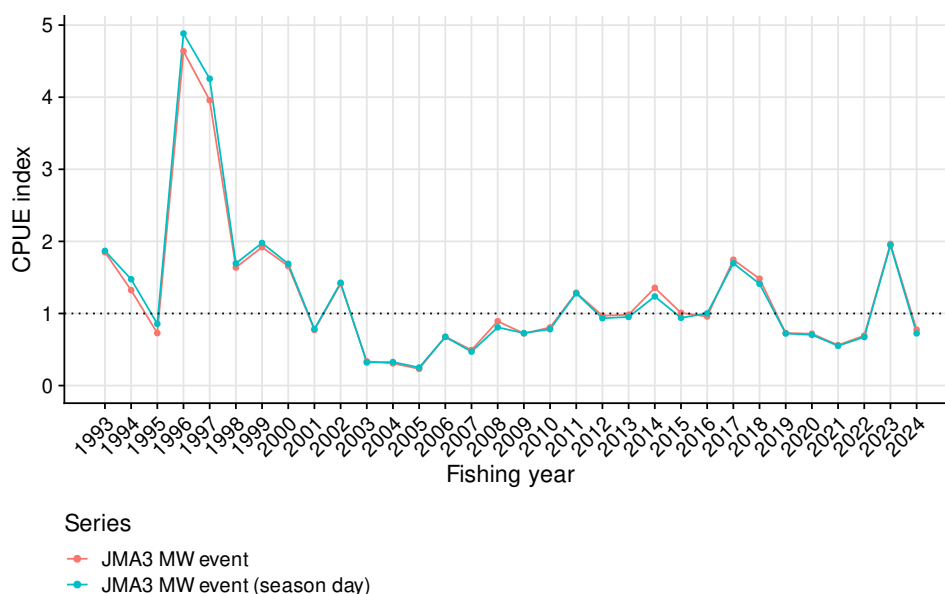


Figure 157: Comparison of the combined (binomial and positive) species group (JMA) CPUE indices for JMA 3 in models where the seasonal effect was modelled either using a categorical variable for month, or a natural spline on day of the fishing year.

8.5.1 Use of the species composition modelling

Further sensitivity analyses specifically addressed how the species composition modelling was used in the CPUE analyses. In the base approach (the JMA3 MW pred JMD event and the JMA3 MW pred JMM event series), the species proportions (of JMD and JMM) for a given fishing event that caught jack mackerels were estimated using the mean of multiple (50) draws from the posterior distribution estimated in the species composition modelling. In addition, the weight given to a tow in the CPUE model fitting was assigned using the model developed for the performance of the species composition modelling. Tows where the species composition modelling was more uncertain were given a lower

weight; this contrasts with normal CPUE modelling where all fishing events are given equal weight. To investigate the sensitivity of the results to the model weights, we refitted the models for JMD (JMA3 MW pred JMD event no weights; Appendix D.5) and JMM (JMA3 MW pred JMM event no weights; Appendix D.6) without applying relative weights to the tows included in the dataset.

Over multiple draws, it was extremely rare that the catch of JMD or JMM was estimated to be zero; however the estimated catches could be positive but very small. A consequence of this was that the binomial parts of the CPUE models for JMD and JMM were virtually identical. To investigate the sensitivity of the annual indices to this feature, we applied a threshold to the estimated catches of JMD (JMA3 MW pred JMD event threshold; Appendix D.7) and JMM (JMA3 MW pred JMM event threshold; Appendix D.8) where catches less than 100 kg were set to zero. This is analogous to the censoring of catch data that normally occurs due to the ‘top X’ species reporting in estimated catch data.

For both JMD (Figure 158) and JMM (Figure 159) the main difference in the annual indices in these sensitivity tests was observed when the CPUE data were not weighted. The thresholding of catches resulted in minimal differences in the indices, but the removal of weights tended to make the series less variable, reducing the peaks in JMD in 2023, and JMM in 1996/1997.

The lack of an effect of thresholding is likely to be due to compensation in the fits of the binomial and positive series. The decision to fit the CPUE models with weights related to the performance of the species composition modelling is considered to be the appropriate approach, on principle.

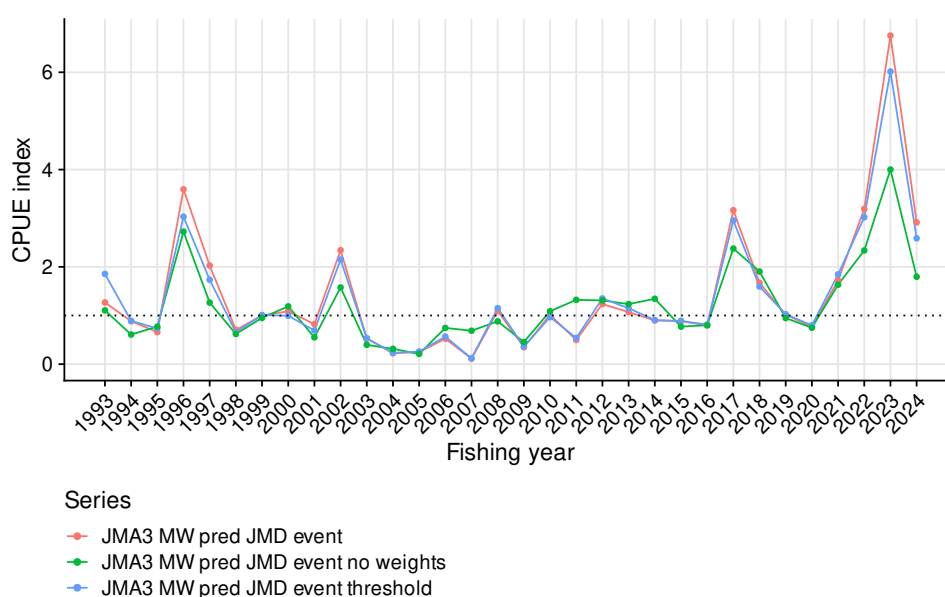


Figure 158: Comparison of the combined (binomial and positive) CPUE indices for JMD in JMA 3, with different approaches to using the species composition modelling.

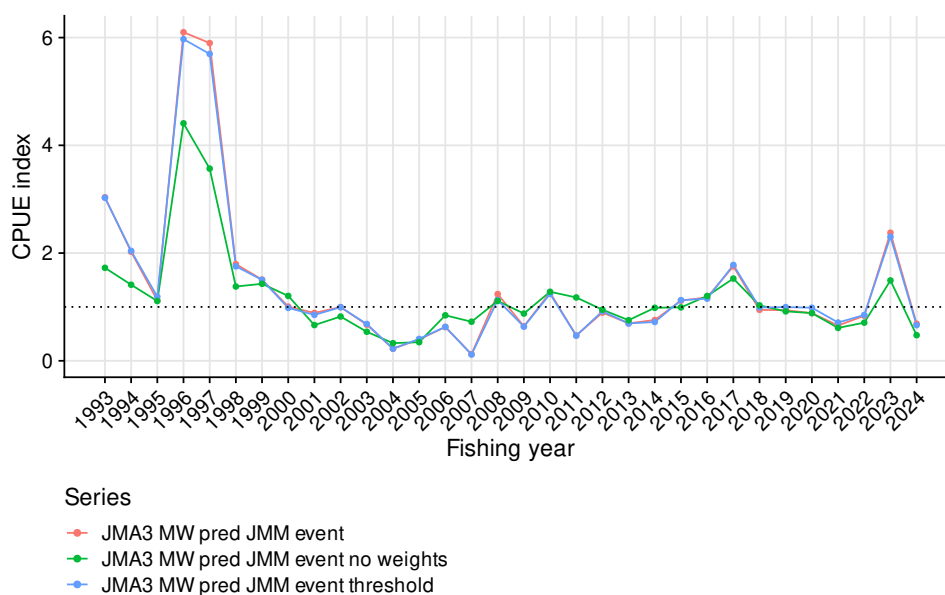


Figure 159: Comparison of the combined (binomial and positive) CPUE indices for JMM in JMA 3, with different approaches to using the species composition modelling.

The final sensitivity analysis for the use of the species composition modelling aimed to address whether using the mean of the posterior predicted catch of each species from the species composition modelling adequately captured the uncertainty in these predictions. This was investigated for the JMD (*T. declivis*) models only, by fitting 10 replicated models (JMA3 MW pred JMD event draws1 to JMA3 MW pred JMD event draws10; Table 8) that were identical to the primary JMA3 MW pred JMD event, except that the JMD catch was estimated using a single draw from the posterior of the species composition modelling. Weights, based on the model for the precision of the species composition modelling, were again used when fitting the positive catch part of the CPUE model (noting that model performance was estimated based on the mean of the posterior rather than for individual draws). Parametric bootstrapping was used, as normal, to estimate the uncertainty around each index; these draws were combined from the 10 individual models to provide a composite index.

As evident in Tables D.49 to D.57, and Table D.60, both the predicted catches and the proportion of tows with zero catches varied quite substantially between the individual datasets. This variability was ultimately reflected in the uncertainty around the composite CPUE series (Figure 160). Although the composite series (JMA3 MW pred JMD event - composite) had a generally similar trend to the base JMD series (JMA3 MW pred JMD event), the confidence intervals around each annual index were larger, with uncertainty greatest in 2023 and 2024. This recent uncertainty is largely attributable to uncertainty in the binomial part of the composite index (Figure 161); while the positive part of the composite index also showed increased uncertainty (Figure 162), this was evident throughout the time period.

Full diagnostics for one of the single-draw models are included in Appendix D.18. From the residual diagnostics for the positive part of the model (Figure D.257 and Figure D.258), it is apparent that very small predicted catches of JMD are included in the series; it is possible that thresholding of these small catches may have made a greater difference to the single-draw models than was apparent with the base approach.

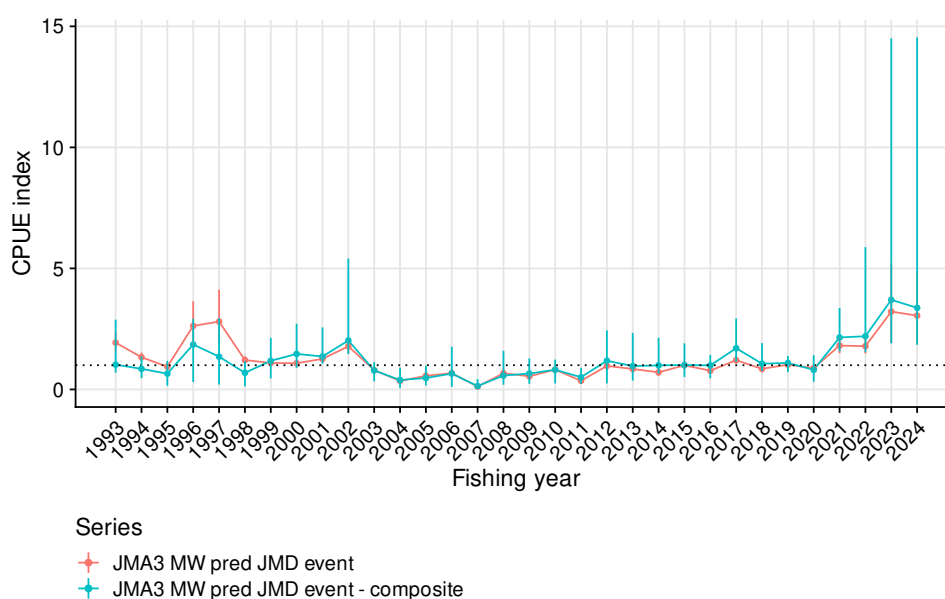


Figure 160: Comparison of the combined (binomial and positive) predicted CPUE indices for JMD, from the base approach, where the mean of the posterior of the species composition modelling was used to estimate the catch of JMD in each tow where jack mackerels were caught, and a composite model where the results of 10 individual CPUE standardisations were combined, each of which assigned the catch of JMD based on a single draw from the species composition modelling.

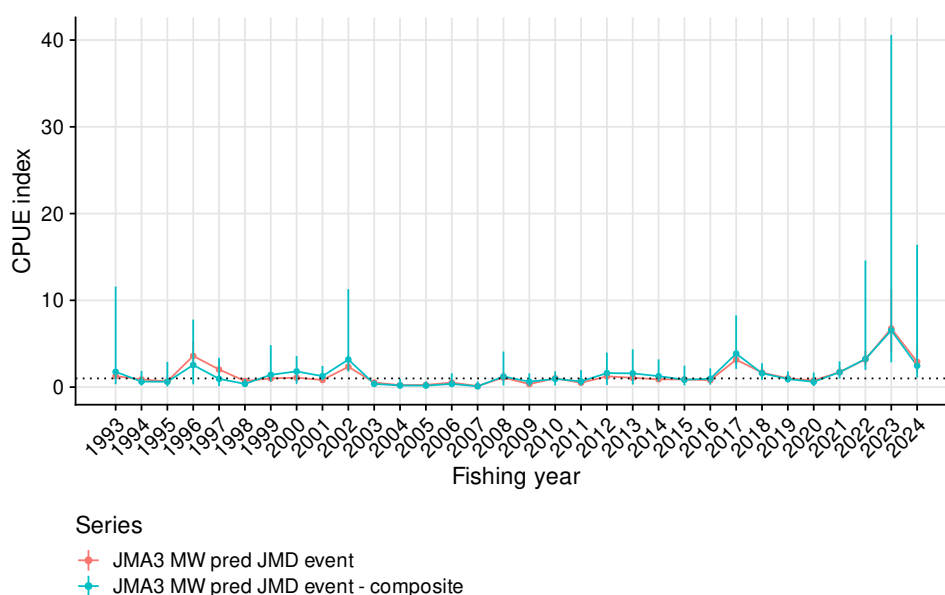


Figure 161: Comparison of the binomial predicted CPUE indices for JMD, from the base approach, where the mean of the posterior of the species composition modelling was used to estimate the catch of JMD in each tow where jack mackerels were caught, and a composite model where the results of 10 individual CPUE standardisations were combined, each of which assigned the catch of JMD based on a single draw from the species composition modelling.

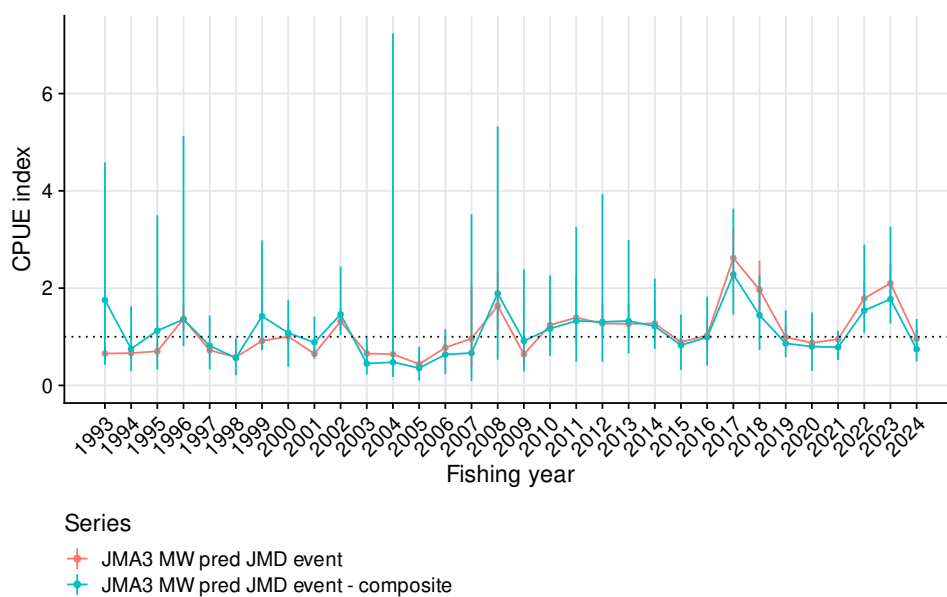


Figure 162: Comparison of the positive predicted CPUE indices for JMD, from the base approach, where the mean of the posterior of the species composition modelling was used to estimate the catch of JMD in each tow where jack mackerels were caught, and a composite model where the results of 10 individual CPUE standardisations were combined, each of which assigned the catch of JMD based on a single draw from the species composition modelling.

9. DISCUSSION

The JMA 3 Quota Management Area (QMA) appears to have been established primarily to deal with the small jack mackerel catches that occurred around southern New Zealand, with the key jack mackerel target fisheries that existed in the mid 1980s having been separated into the JMA 1 and JMA 7 QMAs. The JMA 3 catches were initially bycatch in a range of middle depths and inshore trawl fisheries, together with target purse seine catch taken off the Kaikoura coast.

The target midwater trawl fishery grew substantially in JMA 3 in the late 1990s, primarily in response to the arrival of Chilean jack mackerel (JMM; *Trachurus murphyi*) in New Zealand waters. *T. murphyi* was first identified from eastern and southern parts of JMA 3 and subsequently spread west into JMA 7 and north into JMA 1. While it is assumed that some of the *T. murphyi* initially present in JMA 3 subsequently emigrated to the other QMAs, sufficient remained that *T. murphyi* was the key species taken in the JMA 3 fisheries until the early 2020s (Figure 163).

Observer sampling of the JMA 3 fishery has been much sparser than in the JMA 7 fishery. As a result, it was necessary to develop species composition modelling to estimate the catch by species. The modelling assumed that *T. novaezelandiae* (JMN) was largely absent from JMA 3, at least in the areas of JMA 3 accessible to the midwater fleet. While midwater trawling has provided the platform for the majority of observer sampling in JMA 3, and the species composition modelling solely used these data, most of the catch has been taken by that method (Figure 164) and the use of a model based solely on midwater trawl data should provide a reasonable indication of the overall catch composition.

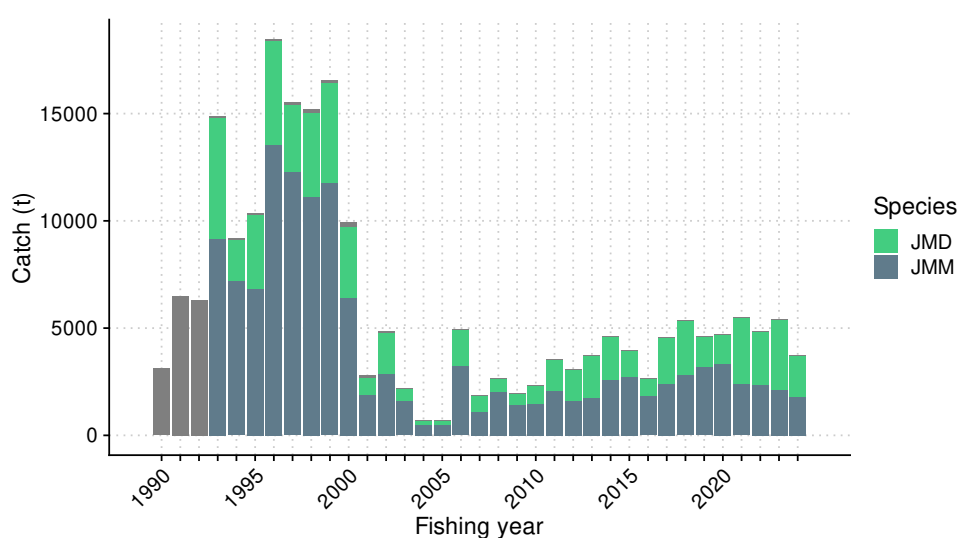


Figure 163: The estimated annual catches of jack mackerels from JMA 3, by species. Catches were estimated using the species composition modelling developed for the CPUE analyses, but applied to all fishing events where a position (latitude/longitude) was reported. The modelling assumed that catches were either of *T. declivis* (JMD) or *T. murphyi* (JMM). Catches from events that could not be separated by species are shown in grey; this included all catch prior to 1993 (the earliest year in the species composition modelling).

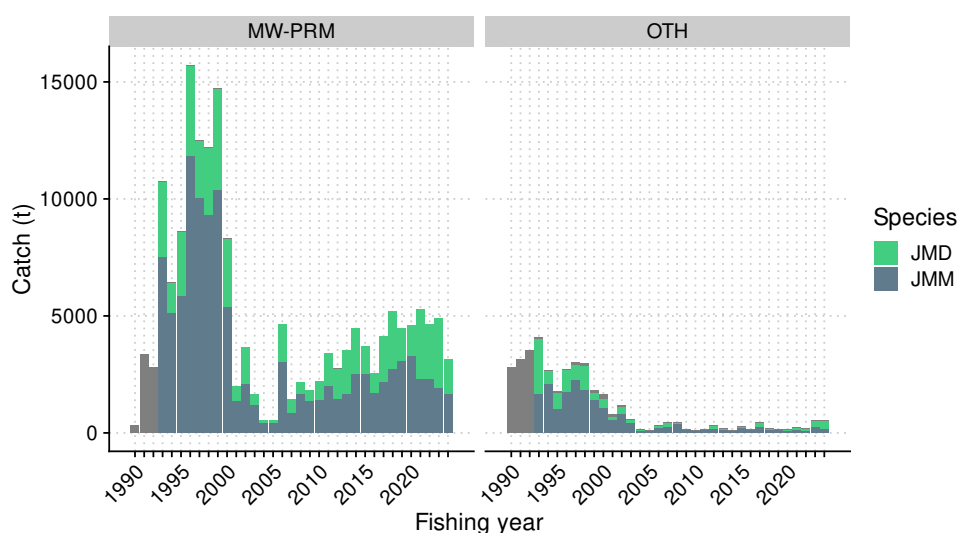


Figure 164: The estimated annual catches of jack mackerels from JMA 3, by species and method. Catches were estimated using the species composition modelling developed for the CPUE analyses, but applied to all fishing events where a position (latitude/longitude) was reported. The modelling assumed that catches were either of *T. declivis* (JMD) or *T. murphyi* (JMM). Catches from events that could not be separated by species are shown in grey; this included all catch prior to 1993 (the earliest year in the species composition modelling).

While *T. murphyi* has been the key species caught in the JMA 3 fishery, it is not considered to comprise a self-sustaining stock in New Zealand waters (Horn & Maolagáin 2021). The native *T. declivis*, that make up the balance of the catches, are, therefore, of primary interest from a stock monitoring and management perspective. Although *T. declivis* are caught throughout the JMA 3 fishery (with the possible exception of areas around the Chatham Islands), there is evidence that *T. declivis* in JMA 3 are not an independent stock.

A lack of younger *T. declivis* in catches from the JMA 3 fishery was noted by Horn et al. (2014). In the 2013 fishing year, there were few fish under 10 years apparent in catches from JMA 3; in contrast, sampling in JMA 7 showed a high proportion of younger fish (Figure 165). Horn et al. (2014) “postulated that the *T. declivis* in JMA 3 may be particularly large fish from the JMA 7 population that migrate south during the autumn outside the spawning season.” While there have been no further catch-at-age studies for JMA 3, the length-frequency distributions from 1987 to 2024 (Figure 51) show a general absence of smaller *T. declivis* in JMA 3, consistent with the hypothesis that it is not an independent stock.

Evidence for a seasonal migration into JMA 3, or back to a spawning ground outside the area, is less compelling. The ‘protracted spring-summer spawning season’ of jack mackerels (Fisheries New Zealand 2024) appears to extend from November to March (Figure 61). The JMA 3 fishery is focussed in January to April, due to the annual operational cycle of the deepwater fleet. There are some indications of increased catch rates in April/May (Figure 109, Figure 122), but also evidence that some *T. declivis* are in spawning condition in JMA 3. There is no particular evidence to link *T. declivis* in JMA 3 to the JMA 7 stock, rather than to the JMA 1 stock.

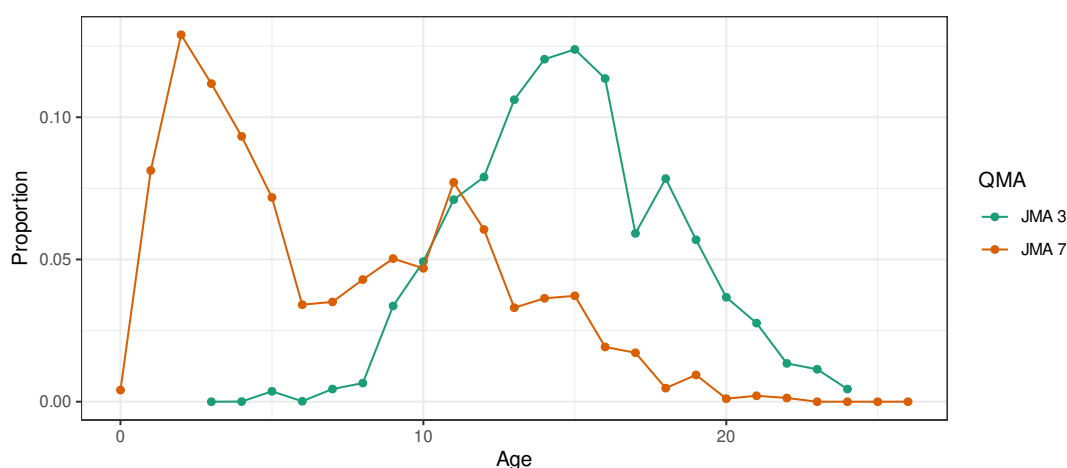


Figure 165: Age frequencies of *Trachurus declivis* in JMA 3 and JMA 7 in the 2013 fishing year, from Horn et al. (2014) and Moore et al. (2024).

9.1 Stock status of jack mackerels in JMA 3

The Deepwater Working Group, and subsequently the participants in a Stock Assessment Plenary meeting held in May 2025, agreed that, to the extent *T. novaezelandiae* (JMN) occur in the JMA 3 area, they are currently largely unfished. Neither the Deepwater Working Group, or the Plenary, reached consensus around the use of the CPUE indices presented in this report to monitor the abundance of *T. declivis* (JMD) or *T. murphyi* (JMM) in JMA 3. The sparseness of the observer data, and the variability in catch composition evident in the species composition modelling, resulted in caution around the results of the CPUE modelling. In addition, some reviewers considered that the scale of the year-to-year changes in abundance were too large to be credible, especially if JMD 3 were to be assessed as a separate stock.

In the case of *T. murphyi*, we suggest that the rapid increase in abundance from 1995 to 1996, indicated by the CPUE analyses, is consistent with the migration of fish from a wider Pacific stock into New Zealand waters. Similarly, the equally rapid decline from 1997 to 1998 is consistent with these fish continuing to migrate further west, into JMA 7, and north, into JMA 1. Catch at age data from JMA 7 (Moore et al. 2024, figure 9) suggest that *T. murphyi* in JMA 7 are an ageing population with little evidence of either local spawning or ongoing migration into the area. In JMD 3, *T. murphyi* typically have a unimodal length distribution centred around 50 cm (Figure 52), although fish 40 cm or smaller are occasionally recorded. There is also evidence that the JMA 3 fishery around the Chatham Islands continues to have a high proportion of *T. murphyi* in the catch. Some ongoing immigration of *T. murphyi* into New Zealand waters could explain the increased abundance of JMM 3 in the late 2000s, and generally stable abundance thereafter.

For *T. declivis*, the observation that the CPUE series for JMD 3 is much more variable than that in JMD 7 is clearly valid (Figure 166). However, catches of JMD 3 are typically much lower than of JMD 7 (Middleton 2025, figure 12); if this indicates that the abundance of *T. declivis* is much lower in JMA 3 than in JMA 7 then greater variation in abundance in JMD 3 is not unreasonable. Alternatively, the interannual variation in JMD 3 may be attributable to movement from (and potentially back to) a source stock (either JMA 7 or JMA 1).

Ultimately, the May 2025 Plenary meeting participants concluded that the magnitude of the peaks in CPUE for JMD 3 indicated that the series did not index a closed population, and either represented a subpopulation subject to movement (local or at stock level) and/or was simply an unreliable index due to the paucity of data. As a working hypothesis it was agreed that the stock status for *T. declivis* in JMA 3 would be reported on the basis that it was a part of the *T. declivis* stock that occurs in JMA 7.

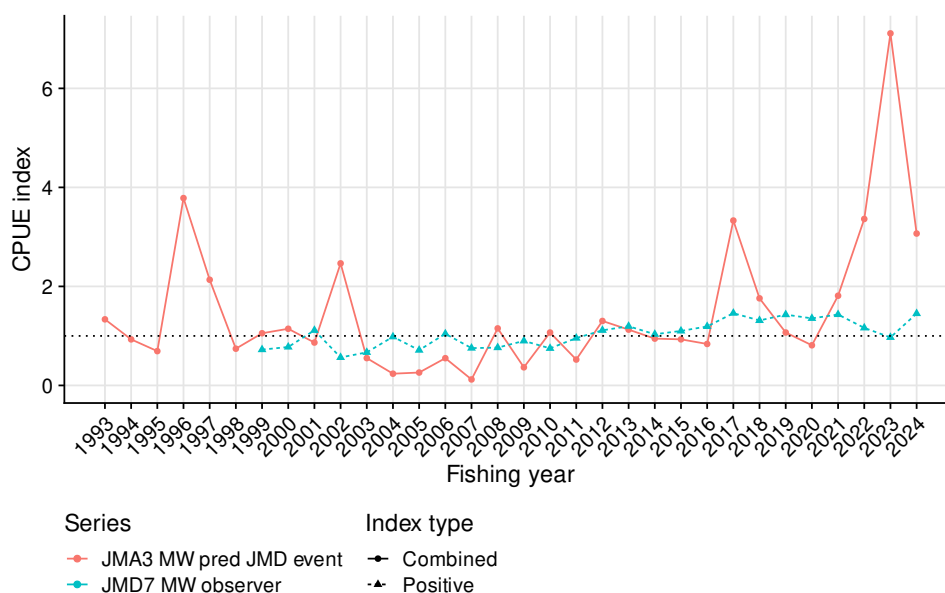


Figure 166: Comparison of the combined CPUE indices for JMD in JMA 3 and JMA 7. The CPUE index for JMD 7 was updated to 2024 by Middleton (2025).

Updated CPUE series for jack mackerels in JMA 7 (Middleton 2025) led to an assessment that both JMD 7 and JMD 3 were Likely to be at or above the target.

9.2 Future research recommendations

While a pragmatic approach to monitoring the JMA 3 stock was adopted as a result of this project, the key uncertainties relate to stock structure and species composition:

- Further investigation of jack mackerel stock structure, at the New Zealand scale, is clearly warranted, with a particular focus on whether *T. declivis* in JMA 3 are more appropriately linked with JMA 1 or JMA 7.
- Ongoing monitoring of the jack mackerel fisheries in JMA 3 would greatly benefit from the collection of more extensive species composition information. An immediate improvement in coverage would be achieved if observers, already present in the fishery, were to collect species composition information from a higher proportion of observed tows. If necessary, jack mackerel species composition sampling could be decoupled from length-frequency sampling, by collecting the weight of each species in a random sample from the catch.

Other worthwhile research would include:

- Developing protocols for ensuring large or offshore fish that are provisionally identified as *T. novaezelandiae* are subject to more definitive identification, and that the potential for confusion between *T. declivis* and *T. murphyi* is considered (see also Appendix C).
- Ageing of both *T. declivis* and *T. murphyi* from JMA 3 would provide data that could assist in assessing the level of misidentification between these species, while also allowing the level of ongoing JMM immigration into New Zealand waters to be investigated.

10. ACKNOWLEDGEMENTS

This work was funded by Fisheries New Zealand, under project JMA2024-01. Data access was provided by the Fisheries New Zealand RDM team, and Cheng Shi of the Fisheries Observer Programme provided helpful information on sampling protocols and fish identification processes. Dave Goad and Denham Cook provided helpful comments on jack mackerel species discrimination. Review and constructive suggestions made by the Deepwater Fisheries Assessment Working Group and Stock Assessment Plenary meeting participants are gratefully acknowledged. The project was managed by Gretchen Skea. Helpful science and editorial reviews were provided by Alexander Arkhipkin and Marianne Vignaux.

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APPENDIX A: DATA GROOMING

Grooming of the statutory commercial catch, effort and landings data followed the approach of Starr (2007), with a set of rules defined for each of the different types of data (Bentley 2012).

A.1 Landings

Table A.1: Grooming rules applied to landings data.

Rule	Effect	Description
FLKIN	Fix	Update landed species to SUR when KIN is landed from trips with diving events and no MHR support
LADTI	Flag	Invalid landing destination
LADTH	Drop	Retained (non-final) landings
LADTT	Flag	Vessel received transshipments
LASCF	Fix	Correct some state codes
LASCD	Drop	Drop landings of secondary product states
LADUP	Drop	Duplicate landings
LACFM	Fix	Replace missing conversion factors with the median over all years
LAGWI	Fix	Estimate missing greenweights
LAGWM	Drop	Missing greenweights that cannot be estimated
LAGWO	Fix	Identify and fix order of magnitude errors in landings

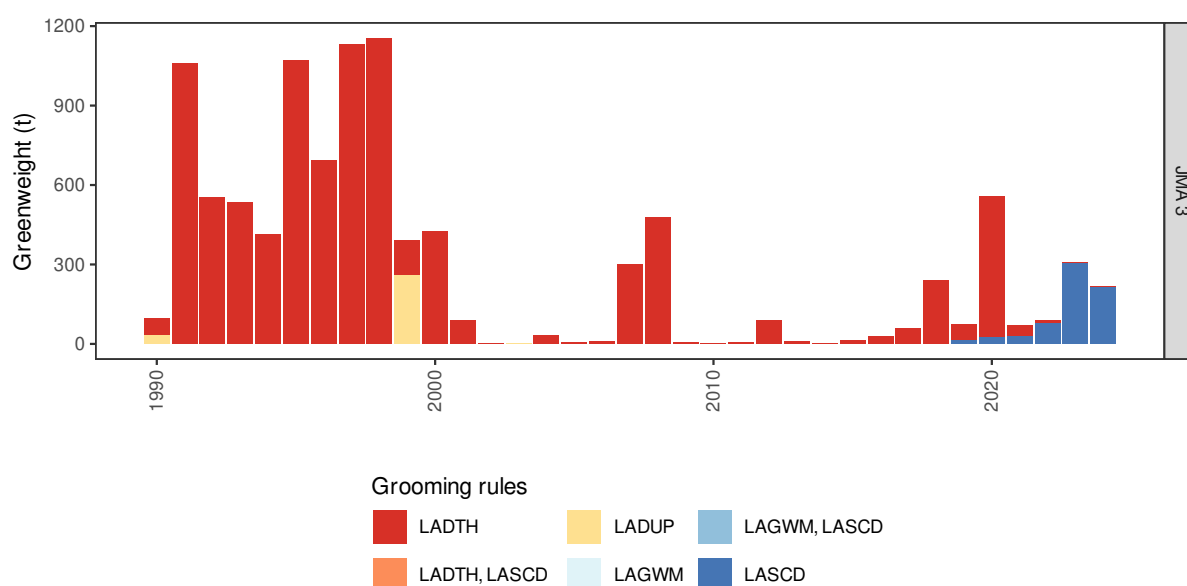


Figure A.1: The quantity of landings dropped, with the relevant grooming rules (Table A.1) indicated, by stock and fishing year.

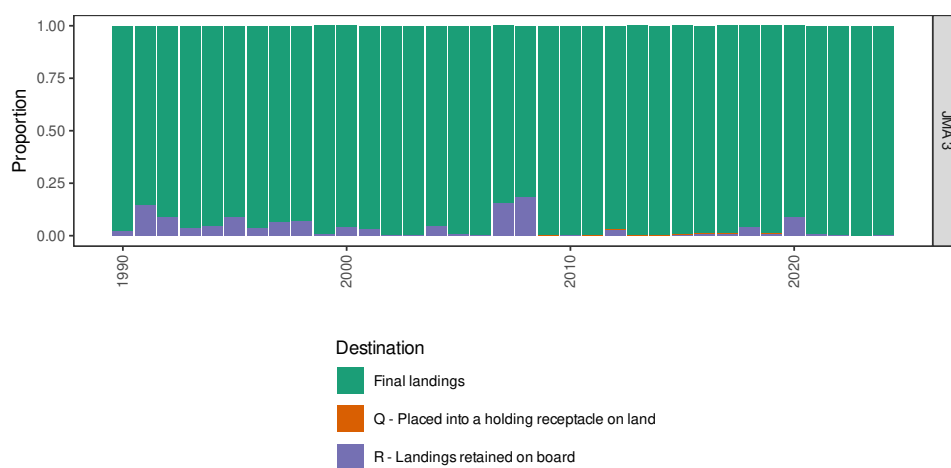


Figure A.2: The proportion of total (final and non-final) landings that are initially to non-final destinations, by stock and fishing year.

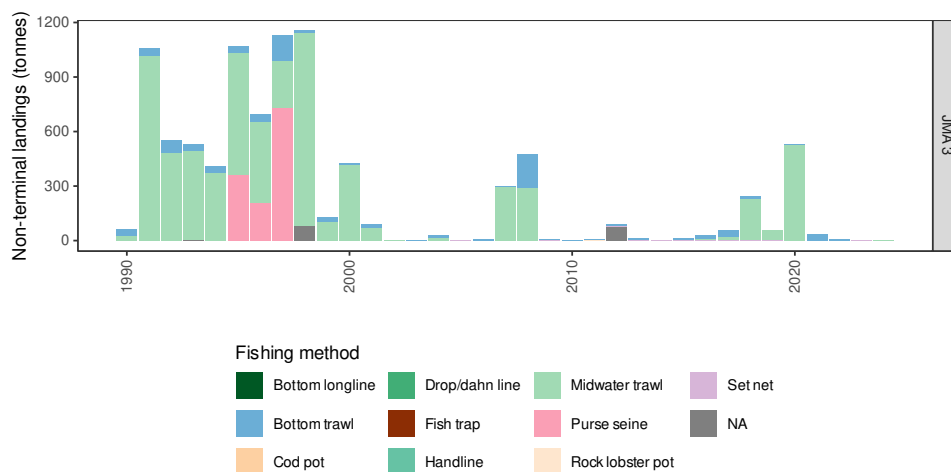


Figure A.3: The quantity of non-final landings, by stock, fishing year, and the modal fishing method used on the trip.

Table A.2: Annual number of trips, and affected greenweight quantity, where the LAGWO rule indicated an order of magnitude error in the landing weight and this was adjusted.

QMA	Fishing year	Trips	Greenweight (kg)	
			Original	Adjusted
JMA 3	1992	2	24 803.0	122.7059
JMA 3	1994	1	100 662.0	100.6620
JMA 3	1996	1	2 580.0	2.5800
JMA 3	2016	1	1 265.5	1.2655
JMA 3	2019	2	7 407.0	9.0990
JMA 3	2020	3	444.0	4.4400
JMA 3	2024	2	300.0	3.0000

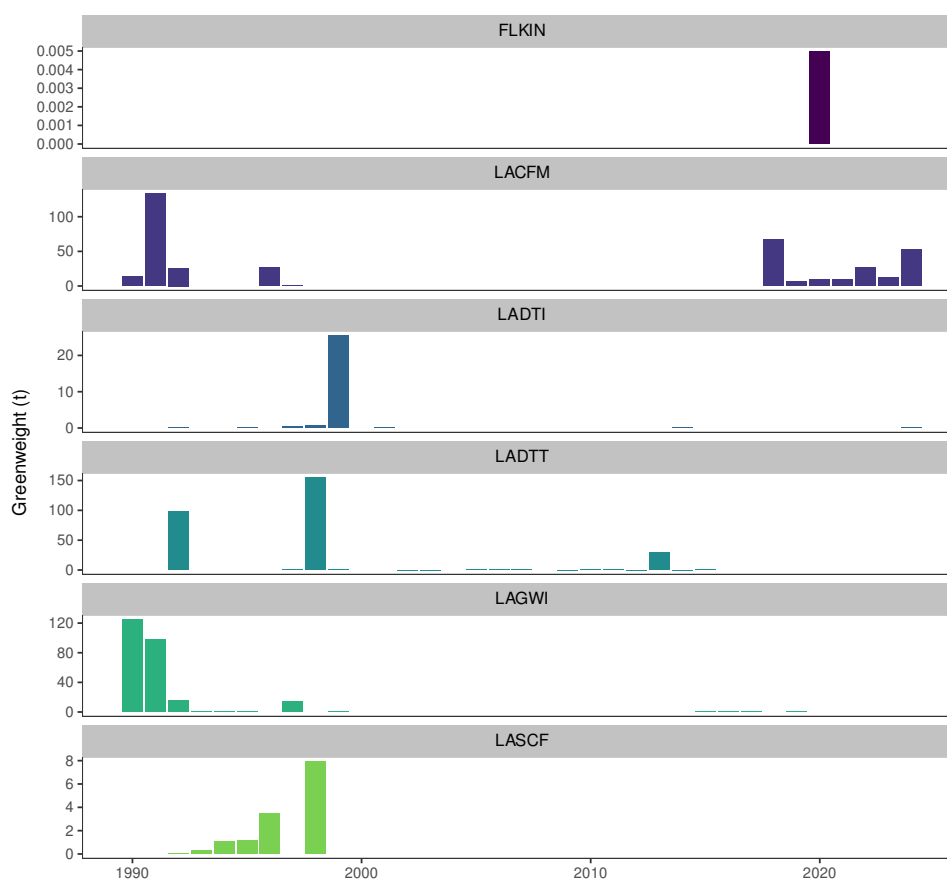


Figure A.4: The quantity of landings flagged by the grooming rules, or where fixes were applied to fields other than the landed greenweight. Note that some landing events may be affected by multiple rules.

A.2 Effort

Table A.3: Grooming rules applied to effort data.

Rule	Effect	Description
FEMDV	Fix	Update historical diving method codes to DV
FEPMN	Fix	Add PSH as a method code for certain vessels if method is null
FEPMI	Fix	Replace missing methods if there is only one method used on the trip (by form type)
FEPMM	Flag	Flag trips if any events have a missing method
FESAI	Fix	Substitute the modal statistical area from a trip for missing areas
FESAM	Flag	Flag events with missing statistical areas
FESAF	Flag	Flag non RLP events using RL statistical area codes
FETSE	Fix	Set target species to group code for HPB and FLA species
FETSW	Fix	Flag and set target species to null if target species is not a valid species code
FETSI	Fix	Replace missing target species with the modal value for a trip
FEETN	Fix	Flag and fix some CP effort errors
FEEMU	Fix	Fix SN mesh sizes recorded in inches
FEMEM	Flag	Flag events where the primary effort measure is missing
FEHDE	Flag	Flag records where the maximum daily effort is out of range
FEDBE	Fix	Transpose bottom and effort depths if reported effort depth > bottom depth

Table A.4: Grooming rules applied to estimated catch data.

Rule	Effect	Description
ESTGT	Fix	Create estimated catch records for events with a total catch weight only

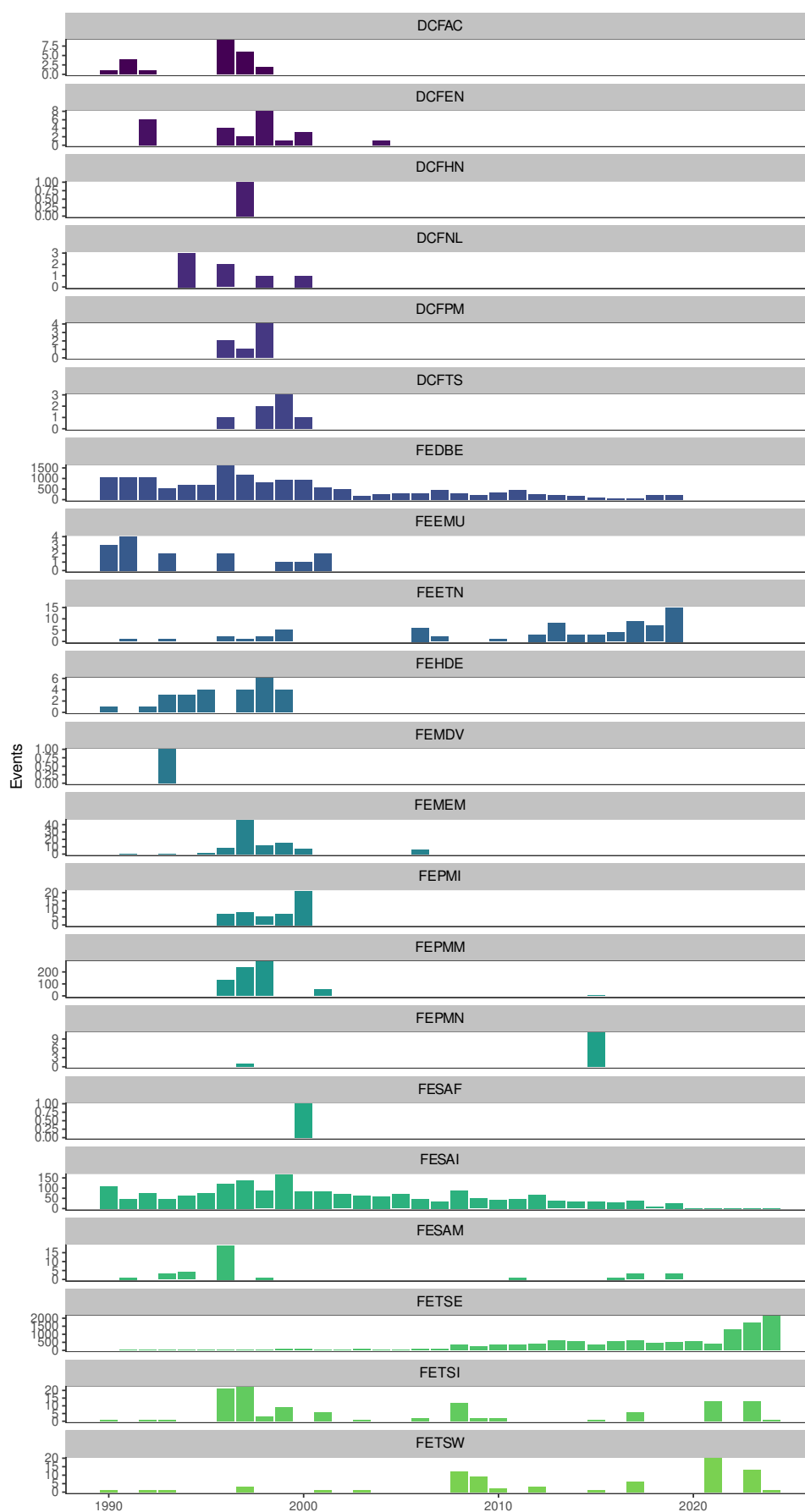


Figure A.5: The number of fishing events flagged or fixed by the grooming rules (Table A.3). Note that some events may be affected by multiple rules.

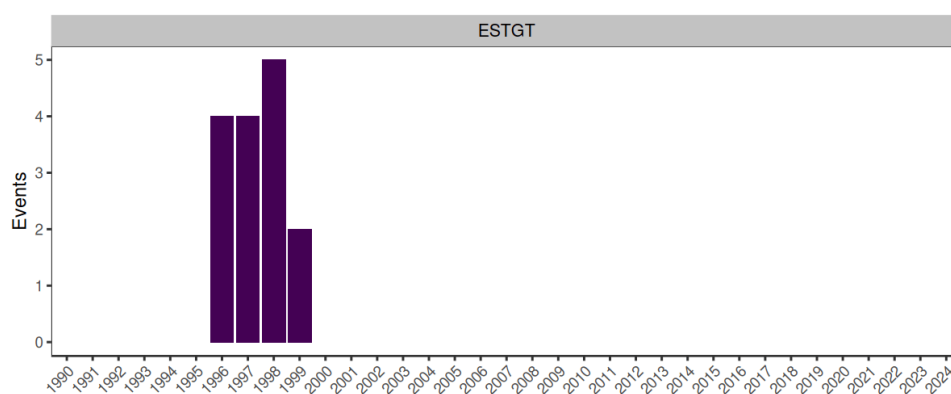


Figure A.6: The number of fishing events where the estimated catch of jack mackerels was flagged or fixed by the grooming rules (Table A.4). Note that some events may be affected by multiple rules.

APPENDIX B: TABULATED FISHERIES CHARACTERISATION DATA

Table B.1: Annual Total Allowable Commercial Catch (TACC; t) and Monthly Harvest Return/Quota Management Report totals (t) for JMA 3 from 1990 to 2024.

Fishing year	JMA 3	
	TACC	MHR/QMR
1990	2 700.00	4 014.19
1991	2 700.00	6 404.16
1992	2 700.00	5 779.62
1993	2 700.00	15 399.81
1994	9 000.00	8 884.64
1995	18 000.00	11 098.25
1996	18 000.00	19 803.09
1997	18 000.00	15 687.55
1998	18 000.00	15 452.23
1999	18 000.00	15 111.33
2000	18 000.00	10 306.02
2001	18 000.00	2 743.58
2002	18 000.02	5 000.48
2003	18 000.02	2 225.42
2004	18 000.02	704.90
2005	18 000.02	715.91
2006	18 000.02	4 999.76
2007	18 000.02	1 856.82
2008	18 000.02	2 629.38
2009	18 000.02	1 963.94
2010	18 000.02	2 706.16
2011	18 000.02	3 591.90
2012	18 000.02	3 084.52
2013	18 000.02	3 829.59
2014	18 000.02	4 692.83
2015	18 000.02	4 114.57
2016	18 000.02	2 756.00
2017	8 780.00	4 664.91
2018	8 780.00	5 559.04
2019	8 780.00	4 650.60
2020	8 780.00	5 354.88
2021	8 780.00	5 601.11
2022	8 780.00	4 857.76
2023	8 780.00	5 300.35
2024	8 780.00	3 794.59

Table B.2: Annual JMA 3 catches (t) from the different sources of data used in the fishery characterisation. QMR = Quota Management Reports; MHR = Monthly Harvest Returns. Catches represent groomed (Appendix A) landings/discards data summed by stock (see Table 2 for destination codes included). Allocated catch represents catches allocated to fishing events in the characterisation dataset, with the percentage taken by key fishing methods indicated. Target catch is the allocated catch taken on fishing events where jack mackerels was targeted. – : no observations.

Fishing year	QMR/MHR (t)	Catches (t)	Allocated catches				Target catches	
			Total (t)	MW-PRM (%)	BT-PRB (%)	PS (%)	tonnes	%
1990	4 014.19	3 185.35	2 986.31	11.24	61.39	27.33	660.27	22.11
1991	6 404.16	6 272.57	6 578.91	50.71	26.80	22.45	1 478.44	22.47
1992	5 779.62	5 770.77	6 340.89	44.06	23.15	32.76	2 120.20	33.44
1993	15 399.81	15 494.92	14 860.14	72.40	5.87	21.66	7 245.40	48.76
1994	8 884.64	8 775.74	9 109.99	70.43	11.11	18.41	4 503.66	49.44
1995	11 098.25	11 163.75	10 422.95	83.23	6.67	10.08	5 785.85	55.51
1996	19 803.09	19 014.44	18 468.77	85.17	7.69	7.13	7 806.90	42.27
1997	15 687.55	15 746.97	15 507.96	80.47	16.34	3.15	8 120.39	52.36
1998	15 452.23	15 036.47	15 205.90	80.33	13.40	5.25	11 887.51	78.18
1999	15 111.33	16 509.23	16 556.77	89.05	5.29	5.67	13 953.19	84.27
2000	10 306.02	9 743.68	9 918.74	83.65	11.34	5.01	6 760.55	68.16
2001	2 743.58	2 801.93	2 791.16	72.02	10.92	17.02	1 619.69	58.03
2002	5 000.48	5 008.73	4 876.76	75.34	20.56	4.10	2 995.12	61.42
2003	2 225.41	2 268.51	2 228.96	74.00	22.26	3.72	1 442.95	64.74
2004	704.90	686.43	681.94	78.31	21.60	-	267.24	39.19
2005	715.91	734.21	720.72	80.93	18.84	-	212.82	29.53
2006	4 999.76	4 962.54	4 962.88	93.45	6.42	0.08	3 852.44	77.63
2007	1 856.82	1 632.53	1 642.90	73.80	25.95	0.01	462.43	28.15
2008	2 629.38	2 144.60	2 170.16	82.48	17.39	-	1 254.54	57.81
2009	1 963.94	2 549.51	2 518.21	91.77	8.06	-	1 409.40	55.97
2010	2 706.16	2 562.41	2 437.56	96.10	3.75	-	706.45	28.98
2011	3 591.90	3 606.82	3 567.84	95.70	4.18	-	2 255.35	63.21
2012	3 084.52	2 828.61	2 814.75	89.91	9.87	-	1 787.26	63.50
2013	3 829.59	4 067.16	3 999.93	94.50	4.64	0.72	2 922.19	73.06
2014	4 692.83	4 713.73	4 602.07	97.74	2.10	-	3 500.73	76.07
2015	4 114.57	4 095.96	3 962.41	93.03	6.92	-	2 325.90	58.70
2016	2 755.99	2 746.92	2 678.67	94.44	5.42	-	1 176.56	43.92
2017	4 664.91	4 498.27	4 369.15	93.49	6.26	-	867.87	19.86
2018	5 559.04	5 587.75	5 395.24	94.04	5.87	-	1 944.21	36.04
2019	4 650.60	4 645.38	4 619.91	96.91	3.02	-	2 115.15	45.78
2020	5 354.88	5 499.06	4 860.07	97.27	2.55	-	2 221.82	45.72
2021	5 601.11	5 618.52	5 511.79	95.99	3.88	-	3 403.53	61.75
2022	4 857.77	4 859.62	4 833.67	96.25	3.65	-	2 273.57	47.04
2023	5 300.35	5 299.33	5 411.52	90.51	9.36	-	2 006.36	37.08
2024	3 794.59	3 768.34	3 689.11	85.22	14.50	-	1 557.22	42.21

Table B.3: Annual jack mackerels catches (t) by destination code for the JMA 3 Quota Management Area. L = Landings to an LFR, T = Transhipments. A complete list of destination codes is provided in Table 2. – : no observations.

Fishing year	L	T	Other	Total
1990	2 169.91	1 003.03	12.41	3 185.35
1991	5 349.83	793.21	129.52	6 272.57
1992	4 950.74	538.40	281.63	5 770.77
1993	14 849.82	541.20	103.90	15 494.92
1994	8 361.22	409.15	5.38	8 775.74
1995	10 768.68	341.70	53.36	11 163.75
1996	17 715.61	1 135.65	163.17	19 014.44
1997	15 313.87	412.30	20.80	15 746.97
1998	14 652.79	179.39	204.29	15 036.47
1999	16 464.34	-	44.89	16 509.23
2000	9 734.92	-	8.77	9 743.68
2001	2 799.68	-	2.24	2 801.93
2002	5 005.99	-	2.74	5 008.73
2003	2 221.74	-	46.77	2 268.51
2004	684.29	-	2.14	686.43
2005	731.59	-	2.62	734.21
2006	4 959.03	-	3.52	4 962.54
2007	1 630.08	-	2.46	1 632.53
2008	2 141.59	-	3.01	2 144.60
2009	2 545.89	-	3.62	2 549.51
2010	2 558.78	-	3.63	2 562.41
2011	3 601.06	-	5.76	3 606.82
2012	2 821.91	-	6.71	2 828.61
2013	4 050.15	-	17.01	4 067.16
2014	4 706.29	-	7.44	4 713.73
2015	4 084.03	-	11.94	4 095.96
2016	2 737.29	-	9.63	2 746.92
2017	4 488.28	-	9.99	4 498.27
2018	5 350.50	-	237.25	5 587.75
2019	4 493.54	-	151.84	4 645.38
2020	5 314.39	-	184.67	5 499.06
2021	5 551.22	-	67.30	5 618.52
2022	4 796.13	-	63.49	4 859.62
2023	5 278.35	-	20.98	5 299.33
2024	3 706.19	-	62.15	3 768.34

Table B.4: Annual catches (t) by landed state of jack mackerels from the JMA 3 Quota Management Area. DRE = Dressed, GRE = Green (or whole), HGT = Headed, gutted, and tailed, HGU = Headed and gutted, MEA = Fish meal. A complete list of product state codes is provided in Table E.1. – : no observations. Records where the landed state was missing were excluded.

Fishing year	DRE	GRE	HGU	MEA	HGT	Other	Total
1990	-	1 642.71	960.96	44.62	537.06	-	3 185.35
1991	2 676.43	2 860.78	502.51	224.99	7.84	0.02	6 272.57
1992	2 026.27	3 282.70	85.77	376.01	-	0.02	5 770.77
1993	5 707.73	5 159.88	3 942.12	632.30	-	52.88	15 494.92
1994	3 449.94	3 119.41	1 699.47	506.82	-	0.11	8 775.74
1995	8 528.91	2 126.38	0.05	507.10	-	1.31	11 163.75
1996	16 074.38	2 183.68	0.03	755.24	-	0.69	19 014.02
1997	13 823.00	1 327.04	1.89	593.21	-	1.37	15 746.51
1998	13 531.42	944.42	159.04	400.99	-	0.38	15 036.25
1999	14 970.55	1 233.69	0.01	304.95	-	0.02	16 509.21
2000	8 450.27	1 076.06	0.01	214.00	-	3.35	9 743.68
2001	2 100.76	648.47	0.01	52.46	-	0.23	2 801.93
2002	4 157.70	657.61	-	193.23	-	0.19	5 008.73
2003	1 963.19	257.50	0.16	47.59	-	0.06	2 268.51
2004	560.81	63.30	0.03	62.28	-	0.00	686.43
2005	650.79	64.92	0.02	15.62	-	2.85	734.21
2006	4 824.26	38.60	0.52	99.01	0.15	-	4 962.54
2007	1 595.46	21.64	-	15.43	-	0.00	1 632.53
2008	2 094.37	33.05	-	17.14	-	0.05	2 144.60
2009	2 498.84	23.22	-	27.36	-	0.08	2 549.51
2010	2 504.24	28.97	-	29.20	-	0.01	2 562.41
2011	3 499.07	56.61	0.01	51.11	-	0.02	3 606.82
2012	2 749.56	46.84	0.12	32.09	-	0.02	2 828.61
2013	3 725.32	235.30	0.00	106.52	-	0.01	4 067.16
2014	4 491.76	97.28	0.00	124.68	-	0.01	4 713.73
2015	3 793.78	254.90	0.04	45.55	-	1.69	4 095.96
2016	2 492.97	206.40	0.00	32.47	-	15.08	2 746.92
2017	4 292.61	113.43	0.42	81.03	-	10.78	4 498.27
2018	5 401.94	73.54	-	56.35	-	55.93	5 587.75
2019	4 378.23	169.82	0.00	95.39	-	1.93	4 645.37
2020	5 252.72	147.93	-	78.50	-	19.92	5 499.06
2021	5 326.07	126.85	-	123.83	-	41.77	5 618.52
2022	4 626.13	157.13	-	68.70	-	7.67	4 859.62
2023	3 996.36	1 211.59	0.00	63.61	-	27.76	5 299.33
2024	3 002.73	679.52	-	80.01	-	6.07	3 768.34

Table B.5: Annual modal conversion factor reported for product state codes of jack mackerels from the JMA 3 Quota Management Areas. DRE = Dressed, FIL = Fillets: skin-on, GRE = Green (or whole), GUT = Gutted, HDS = Heads, HGT = Headed, gutted, and tailed, HGU = Headed and gutted, MEA = Fish meal, SKF = Fillets: skin-off. – : no observations.

Fishing year	GRE	HGT	HGU	MEA	DRE	GUT	FIL	HDS	SKF
1990	1.00	1.60	1.50	5.56	-	-	-	-	-
1991	1.00	1.60	1.50	5.60	1.60	1.10	-	-	-
1992	1.00	-	1.50	5.60	1.60	-	2.50	-	-
1993	1.00	-	1.50	5.60	1.60	1.10	2.50	-	-
1994	1.00	-	1.50	5.60	1.60	1.10	2.50	-	-
1995	1.00	-	1.50	5.60	1.60	1.10	-	-	-
1996	1.00	-	1.50	5.60	1.60	1.10	2.50	-	-
1997	1.00	-	1.50	5.60	1.60	1.10	-	-	-
1998	1.00	-	1.50	5.60	1.60	1.10	2.50	-	-
1999	1.00	-	1.50	5.60	1.60	1.10	-	0.00	-
2000	1.00	-	1.50	5.60	1.60	1.10	-	-	-
2001	1.00	-	1.50	5.60	1.60	1.10	-	-	3.10
2002	1.00	-	-	5.60	1.60	1.10	-	-	-
2003	1.00	-	1.50	5.60	1.60	1.10	-	-	-
2004	1.00	-	1.50	5.60	1.60	-	2.50	-	-
2005	1.00	-	1.50	5.60	1.60	1.10	2.50	-	3.10
2006	1.00	-	1.50	5.60	1.60	-	-	-	-
2007	1.00	-	-	5.60	1.60	1.10	-	-	-
2008	1.00	-	-	5.60	1.60	1.10	-	-	-
2009	1.00	-	-	5.60	1.60	1.10	-	-	-
2010	1.00	-	-	5.60	1.60	1.10	-	-	-
2011	1.00	-	1.50	5.60	1.60	1.10	-	-	-
2012	1.00	-	1.50	5.60	1.60	1.10	-	-	-
2013	1.00	-	1.50	5.60	1.60	1.10	-	-	-
2014	1.00	-	1.50	5.60	1.60	1.10	-	-	-
2015	1.00	-	1.50	5.60	1.60	1.10	2.50	-	-
2016	1.00	-	1.50	5.60	1.60	1.10	2.50	-	-
2017	1.00	-	1.50	5.60	1.60	1.10	2.50	-	-
2018	1.00	-	-	5.60	1.60	1.10	2.50	-	-
2019	1.00	-	1.50	5.60	1.60	1.10	2.50	-	-
2020	1.00	-	-	-	1.60	1.10	2.50	-	-
2021	1.00	-	-	-	1.60	-	2.50	-	-
2022	1.00	-	-	-	1.60	1.10	2.50	-	-
2023	1.00	-	1.50	-	1.60	1.10	2.50	-	-
2024	1.00	-	-	-	1.60	-	2.50	-	-

Table B.6: Reporting forms used for effort on trips landing jack mackerels from the JMA 3 Quota Management Area in terms of data records and their allocated catches. A complete list of form type codes is provided in Table E.2. – : no observations.

Fishing year	Records (N)							Allocated catches (t)						
	TCP	CEL	Other	TCE	ERS - Trawl	ERS - Netting	Total	TCP	CEL	Other	TCE	ERS - Trawl	ERS - Netting	Total
1990	14373	540	-	-	-	-	14913	2160.98	825.33	-	-	-	-	2986.31
1991	18925	1159	-	-	-	-	20084	5046.23	1532.68	-	-	-	-	6578.91
1992	16029	900	-	-	-	-	16929	4235.12	2105.77	-	-	-	-	6340.89
1993	15941	1311	-	-	-	-	17252	11557.65	3302.49	-	-	-	-	14860.14
1994	14754	835	8	-	-	-	15597	7409.35	1700.61	0.03	-	-	-	9109.99
1995	17188	703	13	-	-	-	17904	9338.85	1083.81	0.30	-	-	-	10422.95
1996	21276	911	8	-	-	-	22195	17127.53	1341.22	0.02	-	-	-	18468.77
1997	21325	1442	15	-	-	-	22782	14911.31	595.99	0.66	-	-	-	15507.96
1998	19437	1376	72	-	-	-	20885	14133.44	916.67	155.79	-	-	-	15205.90
1999	19878	1496	-	-	-	-	21374	15529.74	1027.03	-	-	-	-	16556.77
2000	14909	1592	-	-	-	-	16501	9234.59	684.15	-	-	-	-	9918.74
2001	12871	1707	26	-	-	-	14604	2212.55	578.59	0.01	-	-	-	2791.16
2002	14637	1366	-	-	-	-	16003	4593.60	283.16	-	-	-	-	4876.76
2003	13944	1376	-	-	-	-	15320	2105.51	123.45	-	-	-	-	2228.96
2004	12563	898	-	-	-	-	13461	651.34	30.59	-	-	-	-	681.94
2005	12364	1210	39	-	-	-	13613	678.61	41.97	0.14	-	-	-	720.72
2006	10785	1258	-	-	-	-	12043	4935.35	27.53	-	-	-	-	4962.88
2007	7722	734	297	-	-	-	8753	1631.78	8.28	2.84	-	-	-	1642.90
2008	7897	80	294	2530	-	-	10801	2150.52	1.12	1.61	16.90	-	-	2170.16
2009	7449	180	349	2673	-	-	10651	2503.99	1.46	2.94	9.81	-	-	2518.21
2010	6664	93	440	3174	-	-	10371	2417.91	0.64	3.02	15.99	-	-	2437.56
2011	7697	141	498	3729	-	-	12065	3541.42	1.13	3.21	22.09	-	-	3567.84
2012	7006	143	536	3499	-	-	11184	2786.37	2.00	4.42	21.96	-	-	2814.75
2013	7242	158	679	4229	-	-	12308	3943.56	31.55	3.19	21.63	-	-	3999.93
2014	6921	228	515	4785	-	-	12449	4562.04	3.30	4.06	32.67	-	-	4602.07
2015	6170	130	581	4271	-	-	11152	3923.82	0.74	1.37	36.48	-	-	3962.41
2016	6032	170	669	4212	-	-	11083	2636.91	0.76	2.78	38.23	-	-	2678.67
2017	6605	168	840	5297	-	-	12910	4293.92	4.04	6.87	64.31	-	-	4369.15
2018	1045	156	572	5194	6341	-	13308	235.26	1.84	2.99	39.08	5116.07	-	5395.24
2019	128	104	572	4084	9141	191	14220	0.77	0.67	2.29	32.14	4583.44	0.60	4619.91
2020	-	-	416	26	12865	490	13797	-	-	2.29	0.00	4851.52	6.26	4860.07
2021	-	-	457	-	12675	942	14074	-	-	1.36	-	5504.42	6.01	5511.79
2022	-	-	379	-	10638	938	11955	-	-	0.83	-	4828.84	4.01	4833.67
2023	-	-	485	-	10786	1200	12471	-	-	1.37	-	5404.26	5.89	5411.52
2024	-	-	346	-	13500	2065	15911	-	-	0.32	-	3678.90	9.89	3689.11

Table B.7: Allocated catches (t) of jack mackerels in JMA 3 by method of capture and fishing year. A complete list of fishing method codes is provided in Table E.3. – : no observations.

Fishing year	BT	MW	PS	SJ	Other	Total
1990	1833.23	335.68	816.13	-	1.27	2986.31
1991	1763.25	3336.16	1476.84	-	2.66	6578.91
1992	1467.91	2793.66	2077.45	-	1.88	6340.89
1993	872.58	10758.45	3219.17	-	9.94	14860.14
1994	1011.86	6416.06	1676.78	0.03	5.25	9109.99
1995	695.34	8675.37	1050.96	0.32	0.97	10422.95
1996	1419.55	15730.56	1316.55	0.03	2.08	18468.77
1997	2533.86	12479.97	489.04	0.88	4.21	15507.96
1998	2037.06	12214.76	797.78	155.79	0.51	15205.90
1999	875.22	14742.99	937.98	-	0.58	16556.77
2000	1124.86	8296.72	496.85	-	0.31	9918.74
2001	304.92	2010.29	475.06	-	0.88	2791.16
2002	1002.55	3674.28	199.73	-	0.20	4876.76
2003	496.15	1649.37	82.83	-	0.60	2228.96
2004	147.31	534.00	-	-	0.63	681.94
2005	135.81	583.30	-	-	1.61	720.72
2006	318.75	4637.98	3.92	-	2.22	4962.88
2007	426.39	1212.44	0.12	-	3.95	1642.90
2008	377.40	1790.02	-	-	2.73	2170.16
2009	202.88	2311.07	-	-	4.26	2518.21
2010	91.42	2342.49	-	-	3.65	2437.56
2011	149.04	3414.46	-	-	4.34	3567.84
2012	277.68	2530.65	-	-	6.43	2814.75
2013	185.41	3779.78	28.72	-	6.02	3999.93
2014	96.53	4498.17	-	-	7.37	4602.07
2015	274.17	3686.13	-	-	2.11	3962.41
2016	145.30	2529.83	-	-	3.54	2678.67
2017	273.66	4084.57	-	-	10.92	4369.15
2018	316.28	5073.65	-	-	5.31	5395.24
2019	139.12	4477.04	-	-	3.75	4619.91
2020	123.88	4727.59	-	-	8.61	4860.07
2021	213.76	5290.65	-	-	7.37	5511.79
2022	176.31	4652.52	-	-	4.84	4833.67
2023	506.47	4897.79	-	-	7.26	5411.52
2024	535.07	3143.83	-	-	10.21	3689.11

APPENDIX C: OBSERVER IDENTIFICATION OF JMN IN JMA 3

Trachurus novaezelandiae (JMN) are rarely recorded in observer data from JMA 3; while the catch volumes implied by these data are small, we were nevertheless keen to investigate whether these records were real, or could be attributed to misidentification or miscoding of JMN. This was particularly relevant to the decision on whether to implement the species composition modelling as a two or three species model.

We identified three recent (2023 and 2024) observer trips, each of which had one tow with records of JMN in the length-frequency sampling. In all three cases, JMN was the only species recorded from the tow and sample sizes were small (14, 25 and 60 fish). Two of the tows were on the Chatham Rise (one east of the Chatham Islands), while the third was east of Stewart Island (Figure C.1). Other data sources (in particular, trawl surveys, Figure 54) suggest that these locations are beyond the expected range of *T. novaezelandiae*.

The mean size of the recorded JMN is indicated in Figure C.1, while length-frequency distributions, scaled to the tow catch, are shown in Figure C.2 (noting that one tow had an erroneous catch weight recorded, of 3 kg despite an estimated sample weight of 24 kg; this results in scaling down, rather than scaling up). All three tows had fish recorded that were greater than 40 cm; these would be considered at the upper end of expected sizes for JMN. While one tow had exclusively large fish, the others had fish that would be within the normal size range for JMN.

A photograph of a large (approx. 44 cm fork length) jack mackerel, recently sampled in JMA 7 and identified by the observer as JMN, was provided by the Observer Programme. This was discussed with scientists active in the JMA 1 fishery, but they did not reach consensus over the identification. It is recommended that observers are encouraged not to rely on colouration for identification, and are asked to ensure the accessory lateral line is visible in all photos of jack mackerels where the identification needs to be confirmed. Use of a head torch to improve lighting when sampling in trawler factories was recommended.

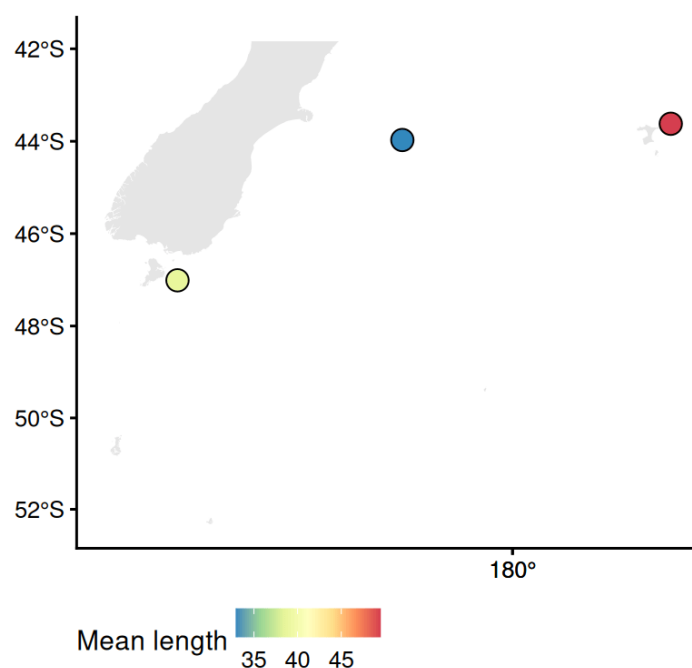


Figure C.1: Locations of the three observed tows recorded from JMA 3 with JMN samples in 2023 and 2024. The colour of the point indicates the mean size of the JMN recorded in the sample.

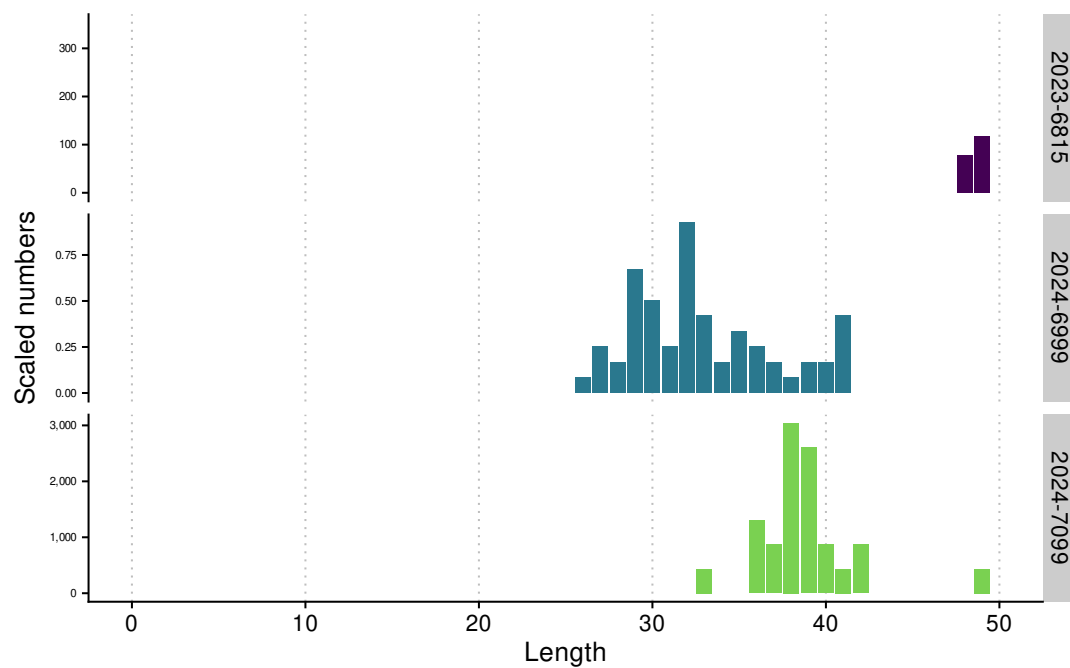


Figure C.2: Scaled length frequency of JMN for three observer sampled tows during 2024 and 2024 that recorded JMN from JMA 3.

APPENDIX D: ADDITIONAL CPUE SERIES

D.1 JMA3 MW event (allow effort allocation)

Table D.1: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW event (allow effort allocation) CPUE series.

Series	JMA3 MW event (allow effort allocation)
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	$\text{allockg_top5} \sim \text{fyear} + \text{vessel_key} + \text{target_species} + \text{month} + \text{stat_area} + \text{ns}(\log(\text{fishing_duration}), 3) + \text{ns}(\log(\text{start_time}), 3) + \text{ns}(\log(\text{bottom_depth}), 3) + \text{ns}(\log(\text{effort_height}), 3) + \text{ns}(\text{effort_speed}, 3)$
Stepwise selection	No
Positive catch distribution	Lognormal

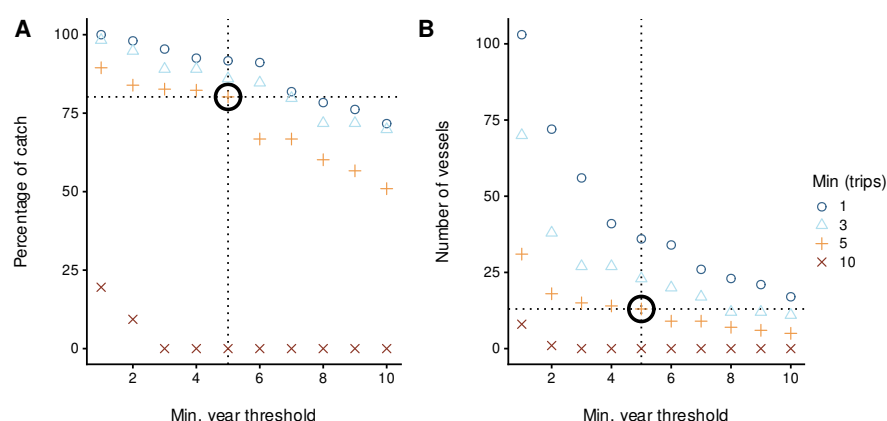


Figure D.1: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW event (allow effort allocation) CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

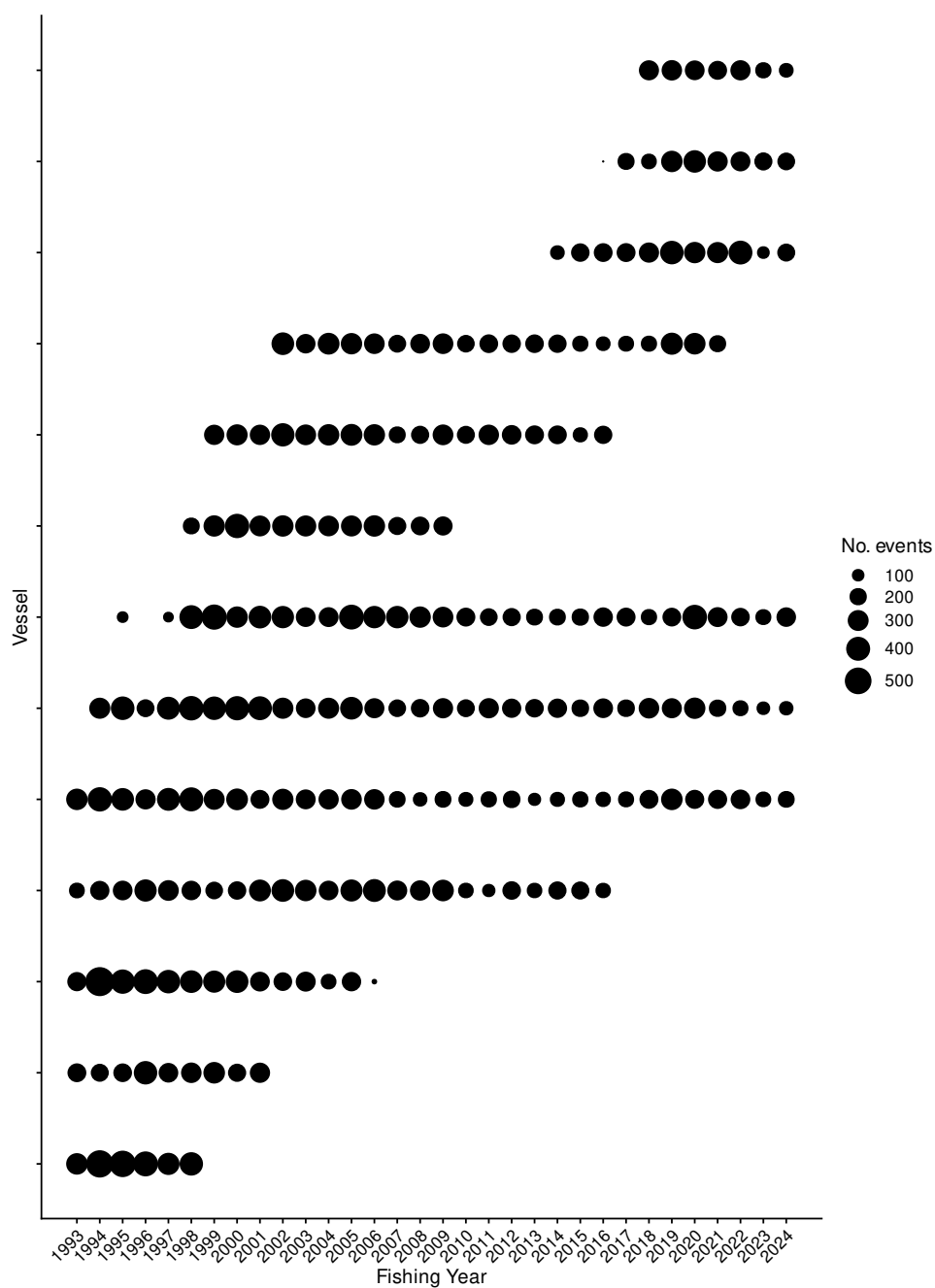


Figure D.2: Number of events by fishing year for core vessels in the JMA3 MW event (allow effort allocation) series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table D.2: Summary of the JMA3 MW event (allow effort allocation) dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 4 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	9582 (100%) n: 7120	5046 (100%) n: 6431	7167 (100%) n: 7634	13816 (100%) n: 8007	12174 (100%) n: 5773	12098 (100%) n: 5656	14572 (100%) n: 5261	8247 (100%) n: 3762	2001 (100%) n: 3011
Fishing speed not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13810 (100%) n: 7999	12150 (100%) n: 5767	12098 (100%) n: 5652	14570 (100%) n: 5257	8247 (100%) n: 3762	2001 (100%) n: 3010
Fishing speed lt 10kts	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
Start date not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
End date not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
Start depth not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7960	12122 (100%) n: 5739	11950 (99%) n: 5634	14548 (100%) n: 5245	8246 (100%) n: 3759	1998 (100%) n: 3000
Headline height not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13746 (99%) n: 7811	12120 (100%) n: 5731	11948 (99%) n: 5623	14531 (100%) n: 5238	8236 (100%) n: 3755	1998 (100%) n: 2999
Fishing speed >3.5kn	9203 (96%) n: 6839	5017 (99%) n: 6143	7114 (99%) n: 7490	13660 (99%) n: 7520	12039 (99%) n: 5480	11904 (98%) n: 5399	14418 (99%) n: 5123	8176 (99%) n: 3702	1988 (99%) n: 2985
Headline height >15m	9180 (96%) n: 6818	4980 (99%) n: 6093	7064 (99%) n: 7447	13389 (97%) n: 7414	11960 (98%) n: 5394	11866 (98%) n: 5374	14363 (99%) n: 5027	8170 (99%) n: 3692	1987 (99%) n: 2978
Headline height <90m	8535 (89%) n: 6666	4946 (98%) n: 6091	7064 (99%) n: 7447	13377 (97%) n: 7403	10684 (88%) n: 5191	10849 (90%) n: 4986	14312 (98%) n: 5013	8158 (99%) n: 3682	1987 (99%) n: 2977
Fishing duration >15mins	8398 (88%) n: 6634	4929 (98%) n: 6074	7031 (98%) n: 7430	13264 (96%) n: 7374	10609 (87%) n: 5175	10833 (90%) n: 4972	14303 (98%) n: 5002	8158 (99%) n: 3679	1987 (99%) n: 2970
Fishing duration <15h	8380 (87%) n: 6616	4918 (97%) n: 6057	7006 (98%) n: 7421	13224 (96%) n: 7356	10435 (86%) n: 5144	10791 (89%) n: 4957	14263 (98%) n: 4993	8098 (98%) n: 3660	1987 (99%) n: 2970
Seabed depth >50m	8380 (87%) n: 6616	4918 (97%) n: 6057	7006 (98%) n: 7420	13224 (96%) n: 7356	10435 (86%) n: 5144	10768 (89%) n: 4954	14263 (98%) n: 4992	8098 (98%) n: 3659	1987 (99%) n: 2970
Seabed depth <350m	8344 (87%) n: 6577	4906 (97%) n: 6017	6996 (98%) n: 7243	13197 (96%) n: 7327	10398 (85%) n: 5131	10756 (89%) n: 4950	14231 (98%) n: 4969	8096 (98%) n: 3649	1982 (99%) n: 2967
Start time >0	8004 (84%) n: 6515	4803 (95%) n: 5975	6792 (95%) n: 7172	12752 (92%) n: 7235	10050 (83%) n: 5077	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3627	1958 (98%) n: 2956
SA subset	8004 (84%) n: 6515	4803 (95%) n: 5975	6792 (95%) n: 7172	12752 (92%) n: 7235	10050 (83%) n: 5077	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3627	1958 (98%) n: 2956
Core fleet selection	3367 (35%) n: 1291	3158 (63%) n: 2310	4337 (61%) n: 2231	7415 (54%) n: 2083	6167 (51%) n: 2079	7606 (63%) n: 2687	9500 (65%) n: 2591	6820 (83%) n: 2577	1810 (90%) n: 2454

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed lt 10kts	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Start date not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
End date not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Start depth not null	3661 (100%) n: 3306	1681 (100%) n: 3109	528 (100%) n: 3279	570 (100%) n: 3636	4607 (100%) n: 2831	1445 (100%) n: 2412	2235 (100%) n: 2249	1800 (100%) n: 2188	2226 (100%) n: 1316
Headline height not null	3661 (100%) n: 3306	1681 (100%) n: 3109	528 (100%) n: 3279	570 (100%) n: 3636	4607 (100%) n: 2831	1445 (100%) n: 2412	2235 (100%) n: 2249	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed >3.5kn	3659 (100%) n: 3266	1671 (99%) n: 3064	526 (100%) n: 3168	570 (100%) n: 3521	4601 (100%) n: 2794	1443 (100%) n: 2380	2205 (99%) n: 2225	1751 (97%) n: 2133	2226 (100%) n: 1303
Headline height >15m	3614 (99%) n: 3243	1669 (99%) n: 3046	519 (98%) n: 3151	570 (100%) n: 3513	4601 (100%) n: 2790	1443 (100%) n: 2359	2205 (99%) n: 2208	1741 (97%) n: 2129	2225 (100%) n: 1300
Headline height <90m	3614 (99%) n: 3243	1669 (99%) n: 3046	516 (98%) n: 3150	570 (100%) n: 3513	4601 (100%) n: 2789	1443 (100%) n: 2359	2205 (99%) n: 2207	1741 (97%) n: 2129	2225 (100%) n: 1300
Fishing duration >15mins	3575 (98%) n: 3229	1669 (99%) n: 3041	516 (98%) n: 3141	570 (100%) n: 3502	4598 (100%) n: 2782	1442 (100%) n: 2354	2204 (99%) n: 2201	1741 (97%) n: 2127	2225 (100%) n: 1298
Fishing duration <15h	3574 (98%) n: 3226	1664 (99%) n: 3040	516 (98%) n: 3139	570 (100%) n: 3502	4598 (100%) n: 2780	1442 (100%) n: 2353	2192 (98%) n: 2198	1740 (97%) n: 2123	2225 (100%) n: 1297
Seabed depth >50m	3569 (97%) n: 3224	1664 (99%) n: 3040	516 (98%) n: 3139	570 (100%) n: 3502	4598 (100%) n: 2780	1442 (100%) n: 2353	2192 (98%) n: 2198	1740 (97%) n: 2123	2225 (100%) n: 1297
Seabed depth <350m	3564 (97%) n: 3222	1664 (99%) n: 3036	516 (98%) n: 3135	570 (100%) n: 3501	4598 (100%) n: 2779	1442 (100%) n: 2351	2192 (98%) n: 2196	1722 (96%) n: 2121	2225 (100%) n: 1296
Start time >0	3500 (96%) n: 3198	1639 (98%) n: 3028	509 (96%) n: 3120	556 (98%) n: 3459	4508 (98%) n: 2766	1402 (97%) n: 2334	2166 (97%) n: 2185	1660 (92%) n: 2109	2181 (98%) n: 1283
SA subset	3500 (96%) n: 3198	1639 (98%) n: 3028	509 (96%) n: 3120	556 (98%) n: 3459	4508 (98%) n: 2766	1402 (97%) n: 2334	2166 (97%) n: 2185	1660 (92%) n: 2109	2181 (98%) n: 1283
Core fleet selection	3322 (91%) n: 2598	1466 (87%) n: 2247	497 (94%) n: 2217	552 (97%) n: 2616	4445 (96%) n: 2206	1247 (86%) n: 1645	1755 (78%) n: 1694	1262 (70%) n: 1922	2077 (93%) n: 1194

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5024 (100%) n: 1678	4301 (100%) n: 2307
Fishing speed not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5024 (100%) n: 1678	4301 (100%) n: 2307
Fishing speed lt 10kts	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Start date not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
End date not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Start depth not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Headline height not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Fishing speed >3.5kn	3389 (100%) n: 1414	2668 (99%) n: 1465	3486 (100%) n: 1229	4347 (100%) n: 1456	3621 (100%) n: 1382	2507 (100%) n: 1506	4141 (100%) n: 1359	4995 (99%) n: 1625	4293 (100%) n: 2269
Headline height >15m	3341 (98%) n: 1397	2668 (99%) n: 1464	3486 (100%) n: 1229	4347 (100%) n: 1456	3618 (100%) n: 1380	2507 (100%) n: 1506	4102 (99%) n: 1356	4995 (99%) n: 1625	4293 (100%) n: 2263
Headline height <90m	3341 (98%) n: 1397	2668 (99%) n: 1463	3486 (100%) n: 1229	4347 (100%) n: 1456	3618 (100%) n: 1380	2507 (100%) n: 1506	4102 (99%) n: 1356	4994 (99%) n: 1624	4293 (100%) n: 2263
Fishing duration >15mins	3339 (98%) n: 1396	2668 (99%) n: 1459	3482 (100%) n: 1224	4347 (100%) n: 1451	3618 (100%) n: 1379	2507 (100%) n: 1501	4102 (99%) n: 1354	4994 (99%) n: 1624	4293 (100%) n: 2260
Fishing duration <15h	3339 (98%) n: 1394	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2507 (100%) n: 1500	4102 (99%) n: 1354	4994 (99%) n: 1624	4279 (99%) n: 2257
Seabed depth >50m	3339 (98%) n: 1394	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2507 (100%) n: 1500	4102 (99%) n: 1354	4994 (99%) n: 1624	4279 (99%) n: 2257
Seabed depth <350m	3339 (98%) n: 1392	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2506 (100%) n: 1494	4102 (99%) n: 1354	4994 (99%) n: 1623	4279 (99%) n: 2256
Start time >0	3297 (97%) n: 1384	2658 (99%) n: 1453	3439 (99%) n: 1217	4181 (96%) n: 1440	3556 (98%) n: 1371	2454 (98%) n: 1486	4034 (97%) n: 1350	4979 (99%) n: 1617	4279 (99%) n: 2252
SA subset	3297 (97%) n: 1384	2658 (99%) n: 1453	3439 (99%) n: 1217	4181 (96%) n: 1440	3556 (98%) n: 1371	2454 (98%) n: 1486	4034 (97%) n: 1350	4979 (99%) n: 1617	4279 (99%) n: 2252
Core fleet selection	3273 (96%) n: 1303	2573 (96%) n: 1407	3375 (97%) n: 1169	4171 (96%) n: 1424	3544 (98%) n: 1363	2408 (96%) n: 1446	3996 (96%) n: 1226	4965 (99%) n: 1600	4126 (96%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Fishing speed not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Fishing speed lt 10kts	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Start date not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
End date not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Start depth not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Headline height not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Fishing speed >3.5kn	4458 (100%) n: 2430	5242 (100%) n: 1919	4624 (100%) n: 1794	4760 (100%) n: 1037	3025 (99%) n: 1342
Headline height >15m	4451 (100%) n: 2426	5242 (100%) n: 1917	4624 (100%) n: 1792	4760 (100%) n: 1035	3014 (99%) n: 1336
Headline height <90m	4451 (100%) n: 2426	5242 (100%) n: 1917	4624 (100%) n: 1792	4760 (100%) n: 1035	3014 (99%) n: 1336
Fishing duration >15mins	4451 (100%) n: 2421	5195 (99%) n: 1912	4624 (100%) n: 1785	4759 (100%) n: 1032	3014 (99%) n: 1331
Fishing duration <15h	4451 (100%) n: 2421	5191 (99%) n: 1910	4624 (100%) n: 1785	4756 (100%) n: 1031	3014 (99%) n: 1330
Seabed depth >50m	4451 (100%) n: 2421	5191 (99%) n: 1910	4624 (100%) n: 1784	4756 (100%) n: 1031	3014 (99%) n: 1330
Seabed depth <350m	4451 (100%) n: 2419	5191 (99%) n: 1910	4624 (100%) n: 1783	4756 (100%) n: 1030	3014 (99%) n: 1329
Start time >0	4449 (100%) n: 2415	5026 (96%) n: 1902	4607 (100%) n: 1781	4746 (100%) n: 1029	3013 (99%) n: 1326
SA subset	4449 (100%) n: 2415	5026 (96%) n: 1902	4607 (100%) n: 1781	4746 (100%) n: 1029	3013 (99%) n: 1326
Core fleet selection	3994 (90%) n: 2235	4852 (93%) n: 1748	4257 (92%) n: 1609	4664 (98%) n: 953	2862 (94%) n: 1157

Table D.3: Summary of the JMA3 MW event (allow effort allocation) dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	5	58	1 291	3 127.90	3 366.83	51.28
1994	6	47	2 310	5 829.05	3 157.74	34.85
1995	7	45	2 231	6 204.75	4 336.53	38.82
1996	6	35	2 083	5 950.93	7 414.52	61.55
1997	7	28	2 079	6 307.20	6 167.20	51.42
1998	8	40	2 687	7 314.30	7 606.02	49.39
1999	8	35	2 591	7 890.05	9 499.77	56.73
2000	8	39	2 577	7 862.04	6 819.68	60.77
2001	8	34	2 454	8 292.20	1 810.30	29.22
2002	8	32	2 598	8 281.02	3 322.19	41.15
2003	8	37	2 247	7 863.04	1 466.25	33.47
2004	8	28	2 217	8 371.00	496.65	30.04
2005	8	35	2 616	8 978.97	552.32	27.60
2006	8	34	2 206	8 645.45	4 445.49	34.54
2007	7	33	1 645	7 353.95	1 247.12	49.36
2008	7	34	1 694	8 465.80	1 754.79	40.97
2009	7	39	1 922	9 346.42	1 261.53	18.37
2010	6	25	1 194	5 190.56	2 077.08	38.36
2011	6	21	1 303	5 820.35	3 272.59	33.00
2012	6	30	1 407	6 036.03	2 572.97	34.75
2013	6	25	1 169	4 960.32	3 374.93	42.86
2014	7	37	1 424	6 238.65	4 171.13	46.91
2015	7	37	1 363	6 244.58	3 544.22	41.60
2016	8	49	1 446	6 456.97	2 408.27	27.73
2017	6	30	1 226	6 471.48	3 995.90	48.37
2018	7	34	1 600	7 558.53	4 965.42	52.50
2019	7	36	2 156	9 997.48	4 126.08	36.83
2020	7	44	2 235	10 344.52	3 993.53	34.54
2021	7	33	1 748	7 981.98	4 852.41	63.73
2022	6	37	1 609	7 566.23	4 257.40	63.46
2023	6	25	953	4 692.92	4 664.04	88.98
2024	6	34	1 157	5 419.63	2 862.00	85.13

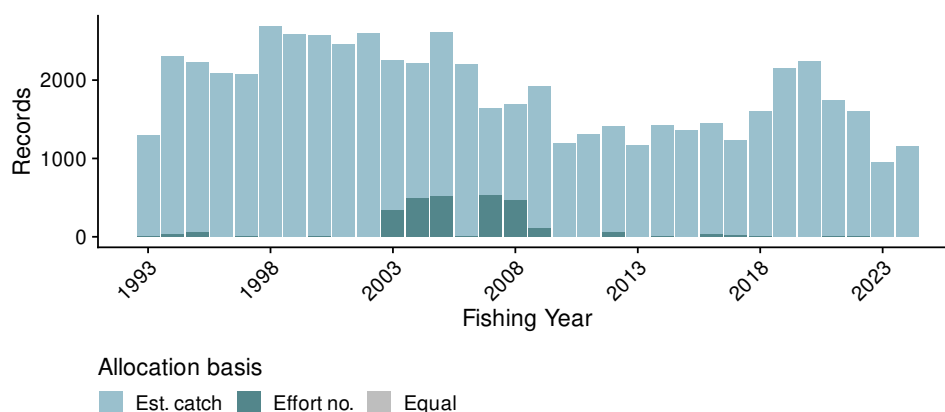


Figure D.3: The allocation approach used for attributing catches to records in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.4: Summary table for occurrence of positive catch in the JMA3 MW event (allow effort allocation) series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	81 504.69	0.00	0.00	*
fyear	31	76 439.94	6.29	6.29	*
vessel_key	12	76 137.18	6.69	0.40	*
target_species	2	59 240.15	27.43	20.74	*
month	11	58 307.68	28.60	1.17	*
stat_area	12	55 331.75	32.28	3.68	*
ns(log(fishing_duration), 3)	3	55 300.63	32.33	0.05	*
ns(log(start_time), 3)	3	55 141.73	32.53	0.20	*
ns(log(bottom_depth), 3)	3	54 284.40	33.59	1.06	*
ns(log(effort_height), 3)	3	54 245.45	33.64	0.06	*
ns(effort_speed, 3)	3	53 772.37	34.23	0.59	*

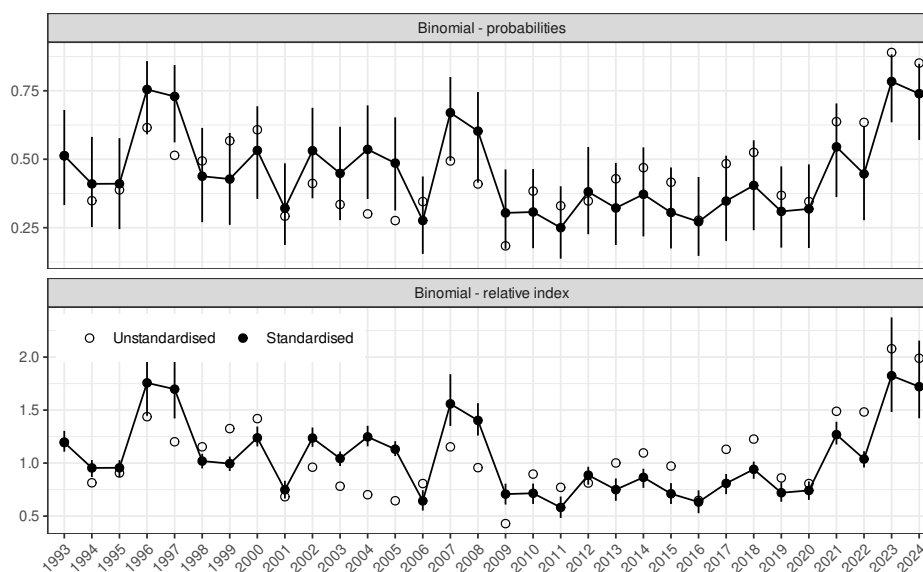


Figure D.4: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW event (allow effort allocation) dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

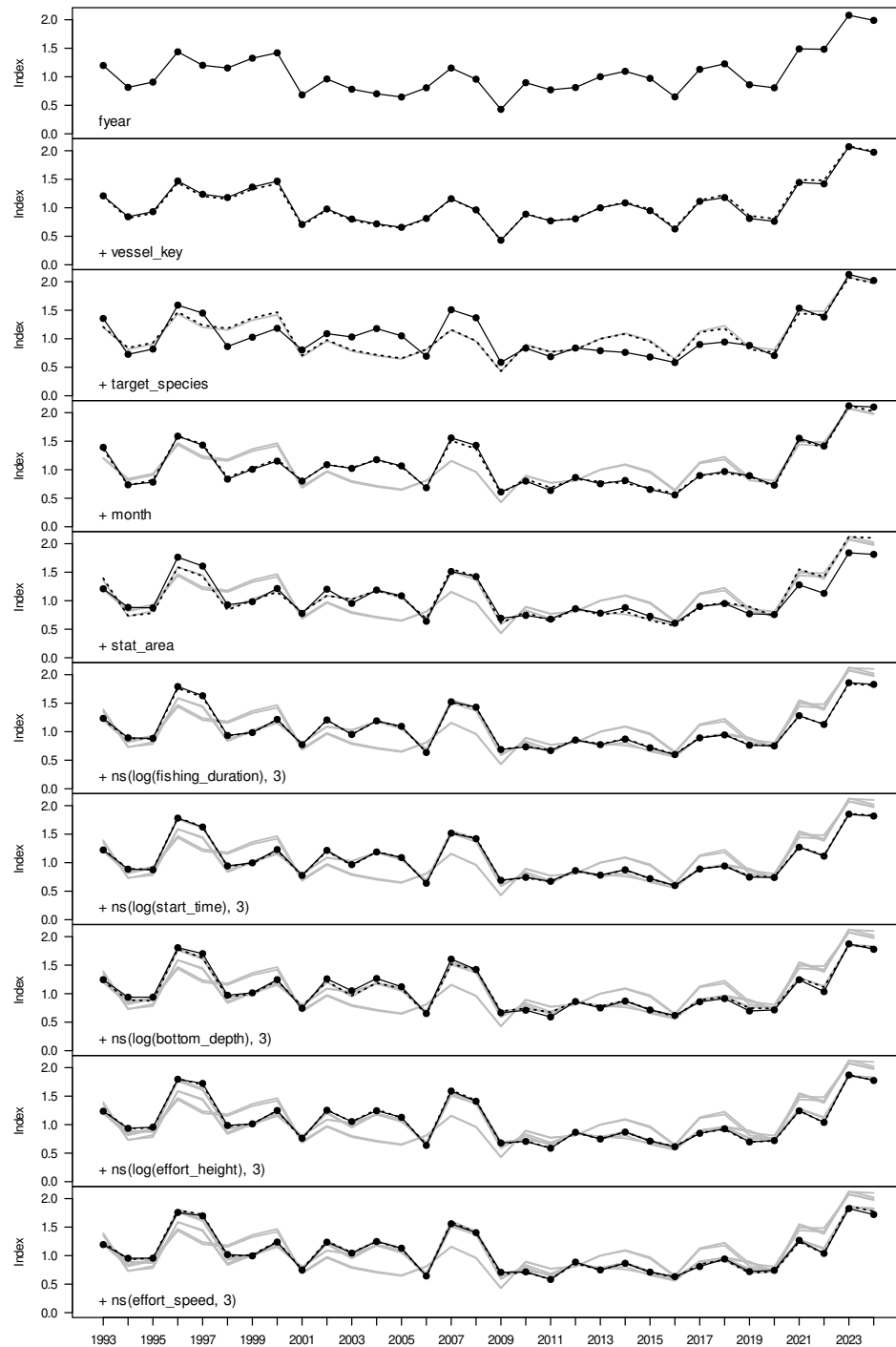


Figure D.5: Step plot for occurrence of catch in the JMA3 MW event (allow effort allocation) dataset.

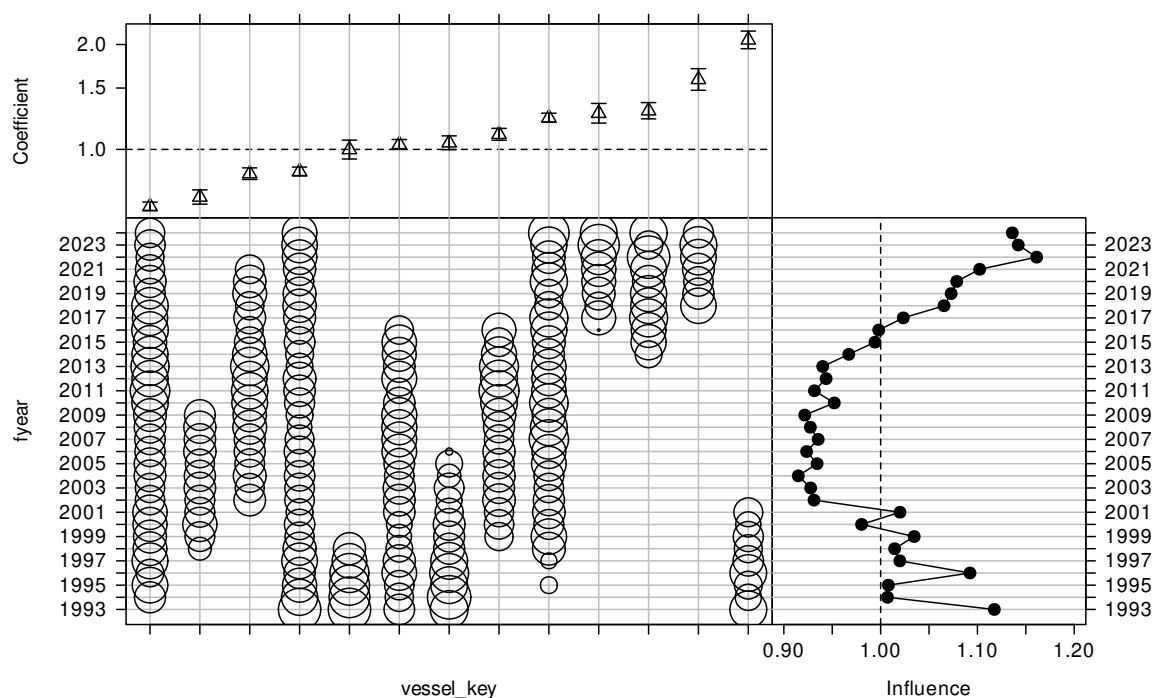


Figure D.6: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

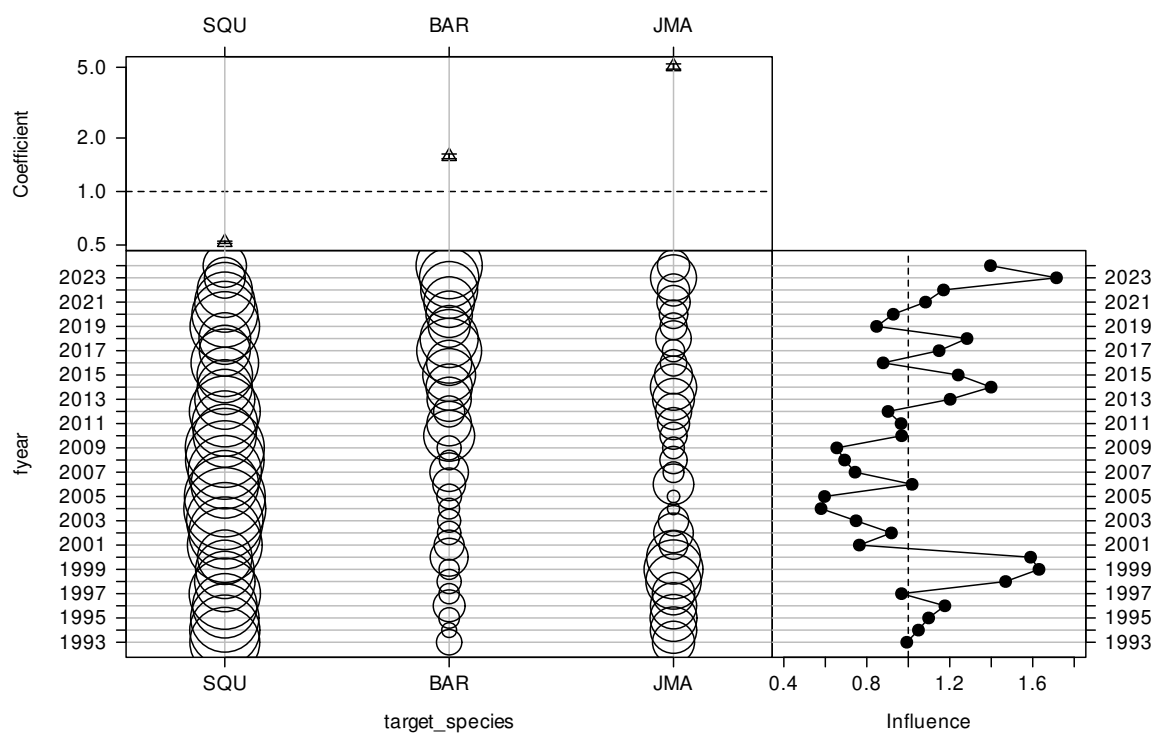


Figure D.7: CDI plot for target species for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

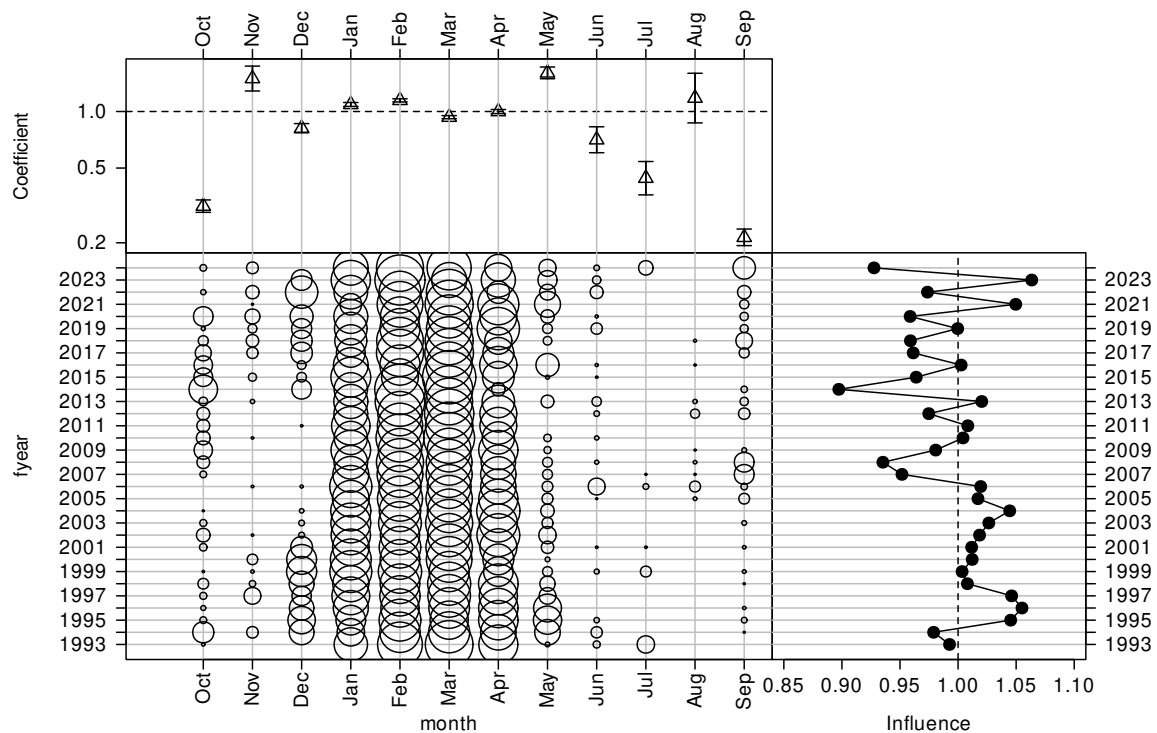


Figure D.8: CDI plot for month for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

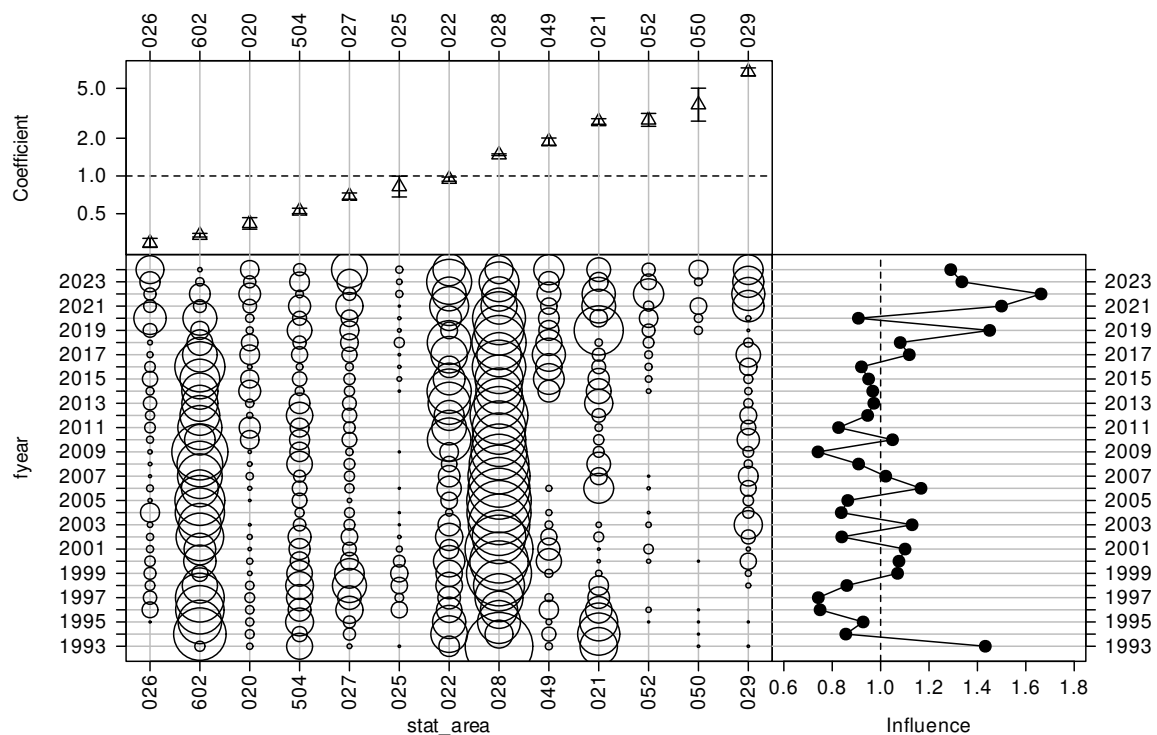


Figure D.9: CDI plot for statistical area for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

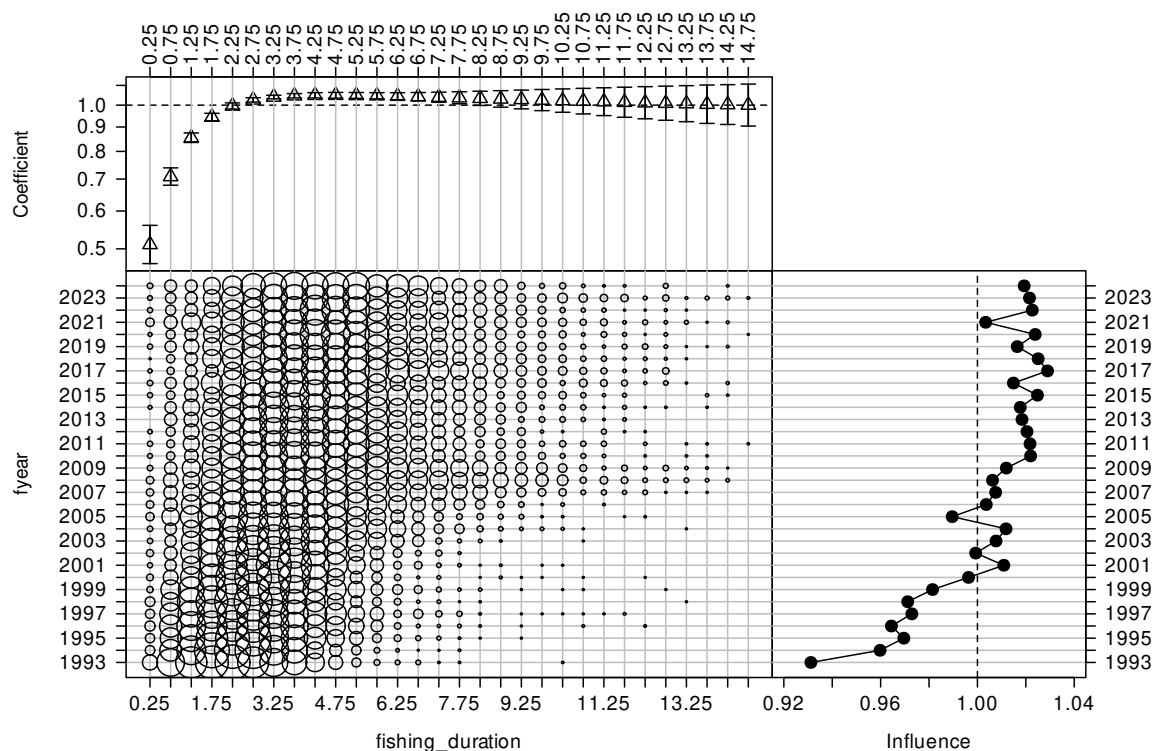


Figure D.10: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

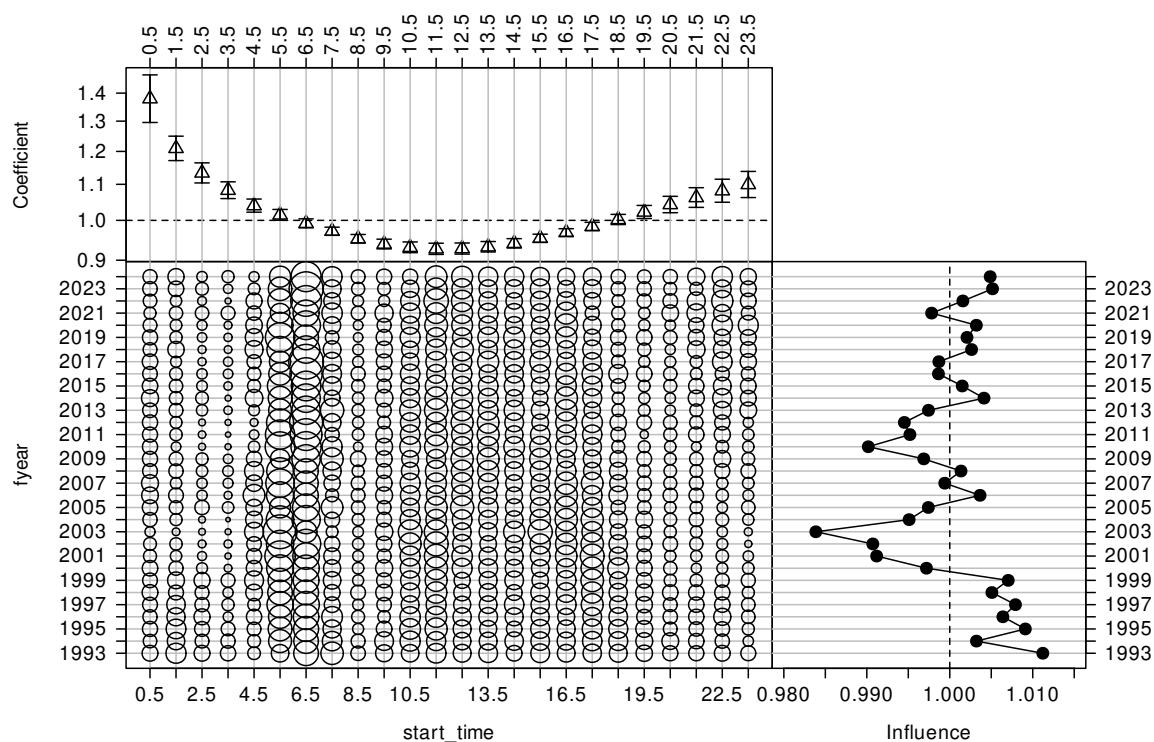


Figure D.11: CDI plot for start time for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

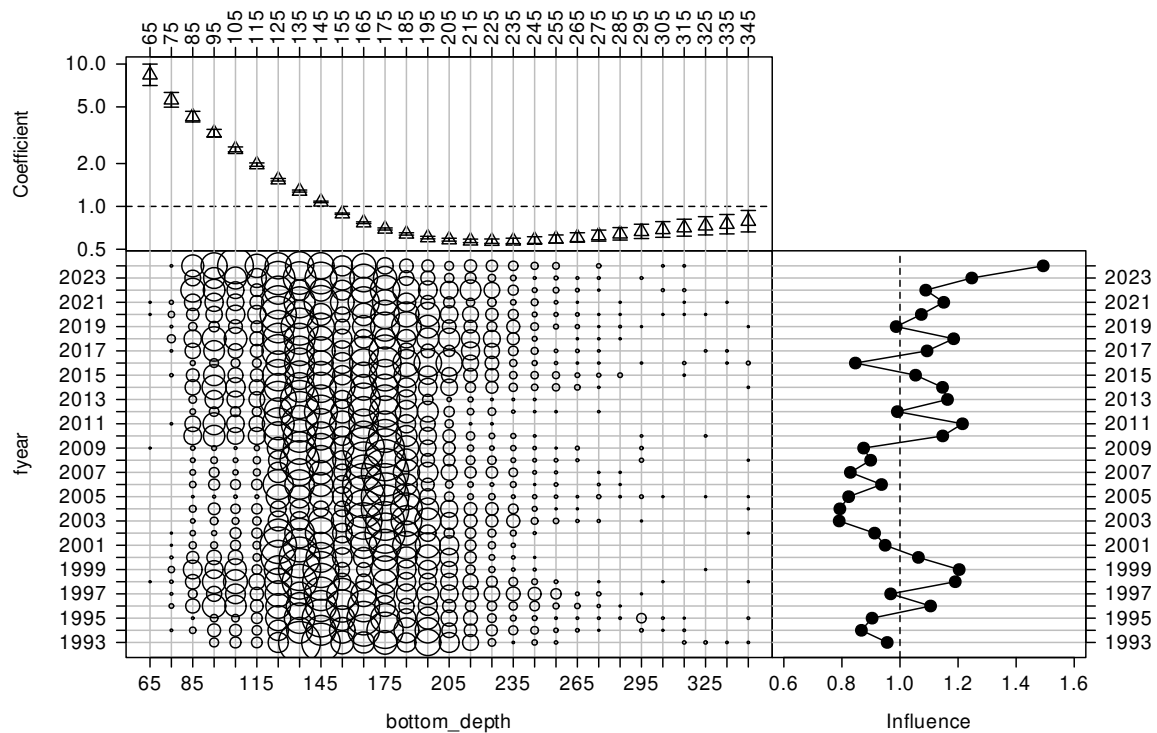


Figure D.12: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

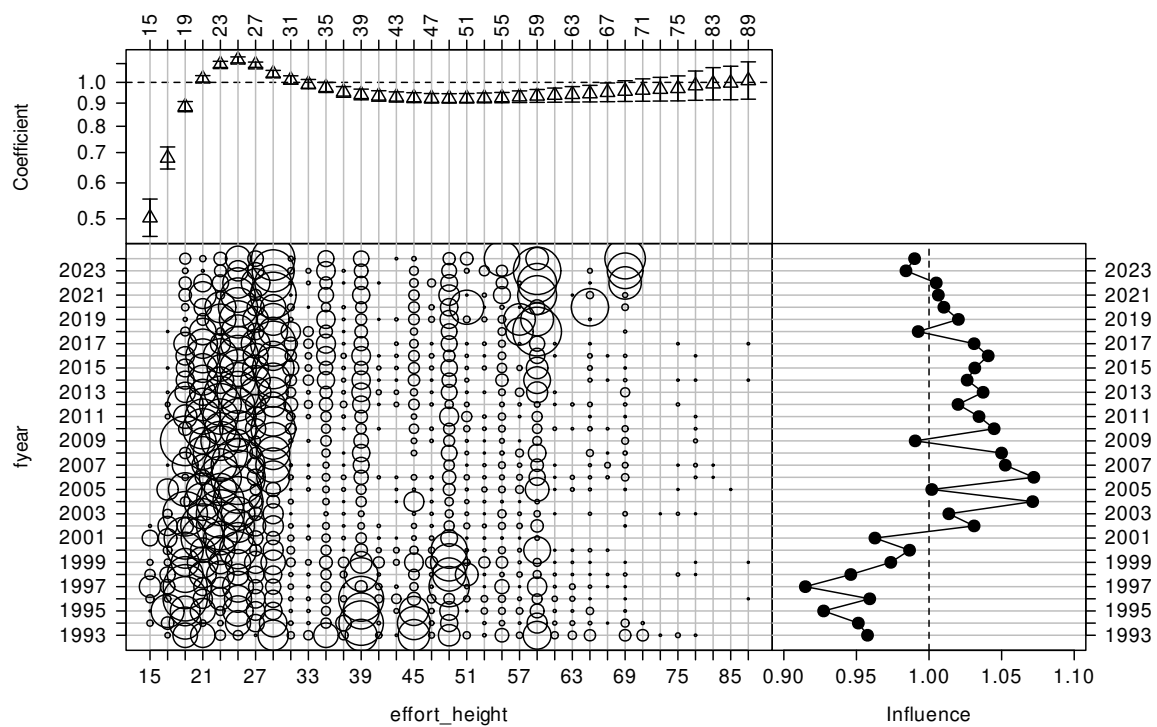


Figure D.13: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

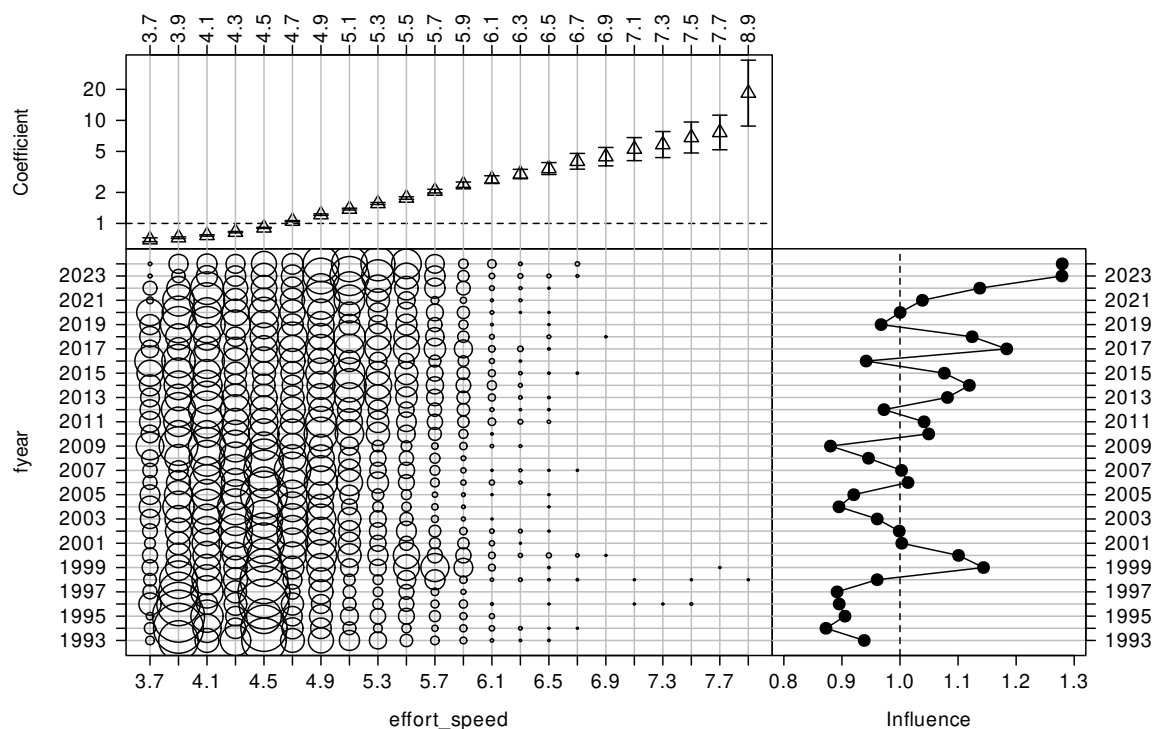


Figure D.14: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

Table D.5: Summary table for the lognormal model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	125 879.4	0.00	0.00	*
fyear	31	112 590.2	40.07	40.07	*
vessel_key	12	111 859.4	41.78	1.71	*
target_species	2	106 748.8	52.15	10.37	*
month	11	105 538.6	54.36	2.21	*
stat_area	12	103 904.4	57.17	2.81	*
ns(log(fishing_duration), 3)	3	103 885.3	57.21	0.04	*
ns(log(start_time), 3)	3	103 799.7	57.36	0.15	*
ns(log(bottom_depth), 3)	3	103 484.4	57.89	0.52	*
ns(log(effort_height), 3)	3	103 340.2	58.13	0.24	*
ns(effort_speed, 3)	3	103 121.3	58.49	0.36	*

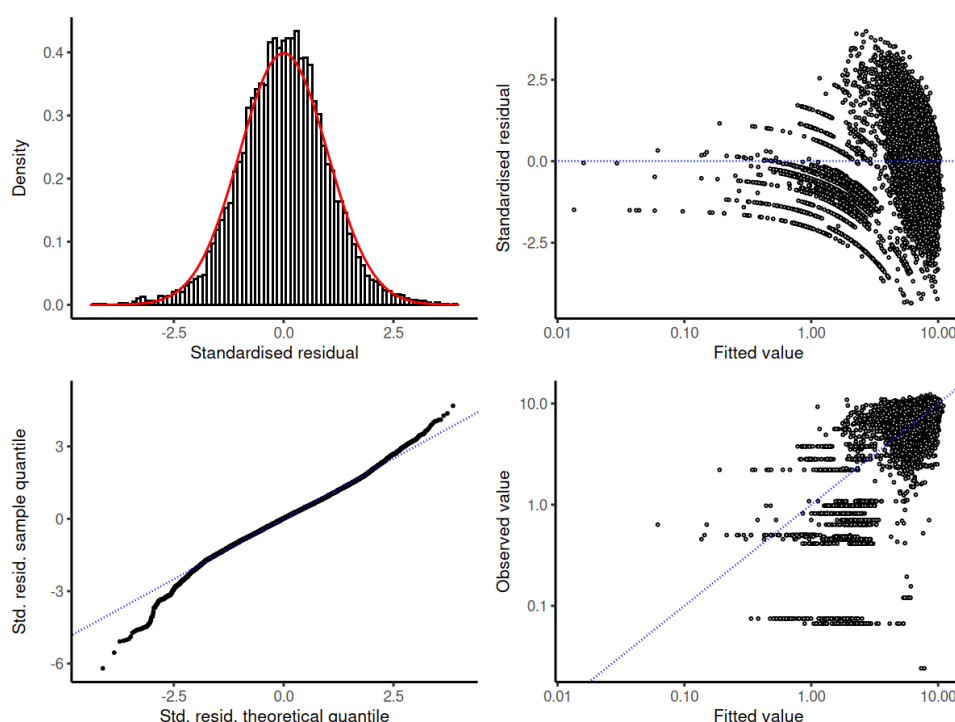


Figure D.15: Diagnostic plots for the selected lognormal model for positive catches in the JMA3 MW event (allow effort allocation) dataset.

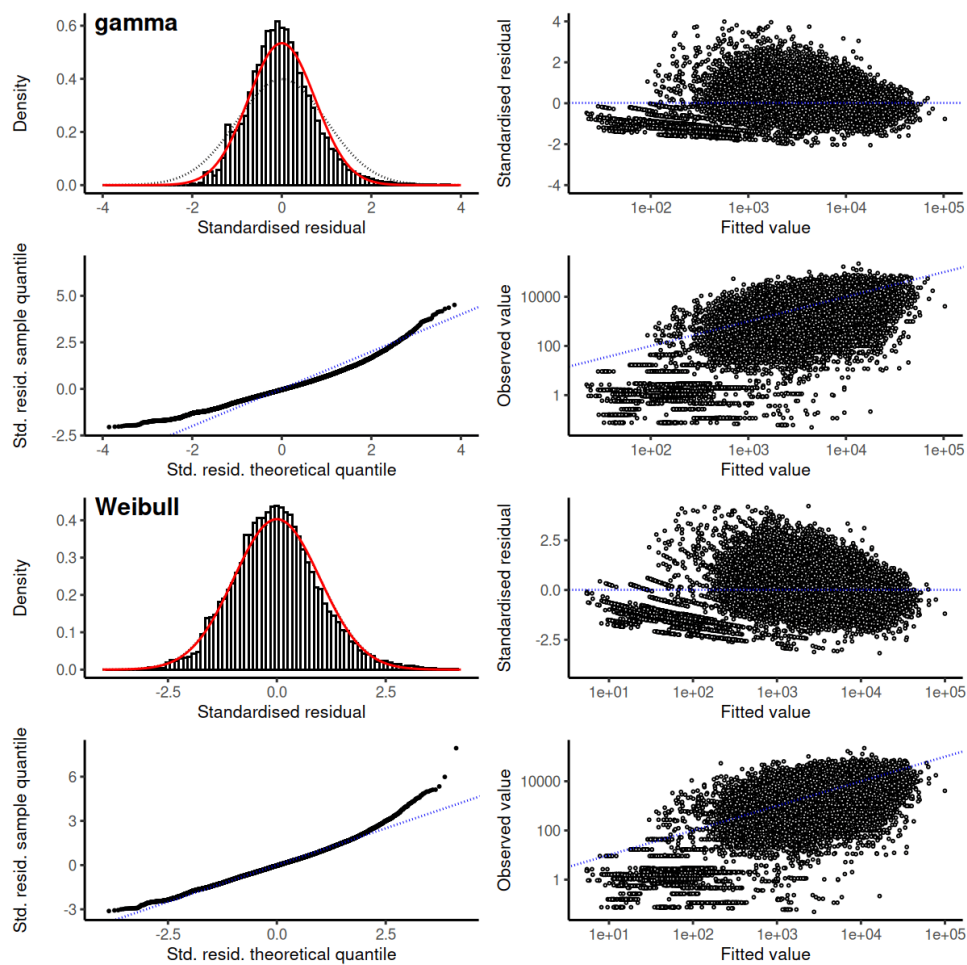


Figure D.16: Diagnostic plots for the alternative gamma and Weibull models considered for positive catches in the JMA3 MW event (allow effort allocation) dataset.

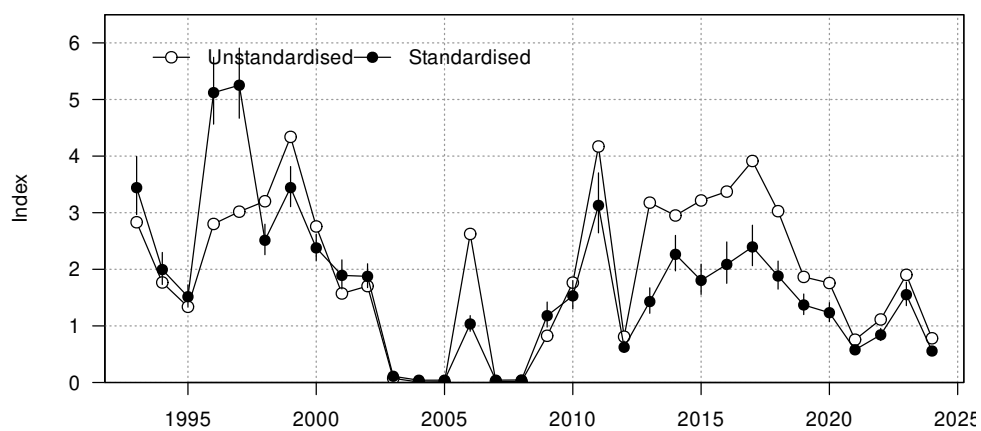


Figure D.17: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the lognormal model for the JMA3 MW event (allow effort allocation) dataset.

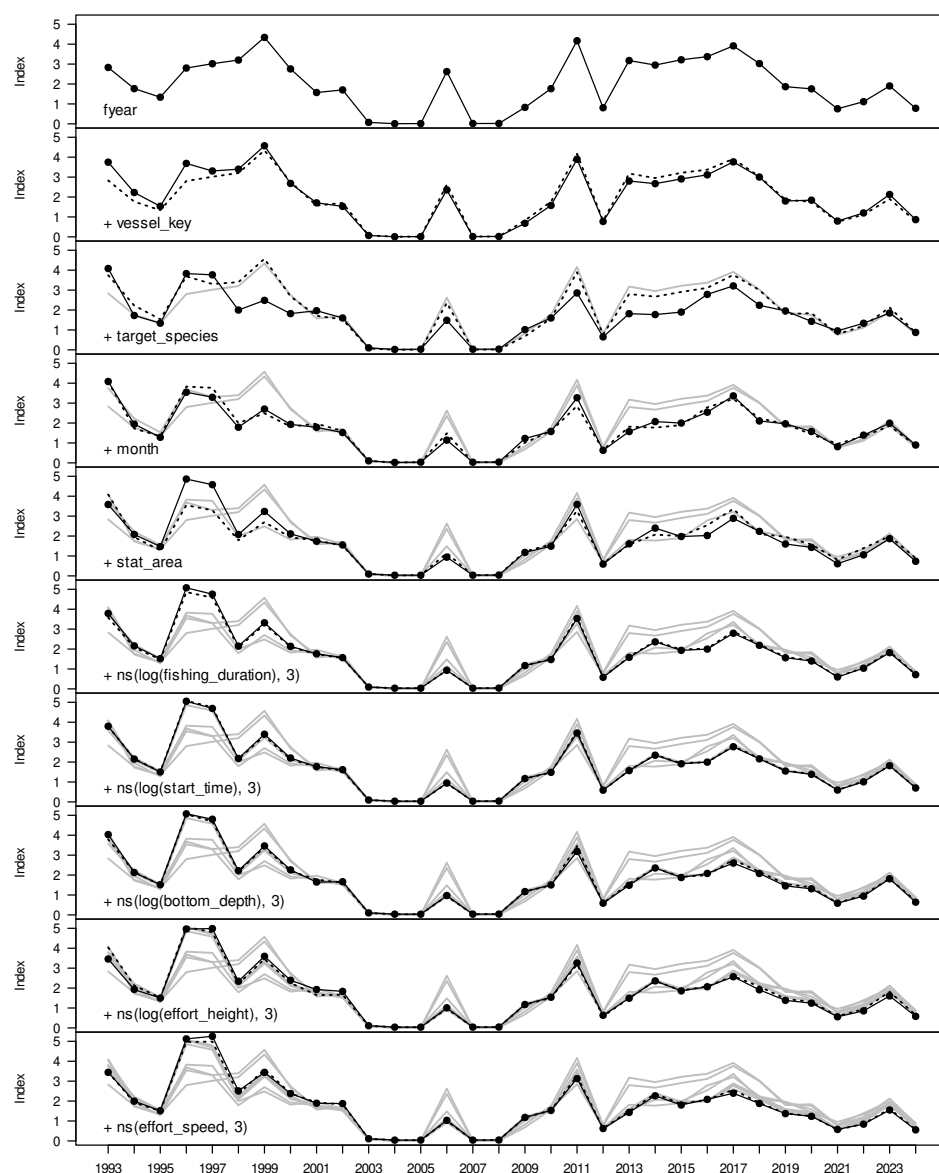


Figure D.18: Changes to the JMA3 MW event (allow effort allocation) positive catch index as terms are successively entered into the lognormal model.

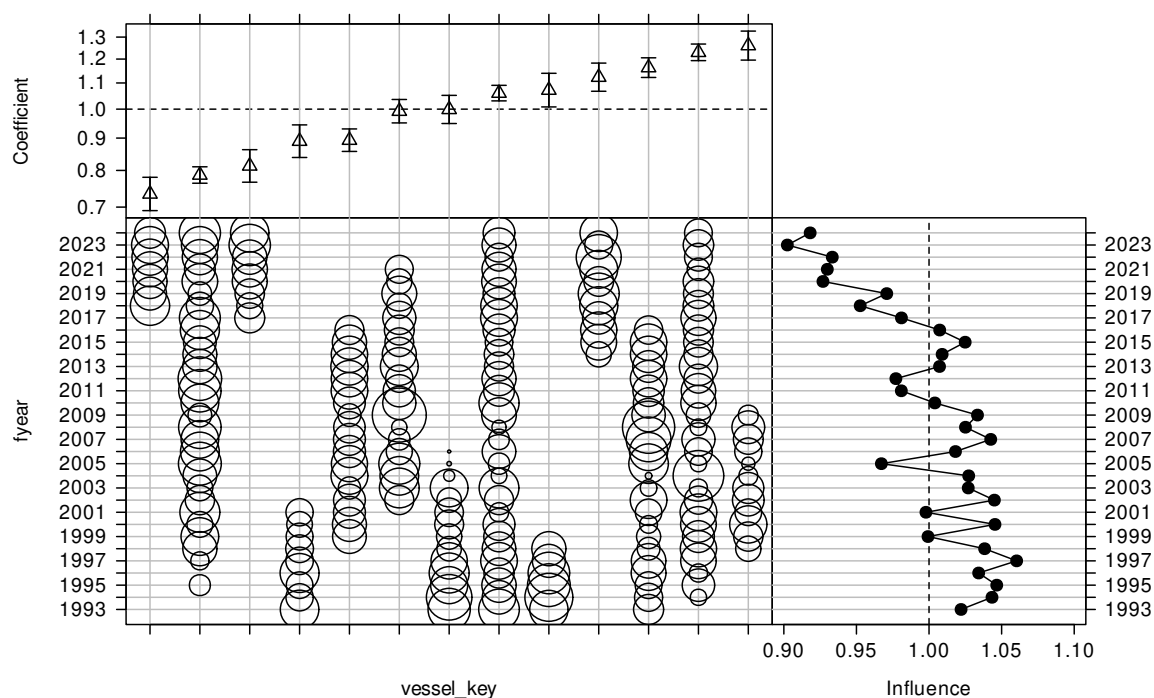


Figure D.19: CDI plot for vessel key for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

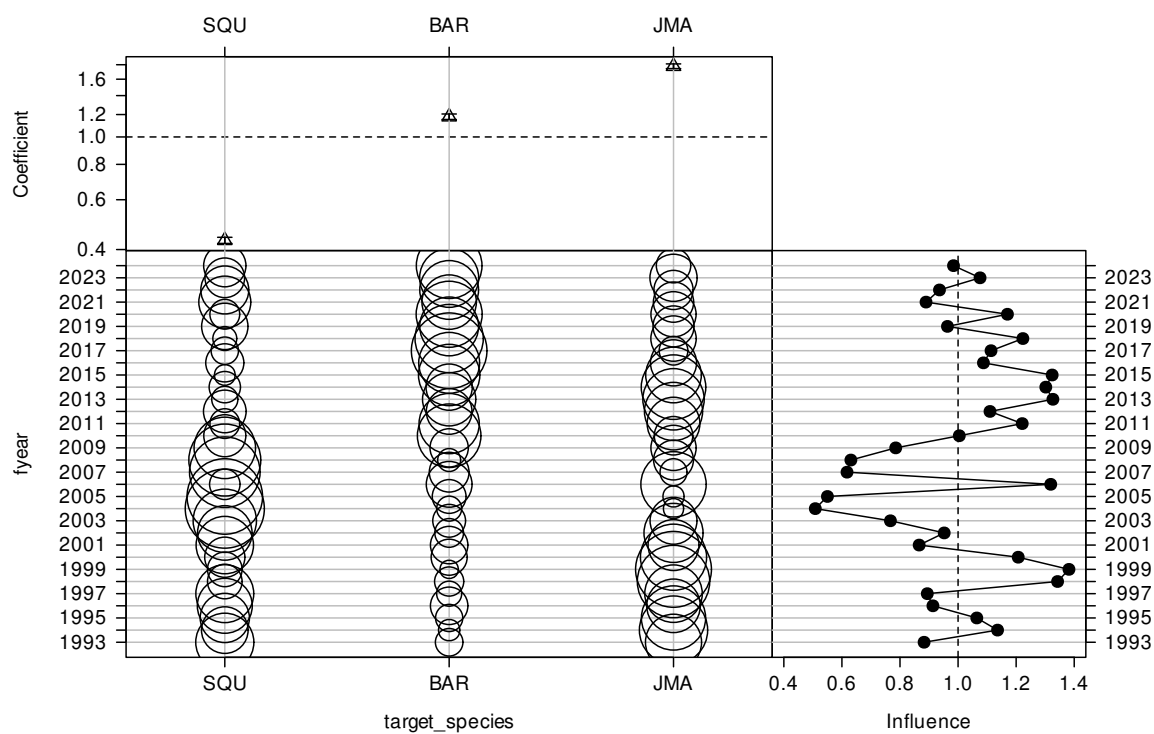


Figure D.20: CDI plot for target species for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

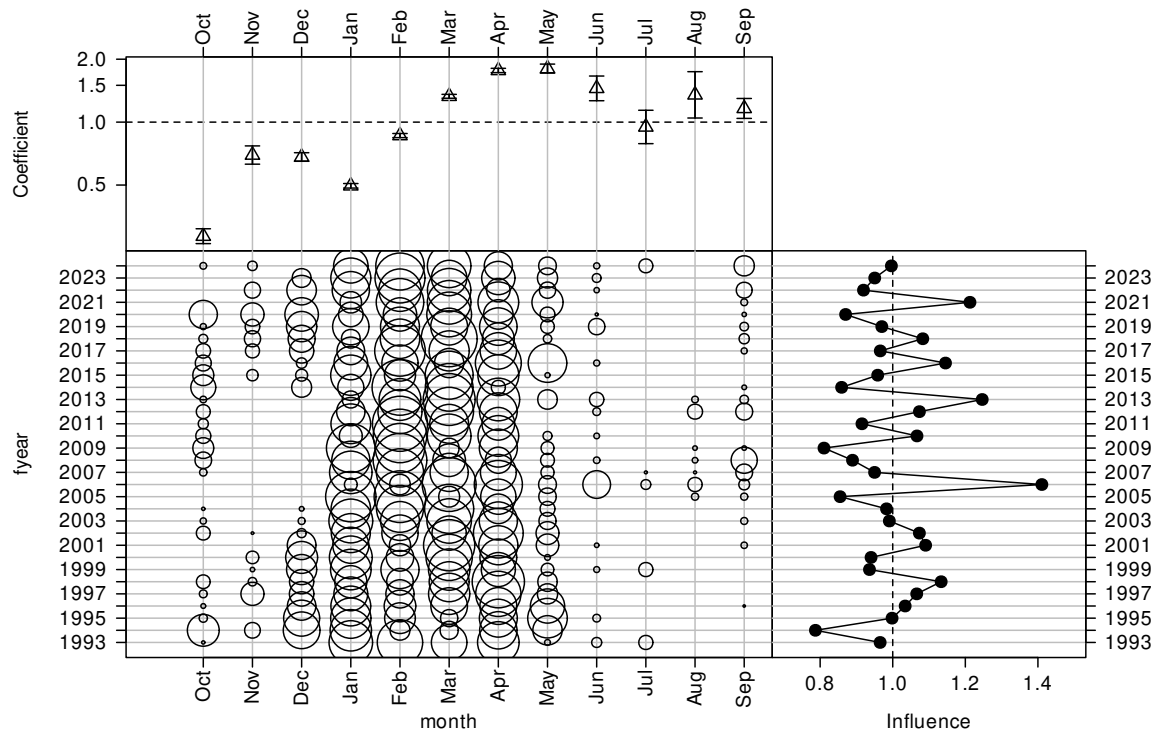


Figure D.21: CDI plot for month for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

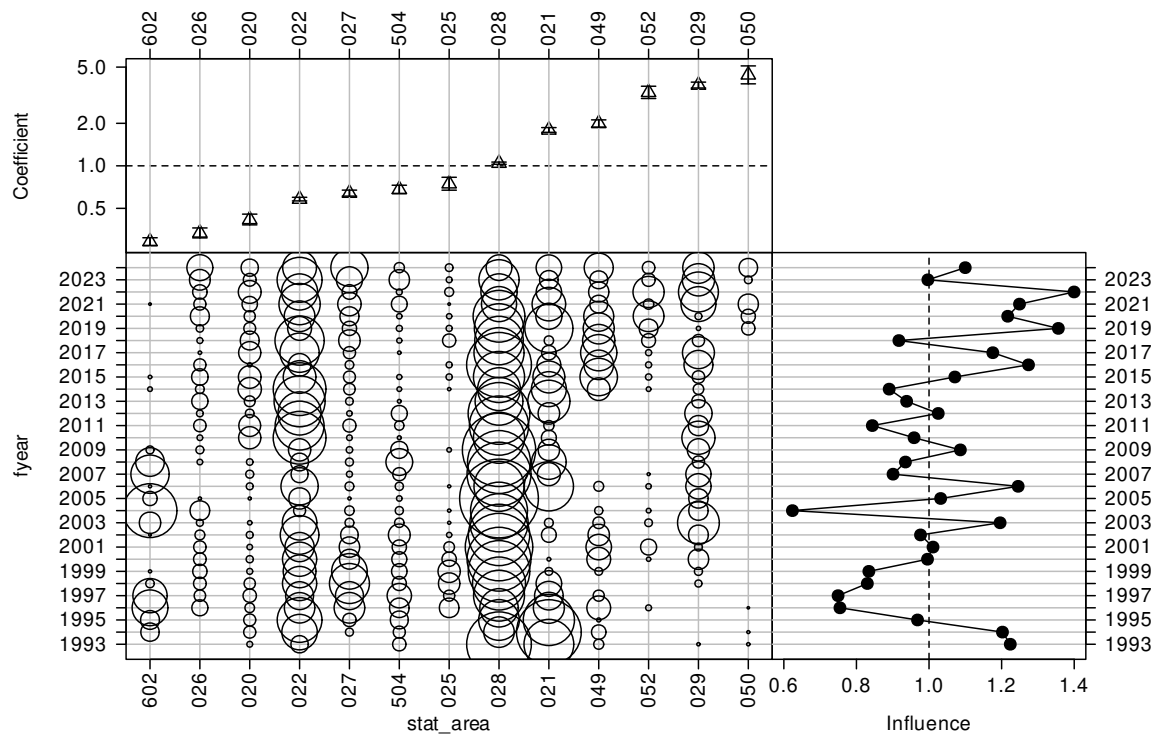


Figure D.22: CDI plot for statistical area for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

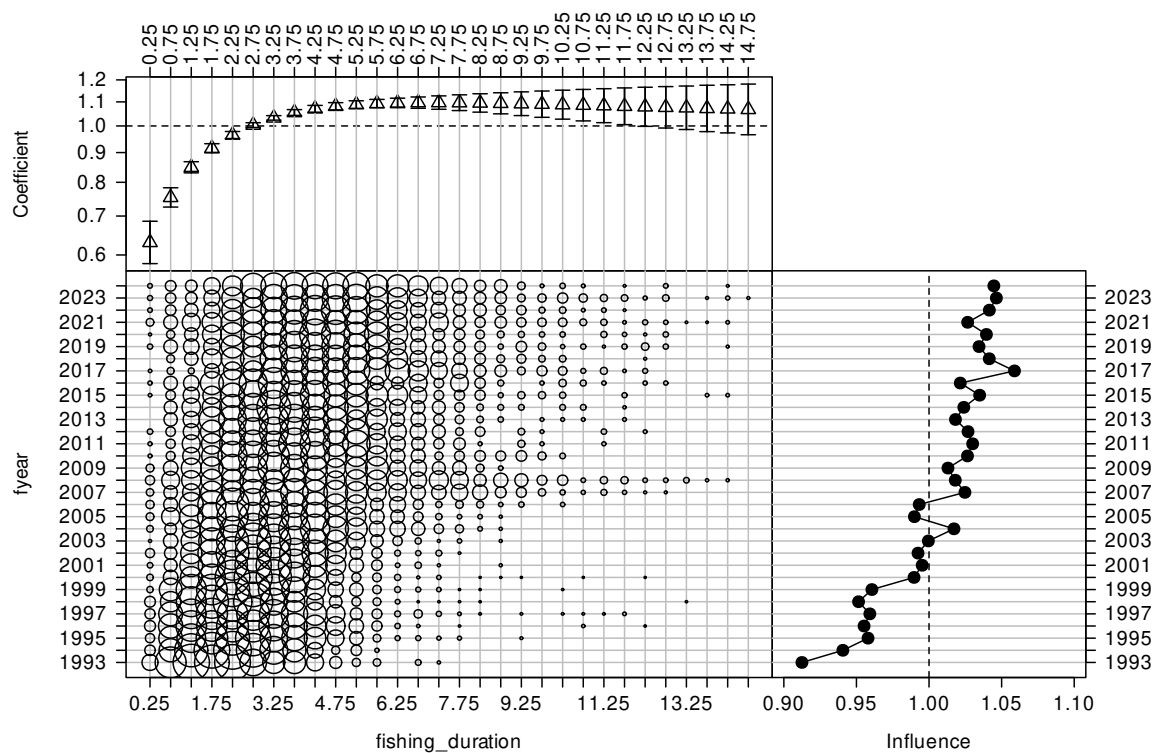


Figure D.23: CDI plot for fishing duration (h) for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

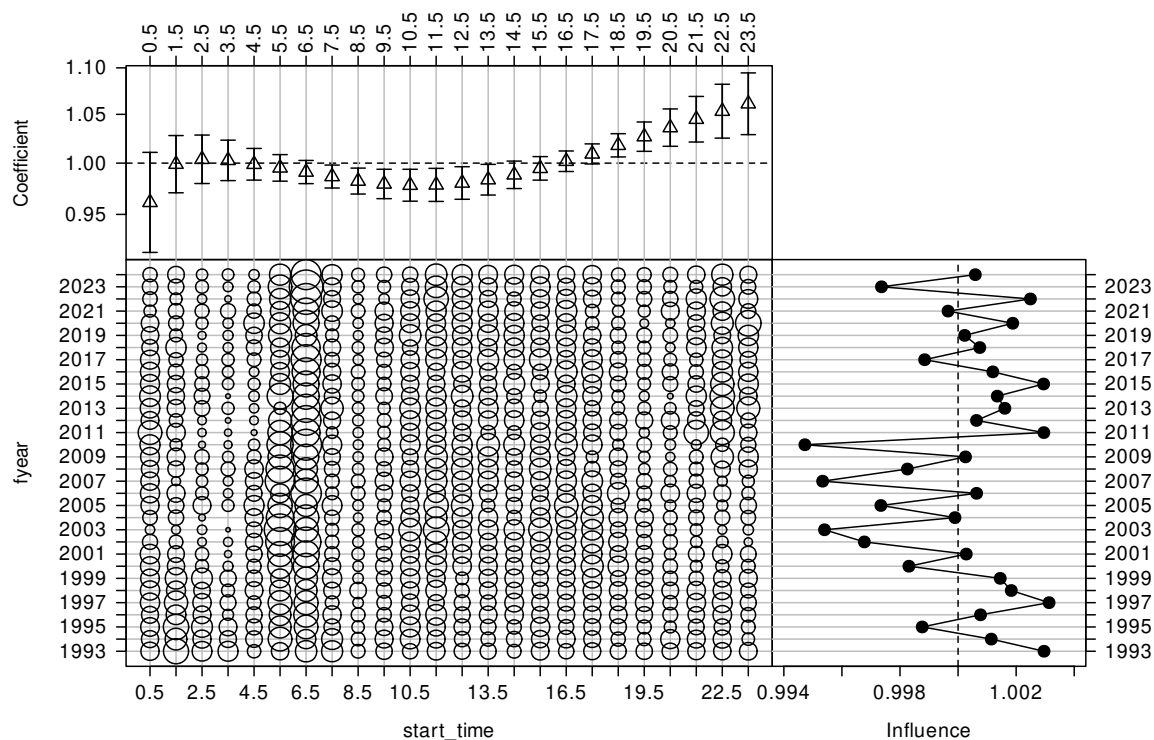


Figure D.24: CDI plot for start time for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

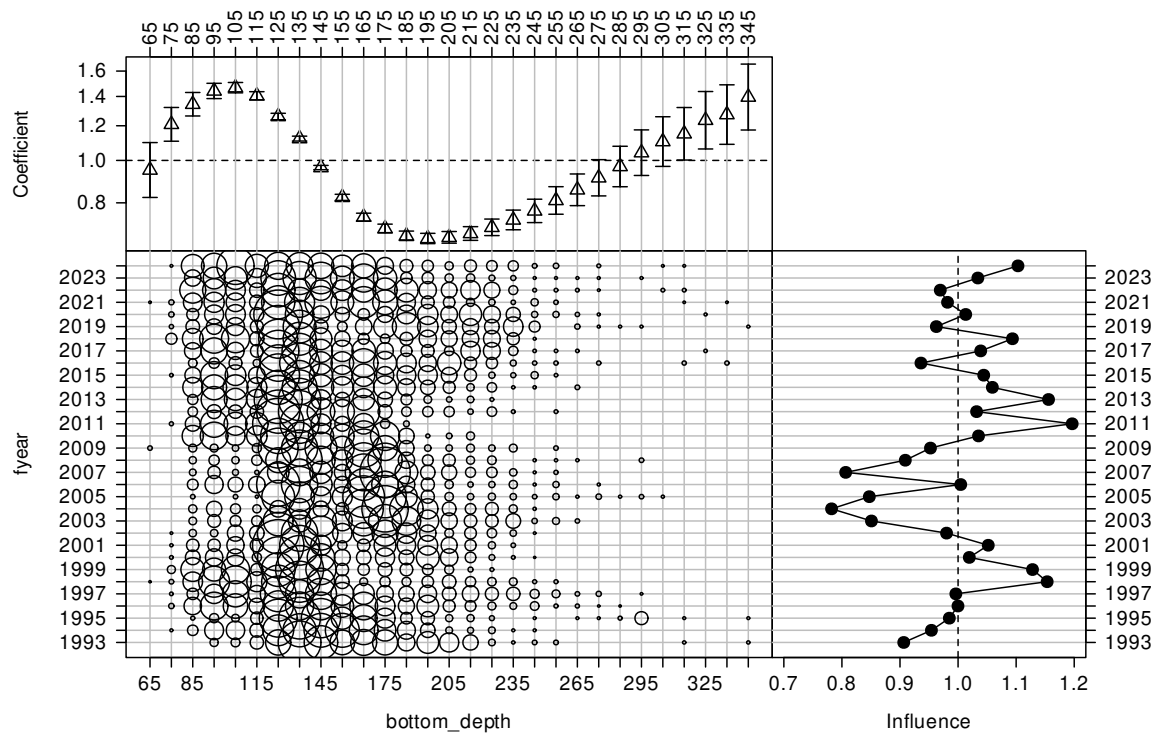


Figure D.25: CDI plot for bottom depth (m) for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

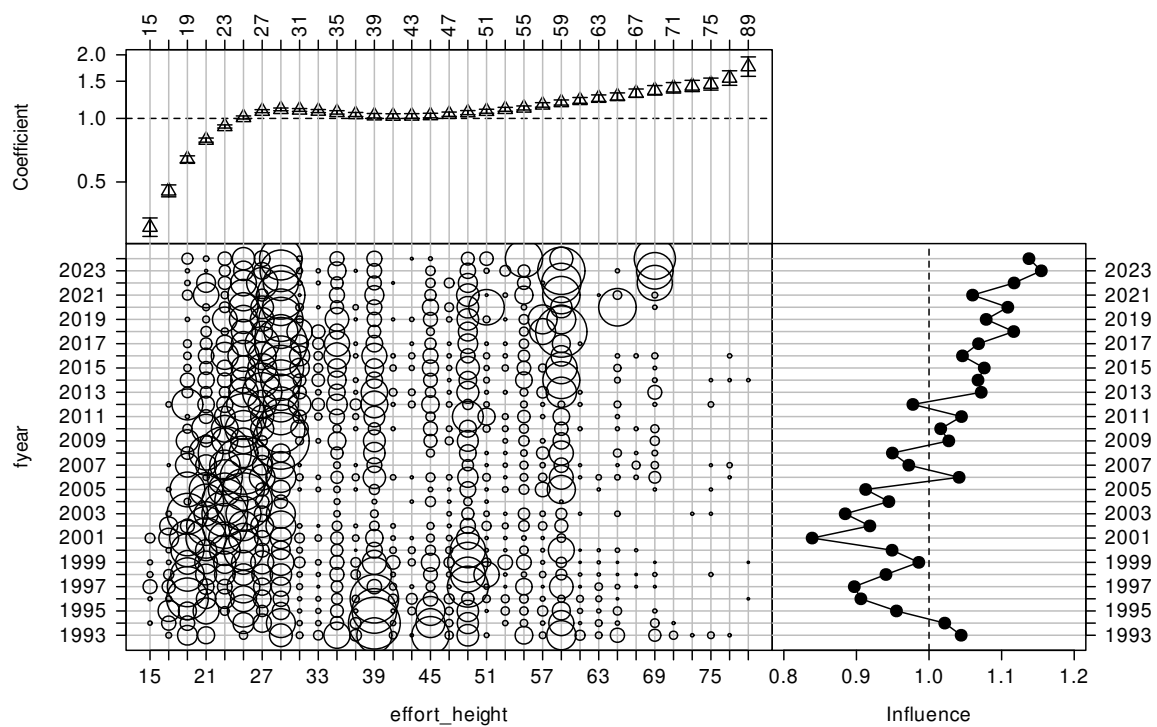


Figure D.26: CDI plot for effort height (m) for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

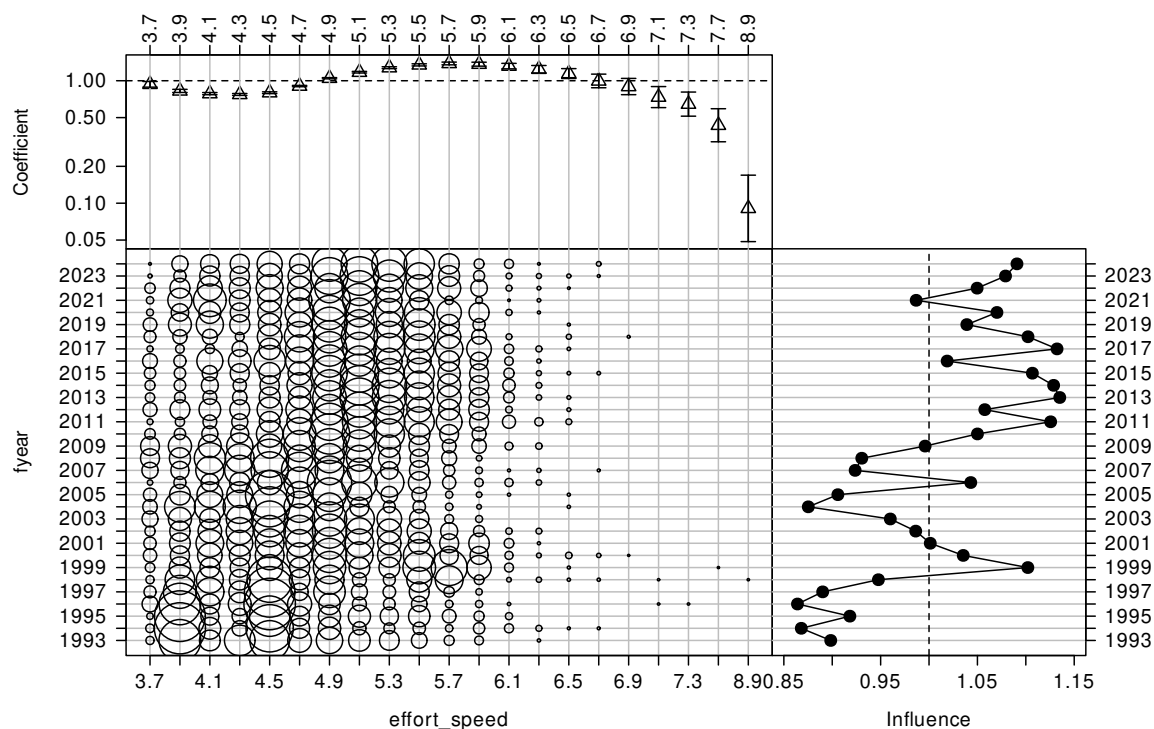


Figure D.27: CDI plot for effort speed for the lognormal model of positive catches in the JMA3 MW event (allow effort allocation) catch-per-unit-effort dataset.

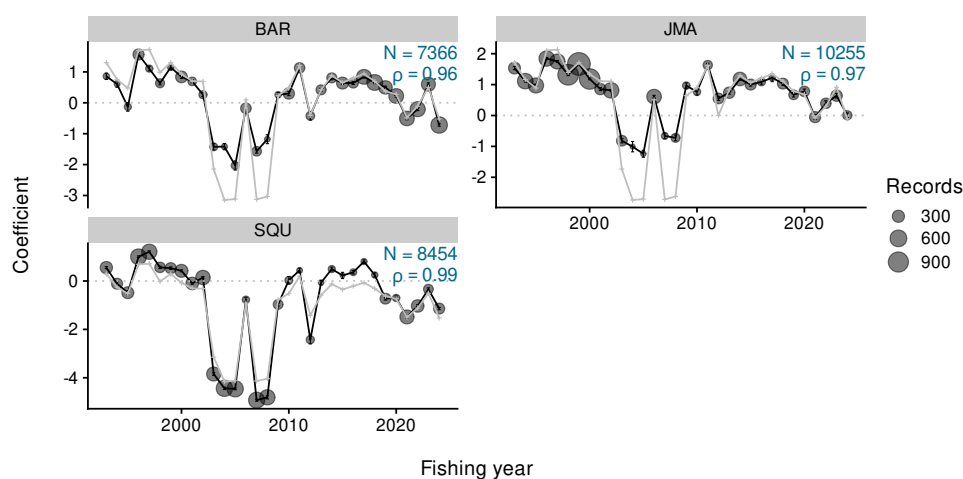


Figure D.28: Residual implied coefficients for target-year in the lognormal positive catch model for the JMA3 MW event (allow effort allocation) dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

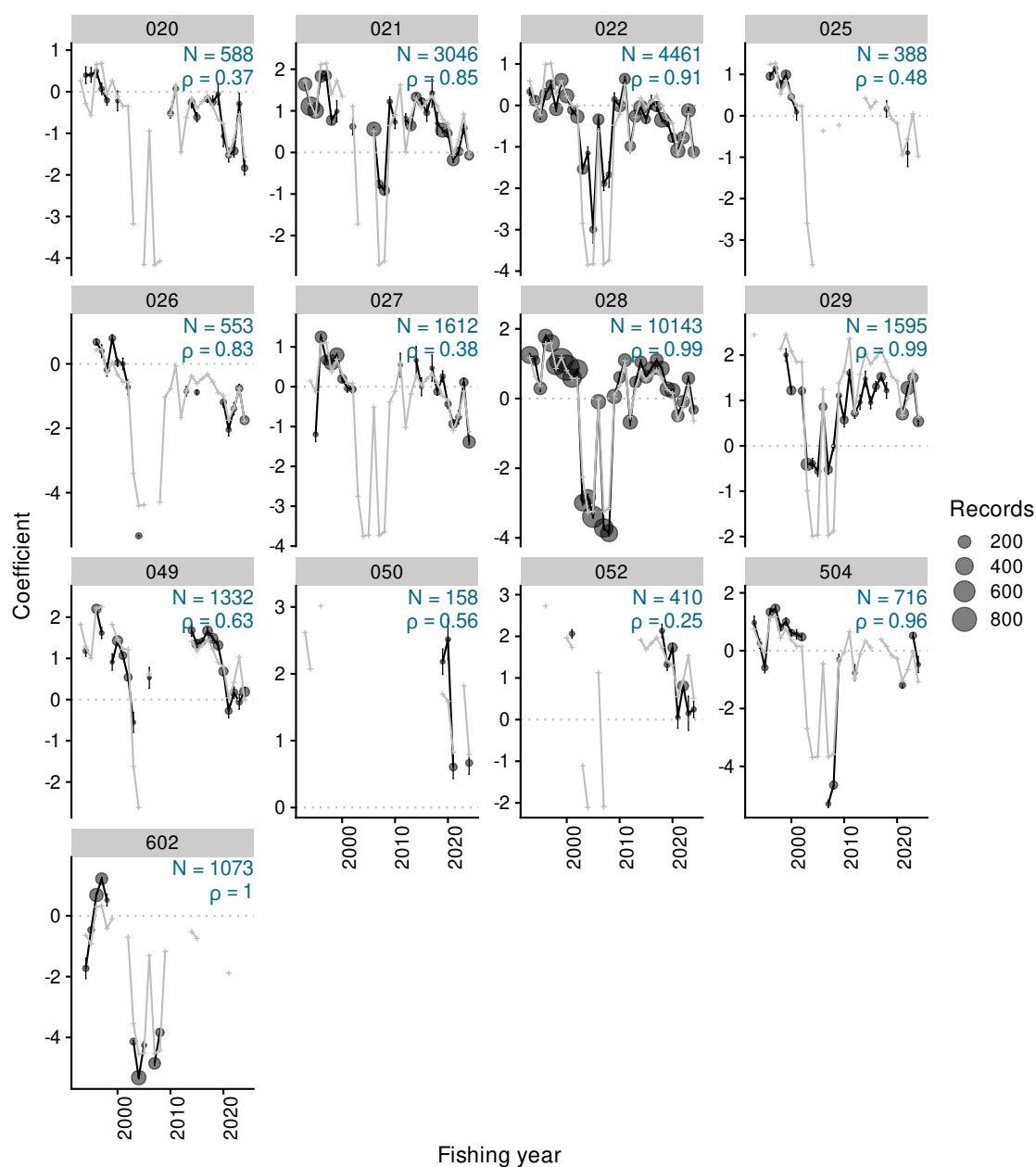


Figure D.29: Residual implied coefficients for area-year in the lognormal positive catch model for the JMA3 MW event (allow effort allocation) dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

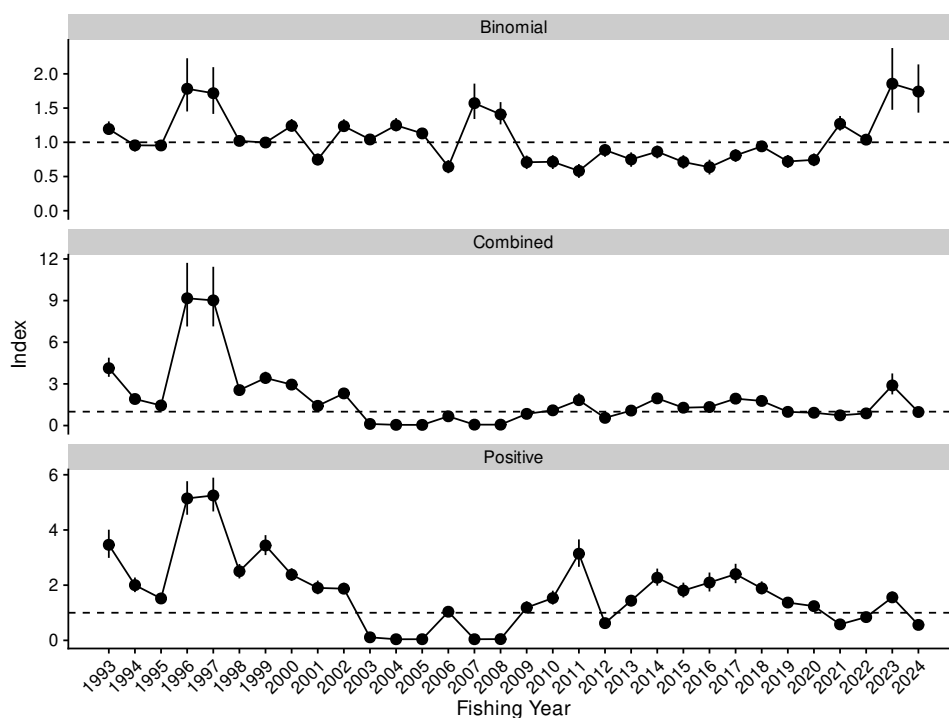


Figure D.30: Standardised indices and 95% confidence intervals for the JMA3 MW event (allow effort allocation) dataset.

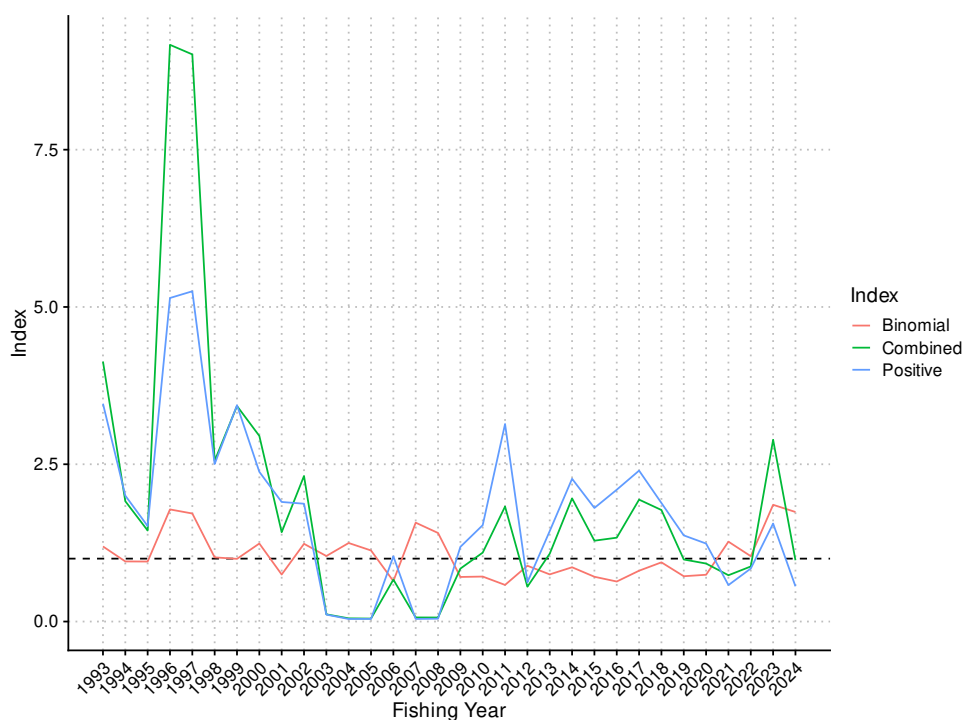


Figure D.31: Standardised indices for the JMA3 MW event (allow effort allocation) dataset.

Table D.6: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW event (allow effort allocation) series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.193	0.050	1.109	1.305	4.133	0.351	3.510	4.887	3.463	0.260	2.989	4.009
1994	0.955	0.042	0.866	1.032	1.913	0.152	1.622	2.216	2.002	0.135	1.747	2.277
1995	0.954	0.039	0.873	1.025	1.447	0.109	1.252	1.680	1.517	0.100	1.331	1.721
1996	1.782	0.198	1.450	2.228	9.167	1.169	7.137	11.718	5.143	0.310	4.552	5.766
1997	1.717	0.174	1.415	2.098	9.014	1.095	7.141	11.436	5.249	0.312	4.671	5.895
1998	1.020	0.037	0.947	1.091	2.554	0.173	2.232	2.911	2.504	0.134	2.242	2.767
1999	0.997	0.032	0.932	1.058	3.426	0.221	3.010	3.877	3.438	0.184	3.090	3.812
2000	1.240	0.047	1.157	1.340	2.950	0.183	2.611	3.327	2.379	0.117	2.154	2.613
2001	0.747	0.043	0.664	0.834	1.420	0.127	1.194	1.692	1.900	0.126	1.670	2.166
2002	1.236	0.047	1.153	1.336	2.314	0.158	2.015	2.635	1.873	0.104	1.678	2.087
2003	1.041	0.036	0.969	1.108	0.115	0.008	0.100	0.132	0.110	0.007	0.097	0.126
2004	1.248	0.049	1.161	1.353	0.051	0.004	0.043	0.059	0.041	0.003	0.035	0.046
2005	1.130	0.035	1.067	1.204	0.047	0.003	0.041	0.054	0.042	0.003	0.036	0.047
2006	0.643	0.049	0.548	0.740	0.667	0.068	0.539	0.807	1.037	0.070	0.910	1.184
2007	1.571	0.132	1.340	1.857	0.065	0.007	0.053	0.079	0.041	0.003	0.036	0.047
2008	1.408	0.083	1.261	1.587	0.064	0.006	0.053	0.077	0.045	0.003	0.039	0.052
2009	0.708	0.050	0.609	0.806	0.841	0.100	0.662	1.055	1.187	0.109	0.991	1.417
2010	0.715	0.051	0.610	0.812	1.096	0.124	0.862	1.349	1.532	0.128	1.296	1.800
2011	0.582	0.052	0.480	0.682	1.827	0.231	1.414	2.319	3.140	0.253	2.665	3.657
2012	0.887	0.047	0.788	0.970	0.554	0.052	0.461	0.663	0.624	0.050	0.535	0.732
2013	0.749	0.053	0.642	0.852	1.078	0.114	0.862	1.309	1.438	0.105	1.235	1.647
2014	0.863	0.048	0.765	0.951	1.958	0.173	1.638	2.316	2.269	0.158	1.982	2.601
2015	0.712	0.050	0.614	0.812	1.285	0.135	1.034	1.562	1.805	0.137	1.554	2.091
2016	0.636	0.055	0.530	0.746	1.333	0.155	1.045	1.654	2.095	0.175	1.770	2.458
2017	0.808	0.047	0.714	0.899	1.938	0.184	1.597	2.318	2.399	0.179	2.071	2.774
2018	0.941	0.041	0.858	1.019	1.773	0.139	1.521	2.066	1.884	0.119	1.670	2.136
2019	0.720	0.048	0.626	0.814	0.986	0.097	0.802	1.181	1.369	0.092	1.199	1.562
2020	0.744	0.047	0.651	0.836	0.922	0.087	0.764	1.106	1.240	0.088	1.078	1.421
2021	1.270	0.054	1.172	1.385	0.736	0.054	0.639	0.851	0.580	0.034	0.518	0.653
2022	1.039	0.040	0.961	1.119	0.875	0.064	0.754	1.005	0.843	0.053	0.745	0.953
2023	1.856	0.230	1.475	2.377	2.889	0.385	2.243	3.753	1.558	0.102	1.368	1.768
2024	1.741	0.180	1.433	2.138	0.975	0.122	0.761	1.241	0.560	0.037	0.491	0.637

D.2 JMA3 MW event (split long vessels)

Table D.7: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW event (split long vessels) CPUE series.

Series	JMA3 MW event (split long vessels)
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	3
Default model	$\text{allockg_top5} \sim \text{fyear} + \text{vessel_key} + \text{target_species} + \text{month} + \text{stat_area} + \text{ns}(\log(\text{fishing_duration}), 3) + \text{ns}(\log(\text{start_time}), 3) + \text{ns}(\log(\text{bottom_depth}), 3) + \text{ns}(\log(\text{effort_height}), 3) + \text{ns}(\text{effort_speed}, 3)$
Stepwise selection	No
Positive catch distribution	Lognormal

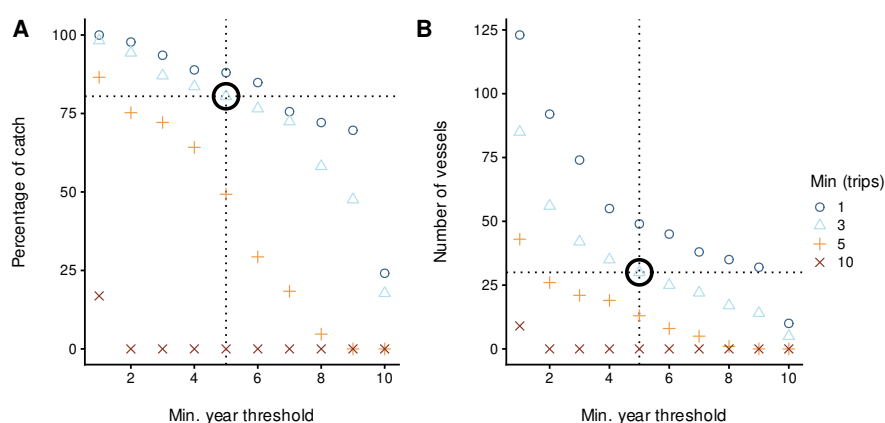


Figure D.32: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW event (split long vessels) CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

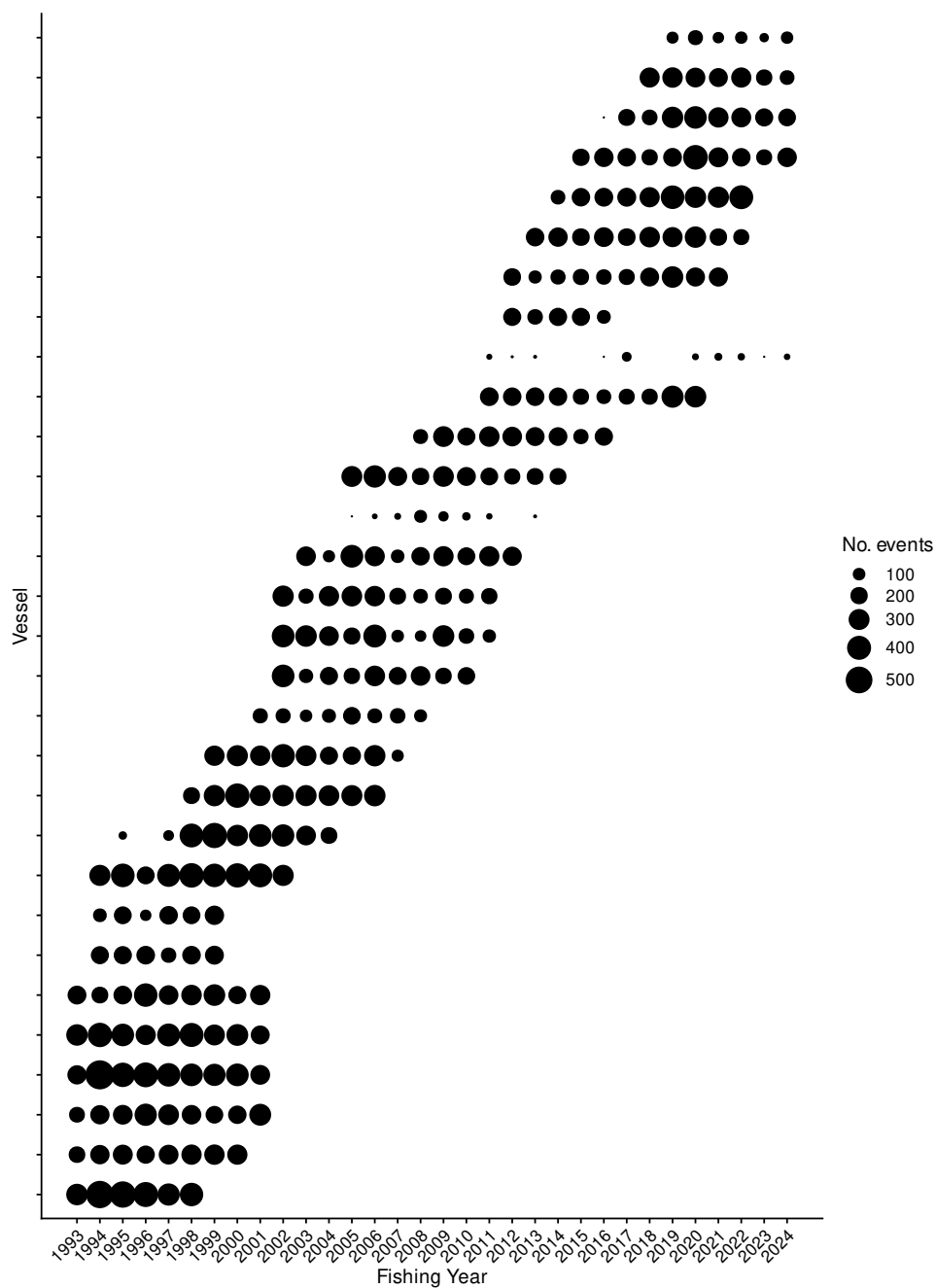


Figure D.33: Number of events by fishing year for core vessels in the JMA3 MW event (split long vessels) series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table D.8: Summary of the JMA3 MW event (split long vessels) dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	9582 (100%) n: 7120	5046 (100%) n: 6431	7167 (100%) n: 7634	13816 (100%) n: 8007	12174 (100%) n: 5773	12098 (100%) n: 5656	14572 (100%) n: 5261	8247 (100%) n: 3762	2001 (100%) n: 3011
Fishing speed not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13810 (100%) n: 7999	12150 (100%) n: 5767	12098 (100%) n: 5652	14570 (100%) n: 5257	8247 (100%) n: 3762	2001 (100%) n: 3010
Fishing speed lt 10kts	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
Start date not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
End date not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
Start depth not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7960	12122 (100%) n: 5739	11950 (99%) n: 5634	14548 (100%) n: 5245	8246 (100%) n: 3759	1998 (100%) n: 3000
Headline height not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13746 (99%) n: 7811	12120 (100%) n: 5731	11948 (99%) n: 5623	14531 (100%) n: 5238	8236 (100%) n: 3755	1998 (100%) n: 2999
Fishing speed >3.5kn	9203 (96%) n: 6839	5017 (99%) n: 6143	7114 (99%) n: 7490	13660 (99%) n: 7520	12039 (99%) n: 5480	11904 (98%) n: 5399	14418 (99%) n: 5123	8176 (99%) n: 3702	1988 (99%) n: 2985
Headline height >15m	9180 (96%) n: 6818	4980 (99%) n: 6093	7064 (99%) n: 7447	13389 (97%) n: 7414	11960 (98%) n: 5394	11866 (98%) n: 5374	14363 (99%) n: 5027	8170 (99%) n: 3692	1987 (99%) n: 2978
Headline height <90m	8535 (89%) n: 6666	4946 (98%) n: 6091	7064 (99%) n: 7447	13377 (97%) n: 7403	10684 (88%) n: 5191	10849 (90%) n: 4986	14312 (98%) n: 5013	8158 (99%) n: 3682	1987 (99%) n: 2977
Fishing duration >15mins	8398 (88%) n: 6634	4929 (98%) n: 6074	7031 (98%) n: 7430	13264 (96%) n: 7374	10609 (87%) n: 5175	10833 (90%) n: 4972	14303 (98%) n: 5002	8158 (99%) n: 3679	1987 (99%) n: 2970
Fishing duration <15h	8380 (87%) n: 6616	4918 (97%) n: 6057	7006 (98%) n: 7421	13224 (96%) n: 7356	10435 (86%) n: 5144	10791 (89%) n: 4957	14263 (98%) n: 4993	8098 (98%) n: 3660	1987 (99%) n: 2970
Seabed depth >50m	8380 (87%) n: 6616	4918 (97%) n: 6057	7006 (98%) n: 7420	13224 (96%) n: 7356	10435 (86%) n: 5144	10768 (89%) n: 4954	14263 (98%) n: 4992	8098 (98%) n: 3659	1987 (99%) n: 2970
Seabed depth <350m	8344 (87%) n: 6577	4906 (97%) n: 6017	6996 (98%) n: 7243	13197 (96%) n: 7327	10398 (85%) n: 5131	10756 (89%) n: 4950	14231 (98%) n: 4969	8096 (98%) n: 3649	1982 (99%) n: 2967
Start time >0	8004 (84%) n: 6515	4803 (95%) n: 5975	6792 (95%) n: 7172	12752 (92%) n: 7235	10050 (83%) n: 5077	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3627	1958 (98%) n: 2956
SA subset	8004 (84%) n: 6515	4803 (95%) n: 5975	6792 (95%) n: 7172	12752 (92%) n: 7235	10050 (83%) n: 5077	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3627	1958 (98%) n: 2956
No effort allocation	7991 (83%) n: 6469	4743 (94%) n: 5846	6770 (94%) n: 7039	12752 (92%) n: 7235	10050 (83%) n: 5076	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3623	1958 (98%) n: 2956
Core fleet selection	3868 (40%) n: 1473	3756 (74%) n: 2875	4647 (65%) n: 2886	8064 (58%) n: 2623	7052 (58%) n: 2732	7978 (66%) n: 3413	9793 (67%) n: 3370	7201 (87%) n: 2852	1833 (92%) n: 2605

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed lt 10kts	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Start date not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
End date not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Start depth not null	3661 (100%) n: 3306	1681 (100%) n: 3109	528 (100%) n: 3279	570 (100%) n: 3636	4607 (100%) n: 2831	1445 (100%) n: 2412	2235 (100%) n: 2249	1800 (100%) n: 2188	2226 (100%) n: 1316
Headline height not null	3661 (100%) n: 3306	1681 (100%) n: 3109	528 (100%) n: 3279	570 (100%) n: 3636	4607 (100%) n: 2831	1445 (100%) n: 2412	2235 (100%) n: 2249	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed >3.5kn	3659 (100%) n: 3266	1671 (99%) n: 3064	526 (100%) n: 3168	570 (100%) n: 3521	4601 (100%) n: 2794	1443 (100%) n: 2380	2205 (99%) n: 2225	1751 (97%) n: 2133	2226 (100%) n: 1303
Headline height >15m	3614 (99%) n: 3243	1669 (99%) n: 3046	519 (98%) n: 3151	570 (100%) n: 3513	4601 (100%) n: 2790	1443 (100%) n: 2359	2205 (99%) n: 2208	1741 (97%) n: 2129	2225 (100%) n: 1300
Headline height <90m	3614 (99%) n: 3243	1669 (99%) n: 3046	516 (98%) n: 3150	570 (100%) n: 3513	4601 (100%) n: 2789	1443 (100%) n: 2359	2205 (99%) n: 2207	1741 (97%) n: 2129	2225 (100%) n: 1300
Fishing duration >15mins	3575 (98%) n: 3229	1669 (99%) n: 3041	516 (98%) n: 3141	570 (100%) n: 3502	4598 (100%) n: 2782	1442 (100%) n: 2354	2204 (99%) n: 2201	1741 (97%) n: 2127	2225 (100%) n: 1298
Fishing duration <15h	3574 (98%) n: 3226	1664 (99%) n: 3040	516 (98%) n: 3139	570 (100%) n: 3502	4598 (100%) n: 2780	1442 (100%) n: 2353	2192 (98%) n: 2198	1740 (97%) n: 2123	2225 (100%) n: 1297
Seabed depth >50m	3569 (97%) n: 3224	1664 (99%) n: 3040	516 (98%) n: 3139	570 (100%) n: 3502	4598 (100%) n: 2780	1442 (100%) n: 2353	2192 (98%) n: 2198	1740 (97%) n: 2123	2225 (100%) n: 1297
Seabed depth <350m	3564 (97%) n: 3222	1664 (99%) n: 3036	516 (98%) n: 3135	570 (100%) n: 3501	4598 (100%) n: 2779	1442 (100%) n: 2351	2192 (98%) n: 2196	1722 (96%) n: 2121	2225 (100%) n: 1296
Start time >0	3500 (96%) n: 3198	1639 (98%) n: 3028	509 (96%) n: 3120	556 (98%) n: 3459	4508 (98%) n: 2766	1402 (97%) n: 2334	2166 (97%) n: 2185	1660 (92%) n: 2109	2181 (98%) n: 1283
SA subset	3500 (96%) n: 3198	1639 (98%) n: 3028	509 (96%) n: 3120	556 (98%) n: 3459	4508 (98%) n: 2766	1402 (97%) n: 2334	2166 (97%) n: 2185	1660 (92%) n: 2109	2181 (98%) n: 1283
No effort allocation	3500 (96%) n: 3196	1638 (97%) n: 2489	507 (96%) n: 2363	555 (97%) n: 2582	4508 (98%) n: 2593	1399 (97%) n: 1705	2162 (97%) n: 1590	1654 (92%) n: 1991	2181 (98%) n: 1263
Core fleet selection	3319 (91%) n: 2512	1436 (85%) n: 1829	496 (94%) n: 1689	545 (96%) n: 2058	4453 (97%) n: 2349	1164 (81%) n: 1139	1912 (86%) n: 1274	1209 (67%) n: 1625	2159 (97%) n: 1235

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5024 (100%) n: 1678	4301 (100%) n: 2307
Fishing speed not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5024 (100%) n: 1678	4301 (100%) n: 2307
Fishing speed lt 10kts	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Start date not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
End date not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Start depth not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Headline height not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Fishing speed >3.5kn	3389 (100%) n: 1414	2668 (99%) n: 1465	3486 (100%) n: 1229	4347 (100%) n: 1456	3621 (100%) n: 1382	2507 (100%) n: 1506	4141 (100%) n: 1359	4995 (99%) n: 1625	4293 (100%) n: 2269
Headline height >15m	3341 (98%) n: 1397	2668 (99%) n: 1464	3486 (100%) n: 1229	4347 (100%) n: 1456	3618 (100%) n: 1380	2507 (100%) n: 1506	4102 (99%) n: 1356	4995 (99%) n: 1625	4293 (100%) n: 2263
Headline height <90m	3341 (98%) n: 1397	2668 (99%) n: 1463	3486 (100%) n: 1229	4347 (100%) n: 1456	3618 (100%) n: 1380	2507 (100%) n: 1506	4102 (99%) n: 1356	4994 (99%) n: 1624	4293 (100%) n: 2263
Fishing duration >15mins	3339 (98%) n: 1396	2668 (99%) n: 1459	3482 (100%) n: 1224	4347 (100%) n: 1451	3618 (100%) n: 1379	2507 (100%) n: 1501	4102 (99%) n: 1354	4994 (99%) n: 1624	4293 (100%) n: 2260
Fishing duration <15h	3339 (98%) n: 1394	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2507 (100%) n: 1500	4102 (99%) n: 1354	4994 (99%) n: 1624	4279 (99%) n: 2257
Seabed depth >50m	3339 (98%) n: 1394	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2507 (100%) n: 1500	4102 (99%) n: 1354	4994 (99%) n: 1624	4279 (99%) n: 2257
Seabed depth <350m	3339 (98%) n: 1392	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2506 (100%) n: 1494	4102 (99%) n: 1354	4994 (99%) n: 1623	4279 (99%) n: 2256
Start time >0	3297 (97%) n: 1384	2658 (99%) n: 1453	3439 (99%) n: 1217	4181 (96%) n: 1440	3556 (98%) n: 1371	2454 (98%) n: 1486	4034 (97%) n: 1350	4979 (99%) n: 1617	4279 (99%) n: 2252
SA subset	3297 (97%) n: 1384	2658 (99%) n: 1453	3439 (99%) n: 1217	4181 (96%) n: 1440	3556 (98%) n: 1371	2454 (98%) n: 1486	4034 (97%) n: 1350	4979 (99%) n: 1617	4279 (99%) n: 2252
No effort allocation	3297 (97%) n: 1384	2657 (99%) n: 1390	3438 (99%) n: 1216	4181 (96%) n: 1438	3556 (98%) n: 1371	2431 (97%) n: 1450	4034 (97%) n: 1337	4979 (99%) n: 1616	4279 (99%) n: 2252
Core fleet selection	3290 (97%) n: 1342	2653 (99%) n: 1347	3378 (97%) n: 1181	4171 (96%) n: 1422	3544 (98%) n: 1363	2386 (95%) n: 1413	4008 (97%) n: 1270	4965 (99%) n: 1599	4278 (99%) n: 2247

Filter	2020	2021	2022	2023	2024
Ungroomed data	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Fishing speed not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Fishing speed lt 10kts	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Start date not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
End date not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Start depth not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Headline height not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Fishing speed >3.5kn	4458 (100%) n: 2430	5242 (100%) n: 1919	4624 (100%) n: 1794	4760 (100%) n: 1037	3025 (99%) n: 1342
Headline height >15m	4451 (100%) n: 2426	5242 (100%) n: 1917	4624 (100%) n: 1792	4760 (100%) n: 1035	3014 (99%) n: 1336
Headline height <90m	4451 (100%) n: 2426	5242 (100%) n: 1917	4624 (100%) n: 1792	4760 (100%) n: 1035	3014 (99%) n: 1336
Fishing duration >15mins	4451 (100%) n: 2421	5195 (99%) n: 1912	4624 (100%) n: 1785	4759 (100%) n: 1032	3014 (99%) n: 1331
Fishing duration <15h	4451 (100%) n: 2421	5191 (99%) n: 1910	4624 (100%) n: 1785	4756 (100%) n: 1031	3014 (99%) n: 1330
Seabed depth >50m	4451 (100%) n: 2421	5191 (99%) n: 1910	4624 (100%) n: 1784	4756 (100%) n: 1031	3014 (99%) n: 1330
Seabed depth <350m	4451 (100%) n: 2419	5191 (99%) n: 1910	4624 (100%) n: 1783	4756 (100%) n: 1030	3014 (99%) n: 1329
Start time >0	4449 (100%) n: 2415	5026 (96%) n: 1902	4607 (100%) n: 1781	4746 (100%) n: 1029	3013 (99%) n: 1326
SA subset	4449 (100%) n: 2415	5026 (96%) n: 1902	4607 (100%) n: 1781	4746 (100%) n: 1029	3013 (99%) n: 1326
No effort allocation	4449 (100%) n: 2414	5026 (96%) n: 1898	4607 (100%) n: 1775	4746 (100%) n: 1029	3013 (99%) n: 1306
Core fleet selection	4444 (100%) n: 2408	4604 (88%) n: 1668	3899 (84%) n: 1472	2657 (56%) n: 619	1038 (34%) n: 733

Table D.9: Summary of the JMA3 MW event (split long vessels) dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	6	59	1 473	3 669.30	3 868.49	53.77
1994	9	55	2 875	7 453.37	3 756.16	31.20
1995	10	55	2 886	8 214.83	4 646.81	30.60
1996	9	45	2 623	7 579.95	8 064.31	55.81
1997	10	39	2 732	8 218.82	7 051.89	47.51
1998	11	51	3 413	9 877.73	7 977.59	42.69
1999	11	48	3 370	11 282.92	9 792.67	51.28
2000	9	42	2 852	9 159.20	7 201.32	61.33
2001	9	37	2 605	8 865.63	1 832.60	28.37
2002	8	30	2 512	8 148.58	3 319.07	40.76
2003	8	33	1 829	6 531.45	1 435.60	19.79
2004	8	22	1 689	6 398.73	495.67	9.95
2005	9	29	2 058	7 498.33	545.47	10.25
2006	9	37	2 349	9 411.95	4 452.65	32.82
2007	8	29	1 139	5 092.85	1 164.44	23.44
2008	8	30	1 274	6 309.78	1 912.40	19.00
2009	7	40	1 625	8 041.22	1 209.00	13.91
2010	7	29	1 235	5 513.48	2 158.85	39.68
2011	8	28	1 342	6 110.85	3 289.56	34.43
2012	7	28	1 347	5 869.87	2 653.23	31.85
2013	8	27	1 181	5 027.15	3 378.09	43.44
2014	7	36	1 422	6 230.98	4 171.12	46.84
2015	7	37	1 363	6 244.58	3 544.22	41.60
2016	9	49	1 413	6 321.38	2 385.74	26.04
2017	7	32	1 270	6 797.15	4 007.50	49.84
2018	7	33	1 599	7 557.02	4 965.42	52.47
2019	8	41	2 247	10 380.50	4 278.47	38.36
2020	9	52	2 408	11 137.45	4 443.54	36.13
2021	8	39	1 668	7 673.87	4 604.15	64.15
2022	7	38	1 472	6 971.50	3 899.41	67.87
2023	5	17	619	3 001.08	2 656.91	89.01
2024	5	24	733	3 373.00	1 037.60	89.63

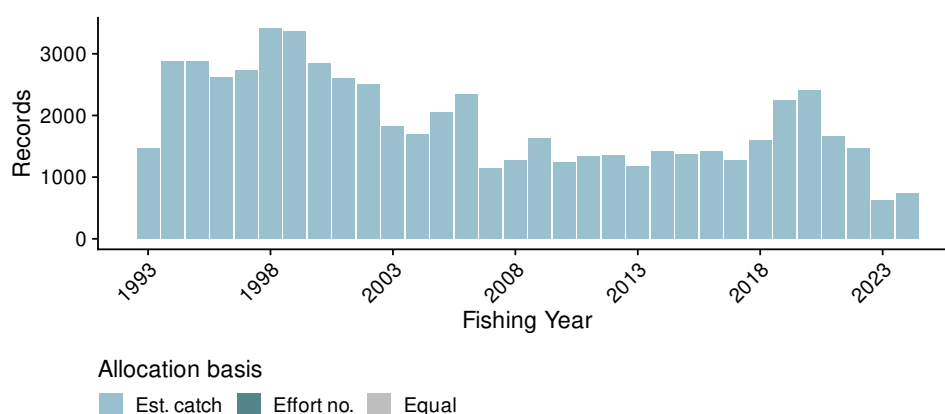


Figure D.34: The allocation approach used for attributing catches to records in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.10: Summary table for occurrence of positive catch in the JMA3 MW event (split long vessels) series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	81 605.86	0.00	0.00	*
fyear	31	74 463.01	8.83	8.83	*
vessel_key	29	72 863.27	10.86	2.03	*
target_species	2	53 424.76	34.69	23.83	*
month	11	52 476.80	35.87	1.19	*
stat_area	12	48 557.89	40.71	4.83	*
ns(log(fishing_duration), 3)	3	48 529.09	40.75	0.04	*
ns(log(start_time), 3)	3	48 392.61	40.92	0.17	*
ns(log(bottom_depth), 3)	3	47 420.24	42.12	1.20	*
ns(log(effort_height), 3)	3	47 402.88	42.15	0.03	*
ns(effort_speed, 3)	3	46 831.42	42.86	0.71	*

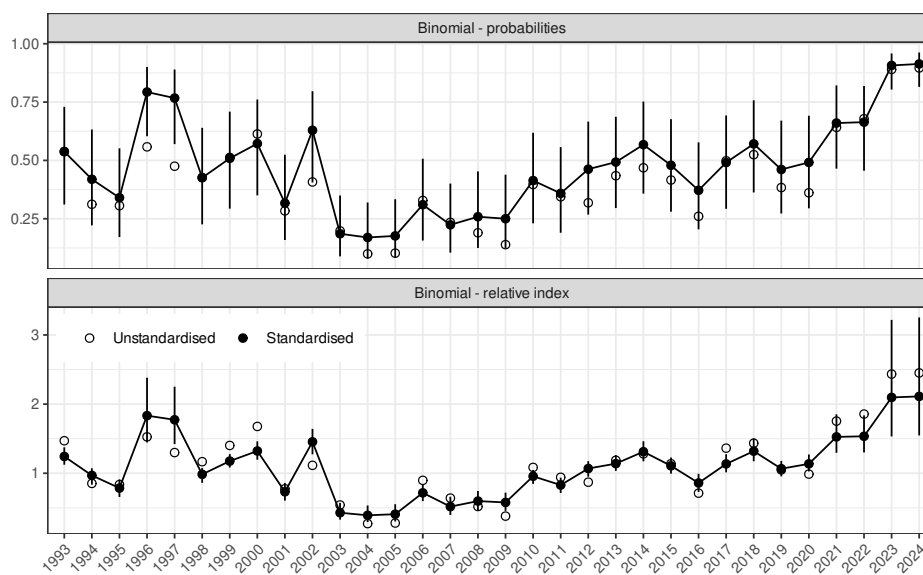


Figure D.35: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW event (split long vessels) dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

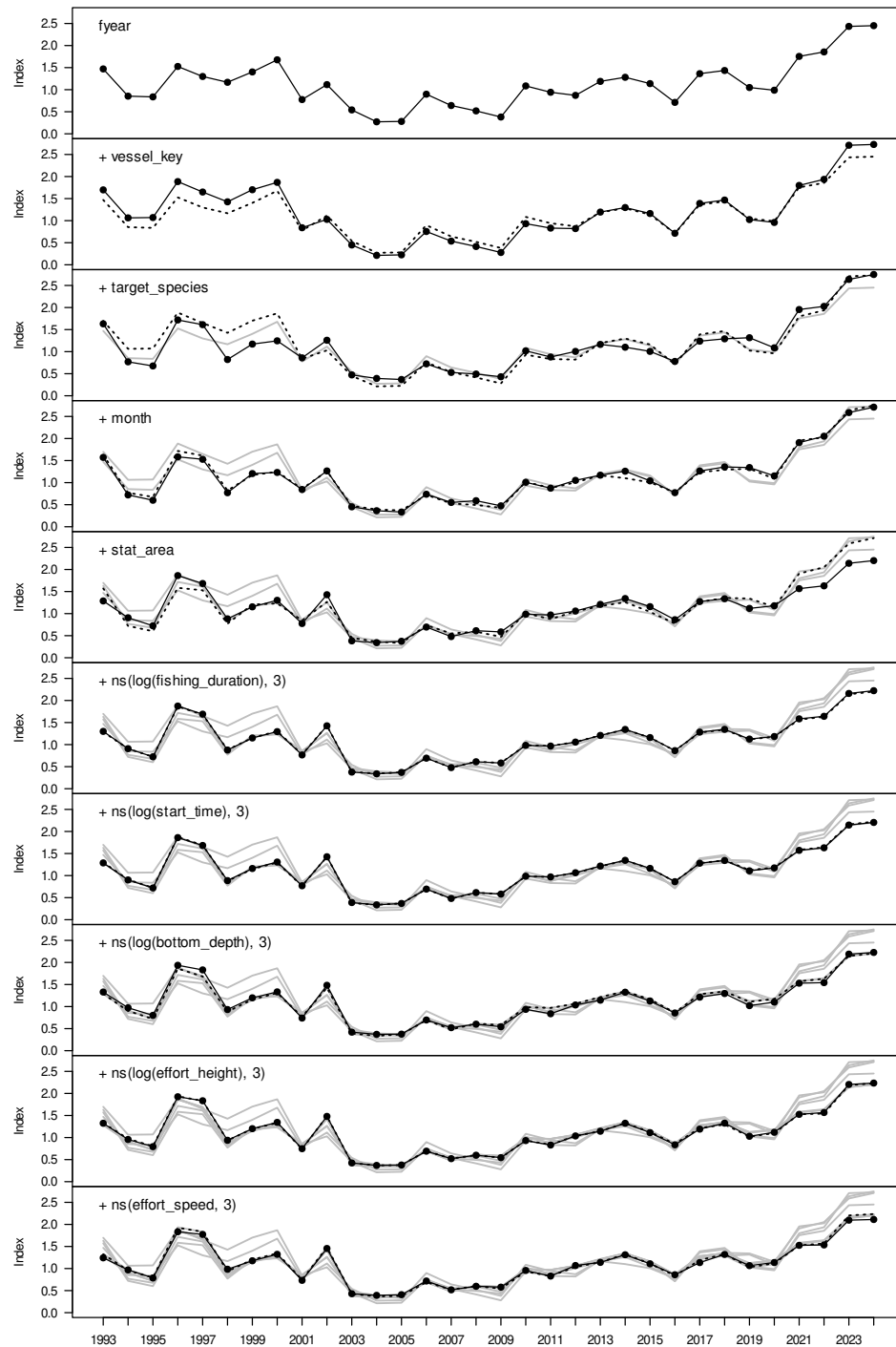


Figure D.36: Step plot for occurrence of catch in the JMA3 MW event (split long vessels) dataset.

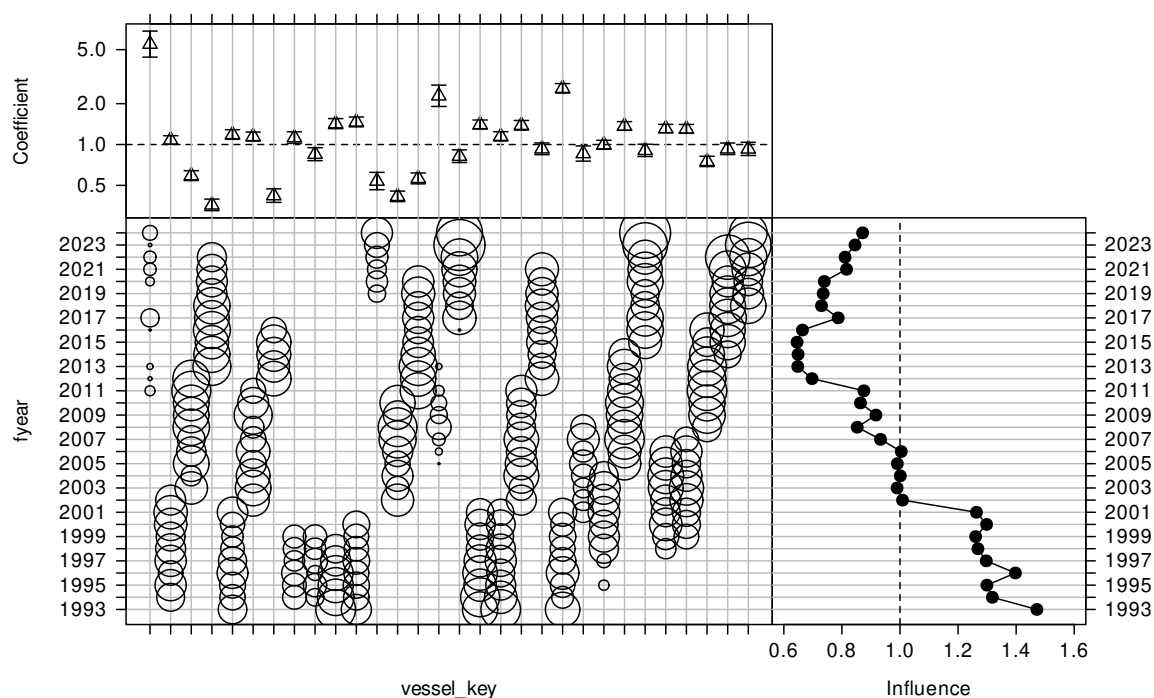


Figure D.37: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

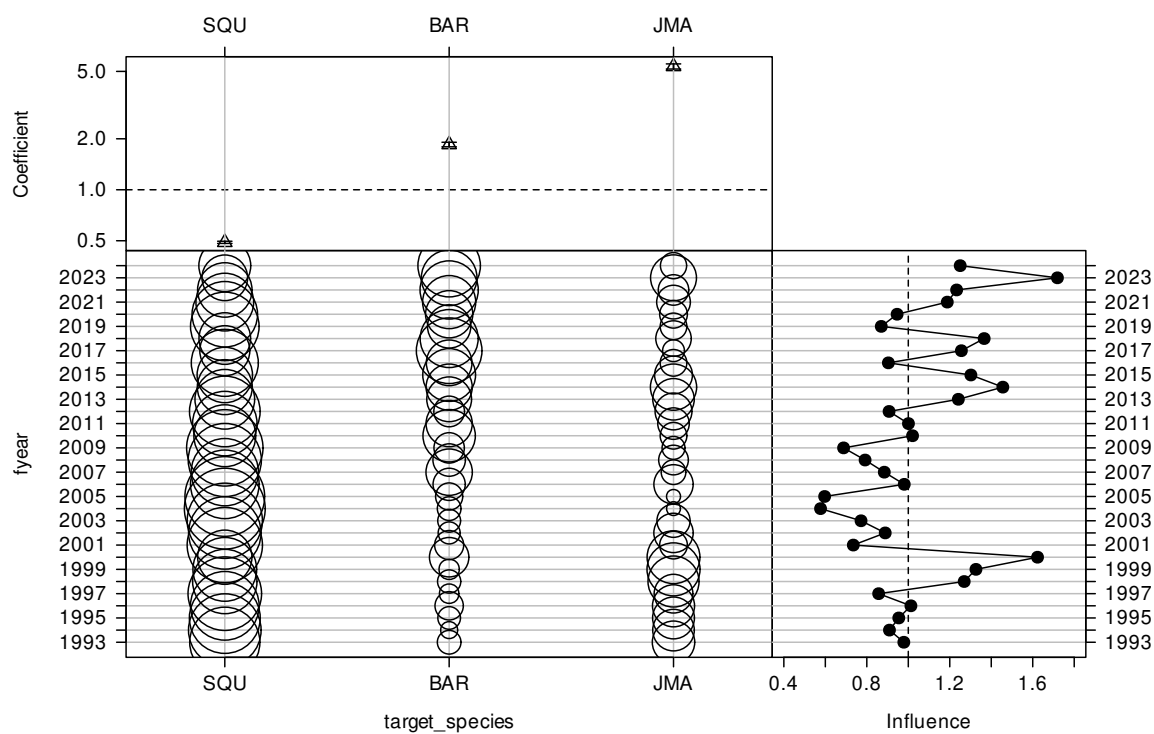


Figure D.38: CDI plot for target species for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

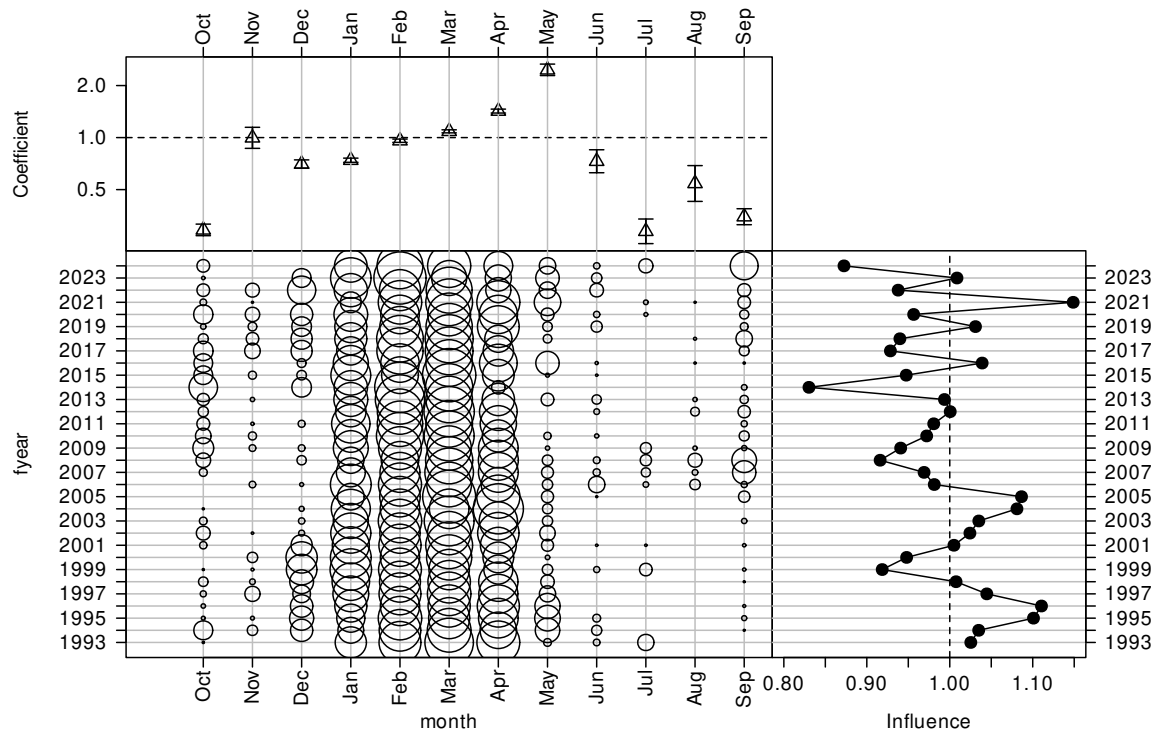


Figure D.39: CDI plot for month for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

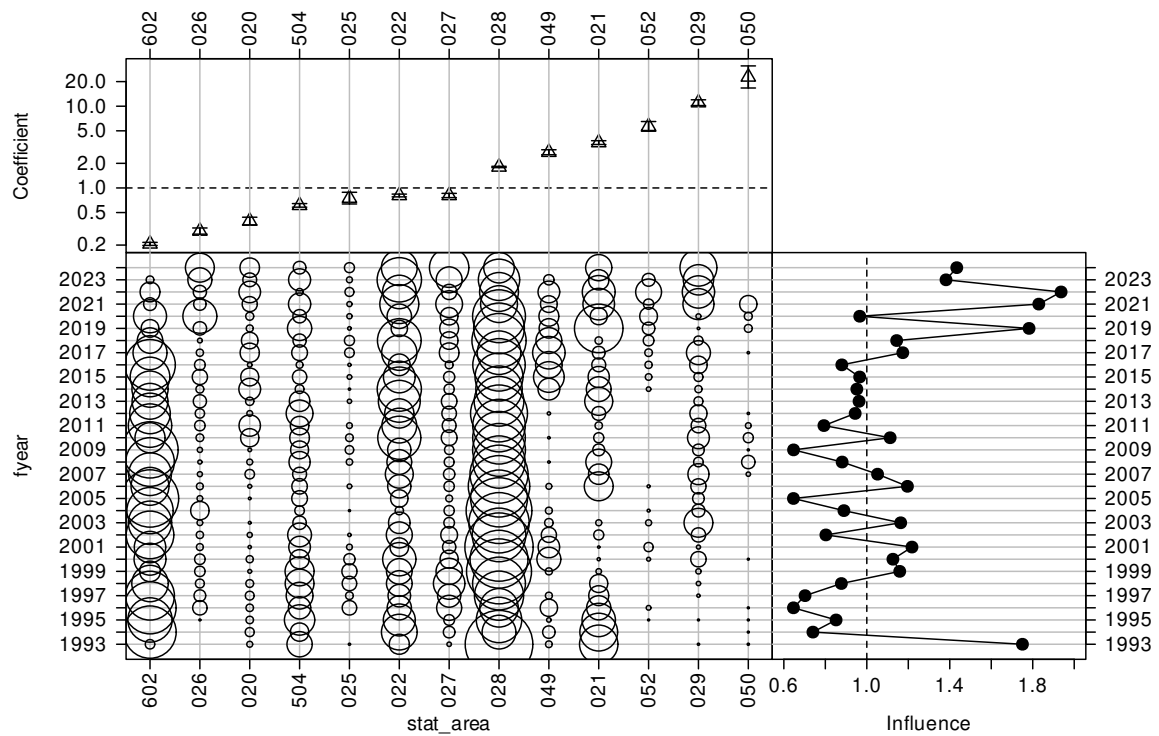


Figure D.40: CDI plot for statistical area for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

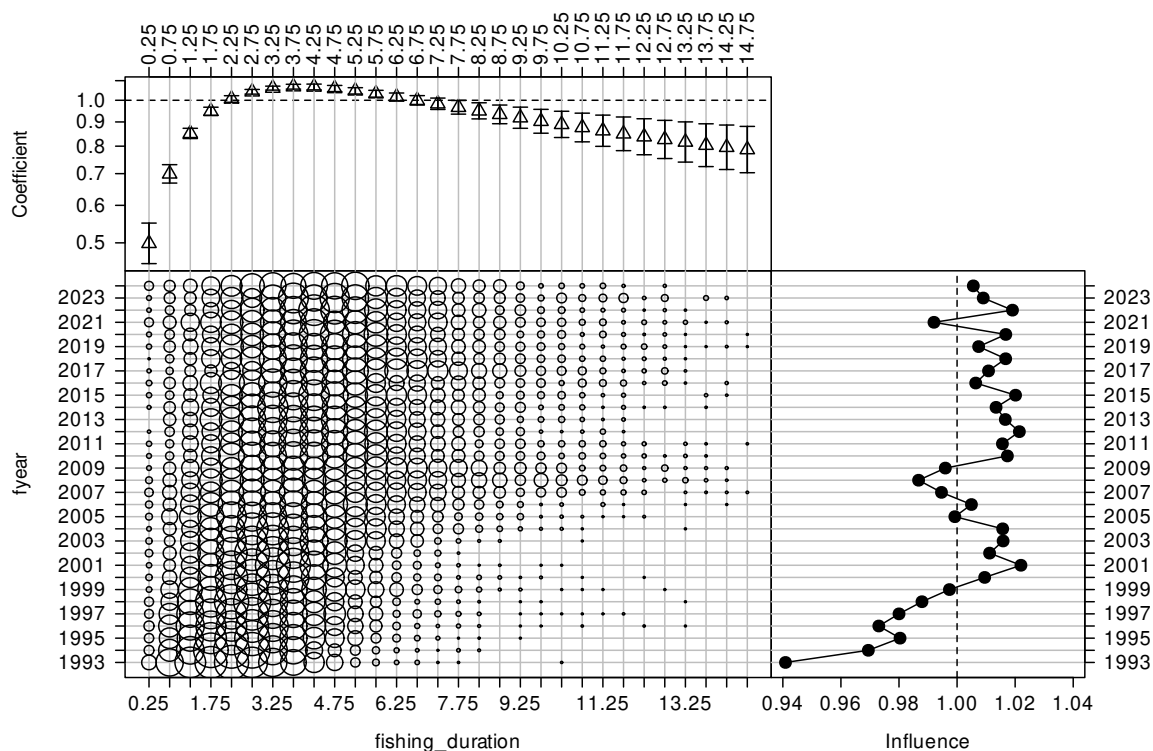


Figure D.41: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

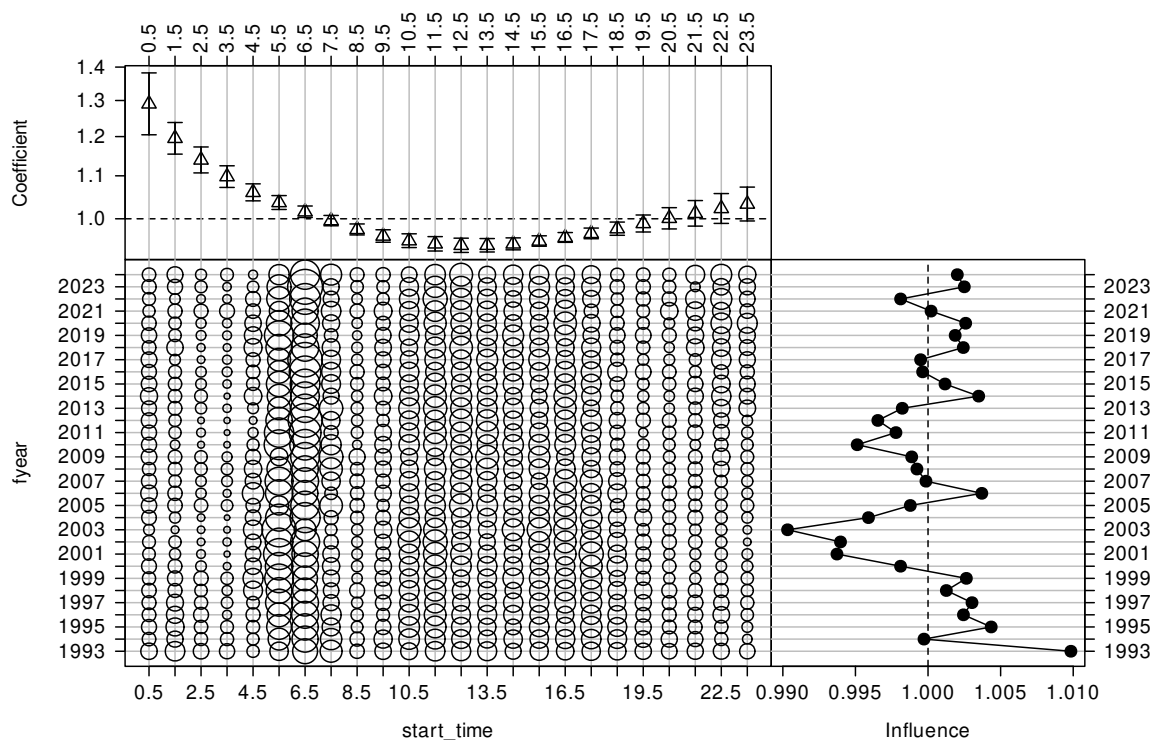


Figure D.42: CDI plot for start time for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

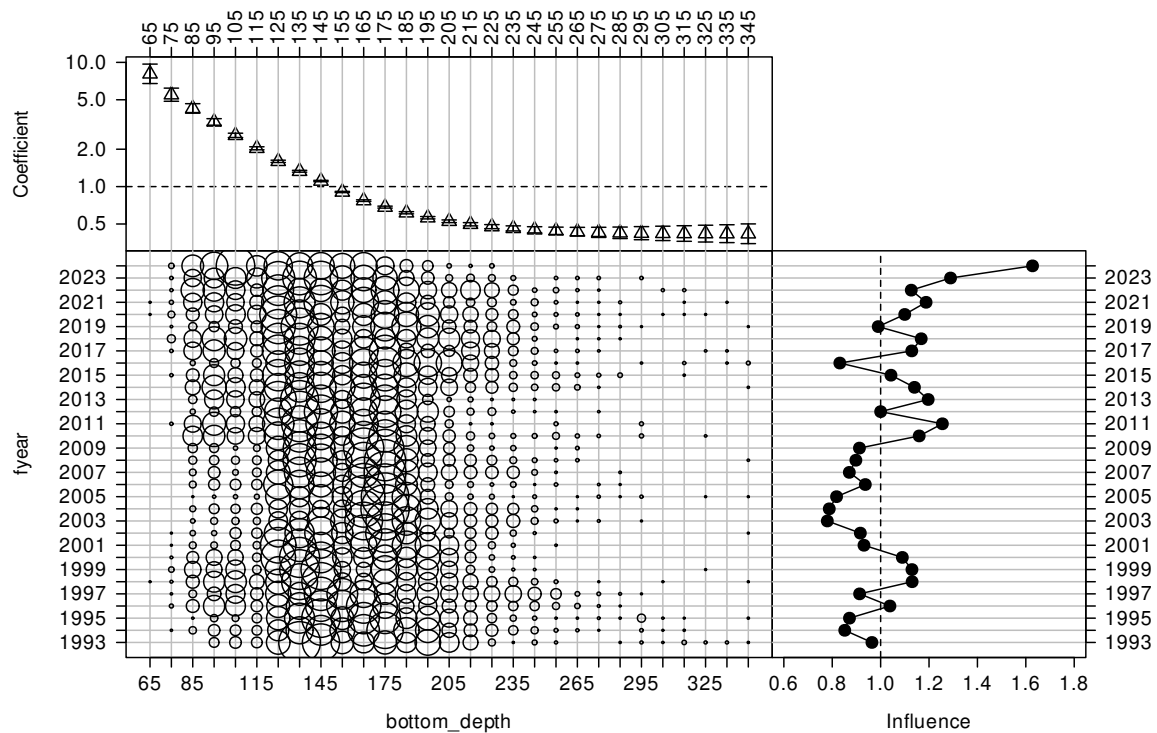


Figure D.43: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

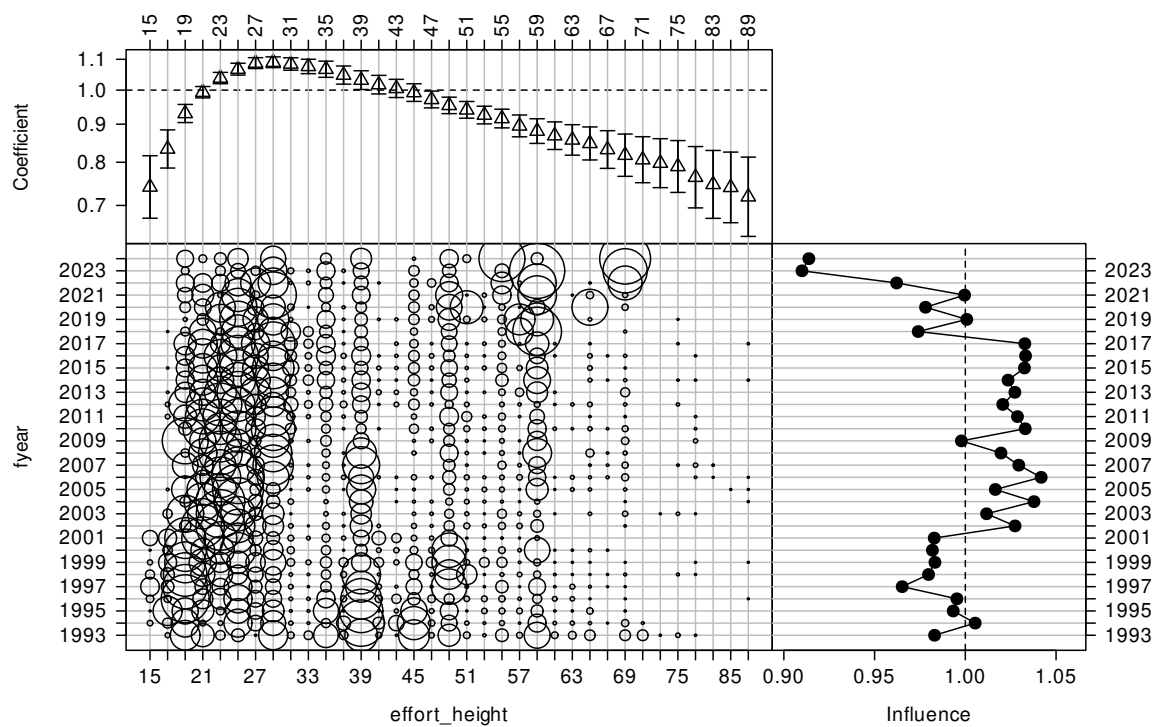


Figure D.44: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

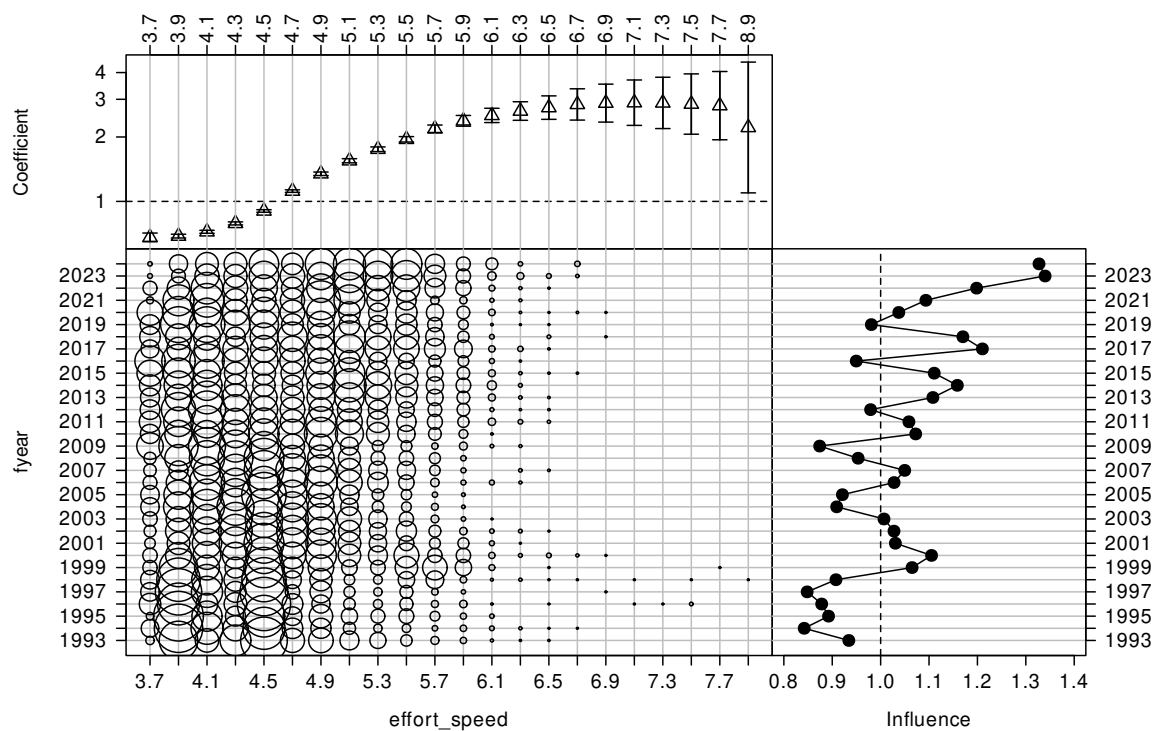


Figure D.45: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

Table D.11: Summary table for the lognormal model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	93 804.77	0.00	0.00	*
fyear	31	92 206.47	6.62	6.62	*
vessel_key	29	90 283.08	13.94	7.33	*
target_species	2	87 717.66	22.59	8.65	*
month	11	87 414.48	23.62	1.03	*
stat_area	12	86 751.83	25.76	2.13	*
ns(log(fishing_duration), 3)	3	86 675.22	26.01	0.25	*
ns(log(start_time), 3)	3	86 519.49	26.50	0.49	*
ns(log(bottom_depth), 3)	3	86 271.98	27.26	0.76	*
ns(log(effort_height), 3)	3	86 096.48	27.81	0.54	*
ns(effort_speed, 3)	3	85 930.65	28.32	0.51	*

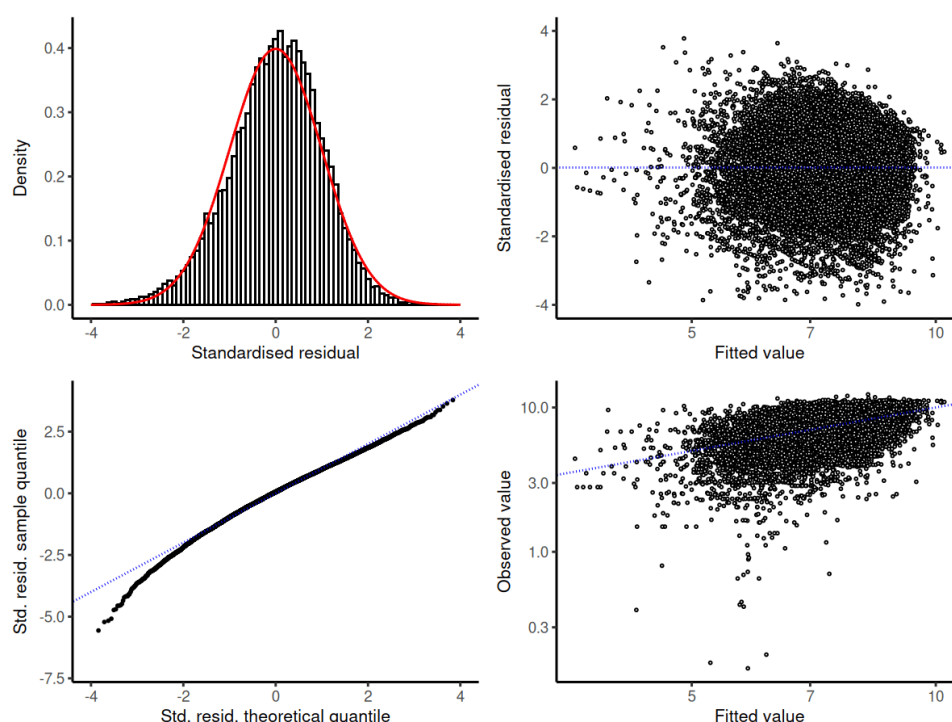


Figure D.46: Diagnostic plots for the selected lognormal model for positive catches in the JMA3 MW event (split long vessels) dataset.

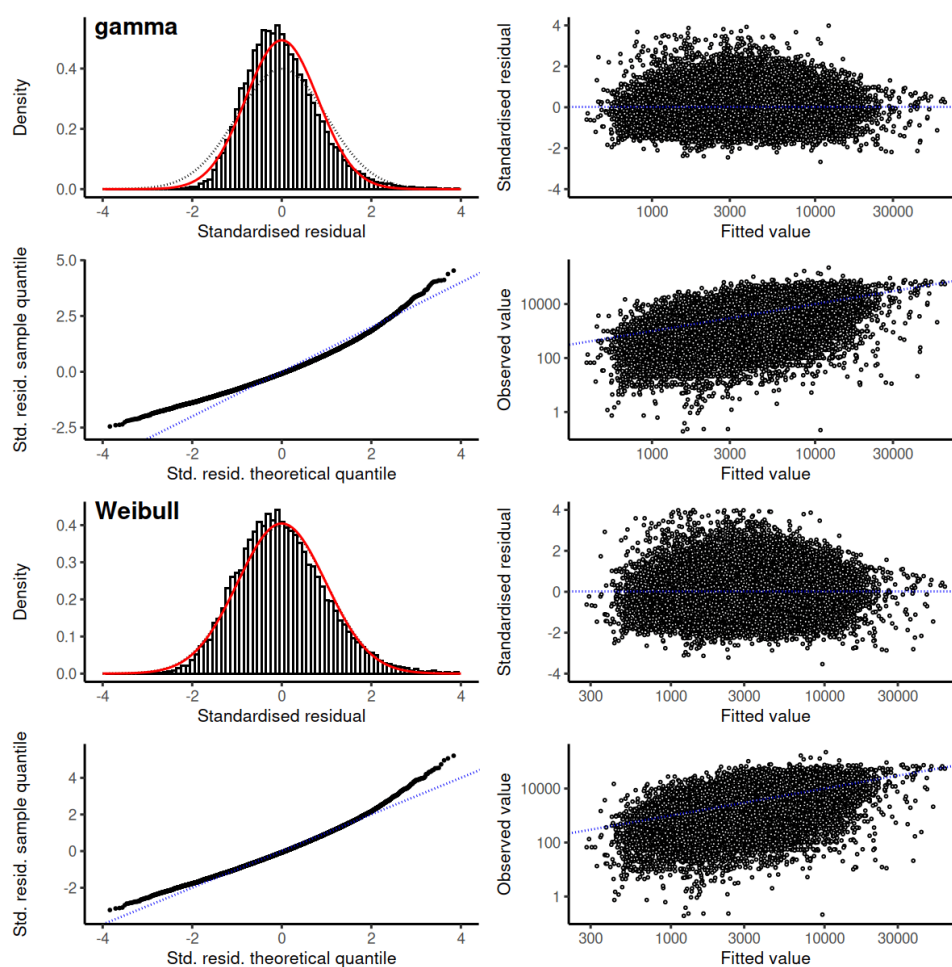


Figure D.47: Diagnostic plots for the alternative gamma and Weibull models considered for positive catches in the JMA3 MW event (split long vessels) dataset.

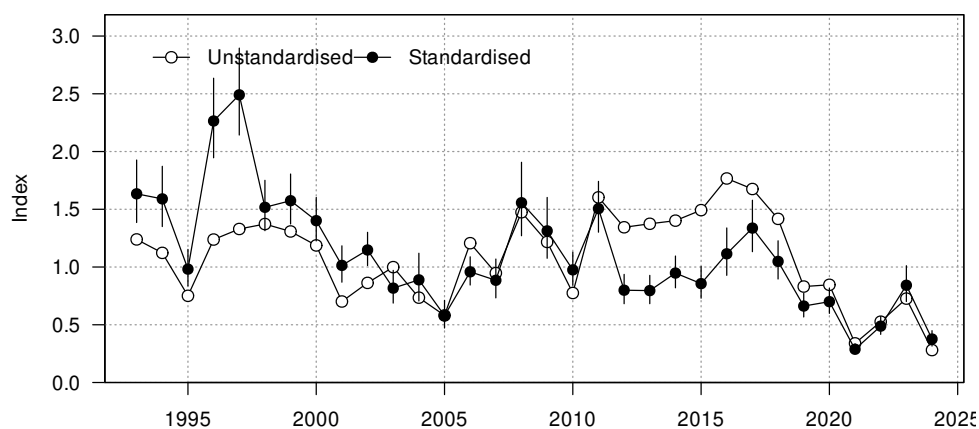


Figure D.48: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the lognormal model for the JMA3 MW event (split long vessels) dataset.

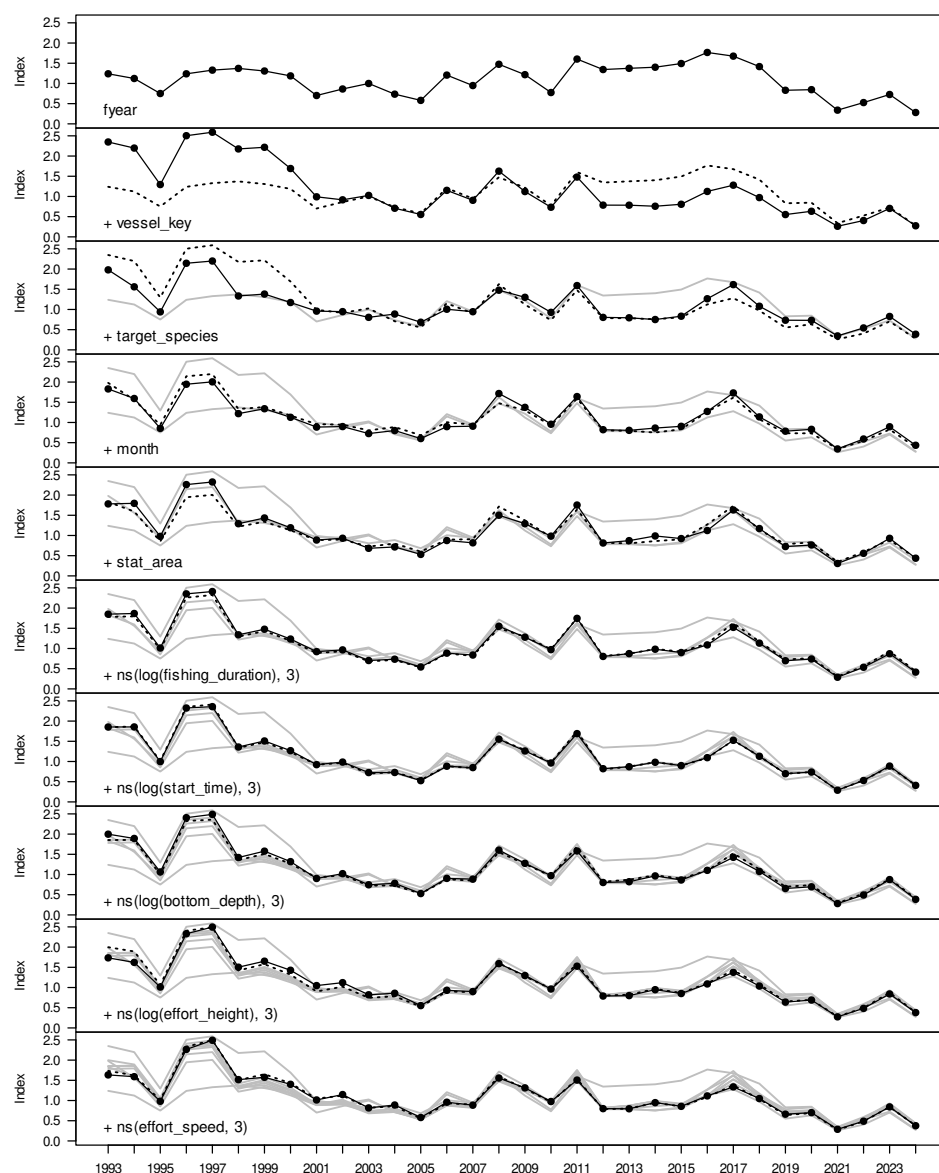


Figure D.49: Changes to the JMA3 MW event (split long vessels) positive catch index as terms are successively entered into the lognormal model.

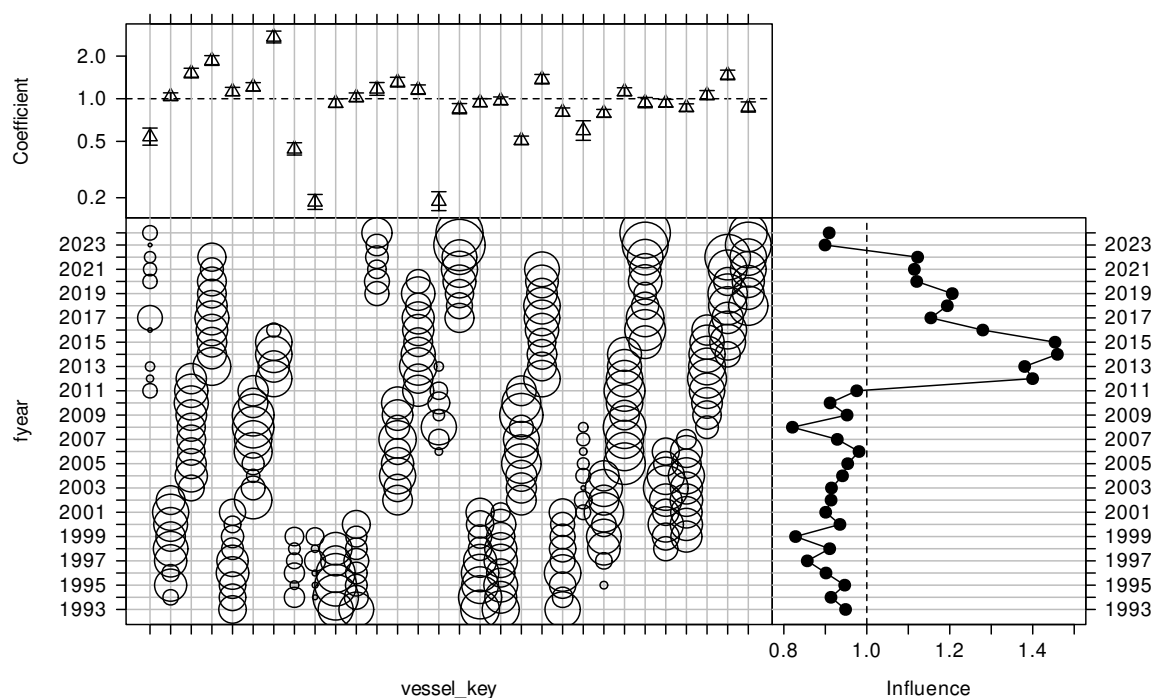


Figure D.50: CDI plot for vessel key for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

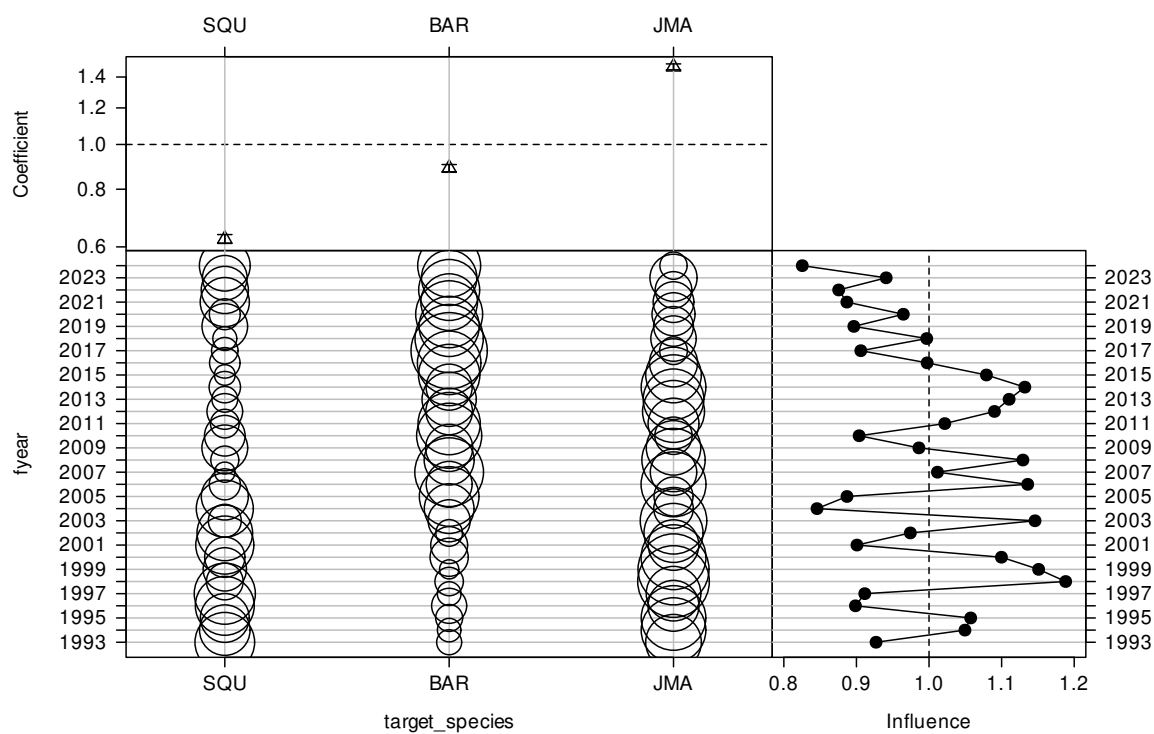


Figure D.51: CDI plot for target species for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

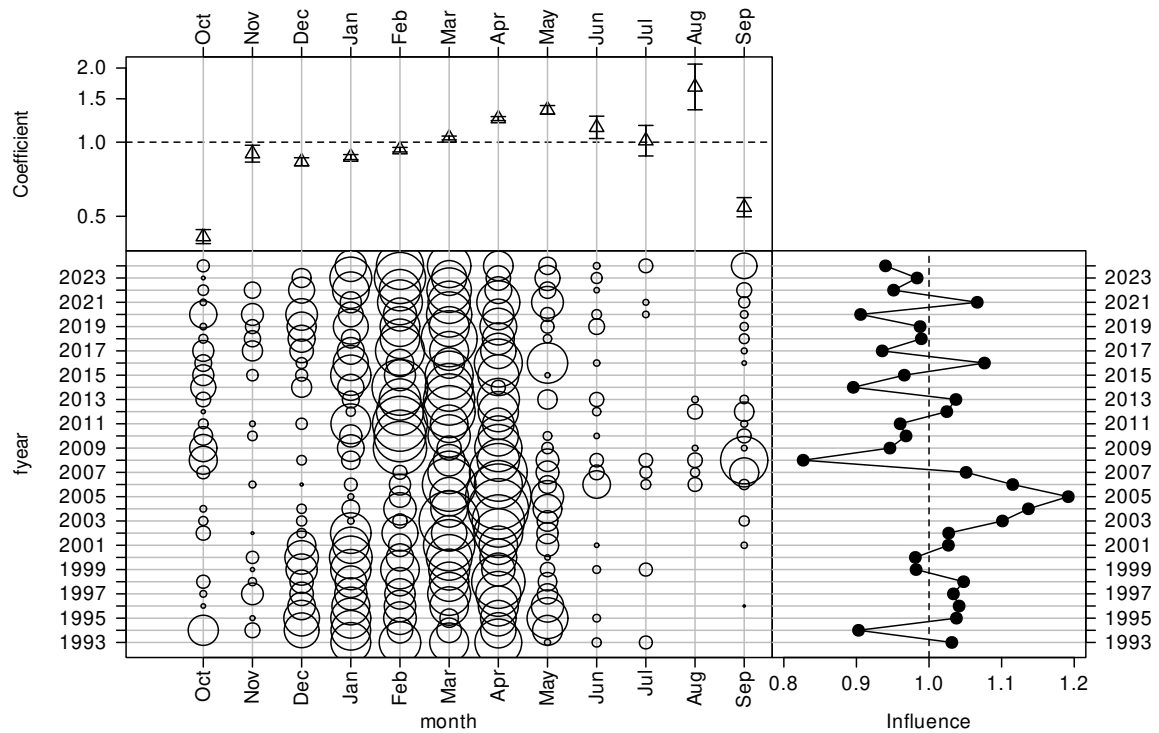


Figure D.52: CDI plot for month for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

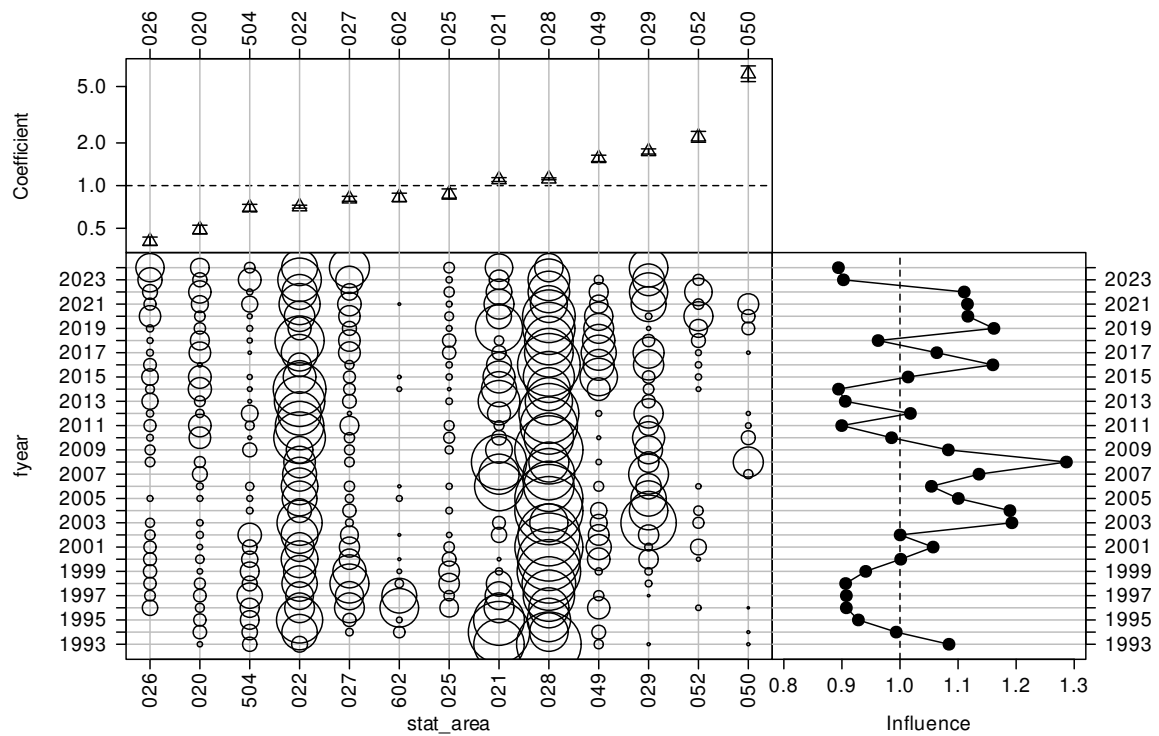


Figure D.53: CDI plot for statistical area for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

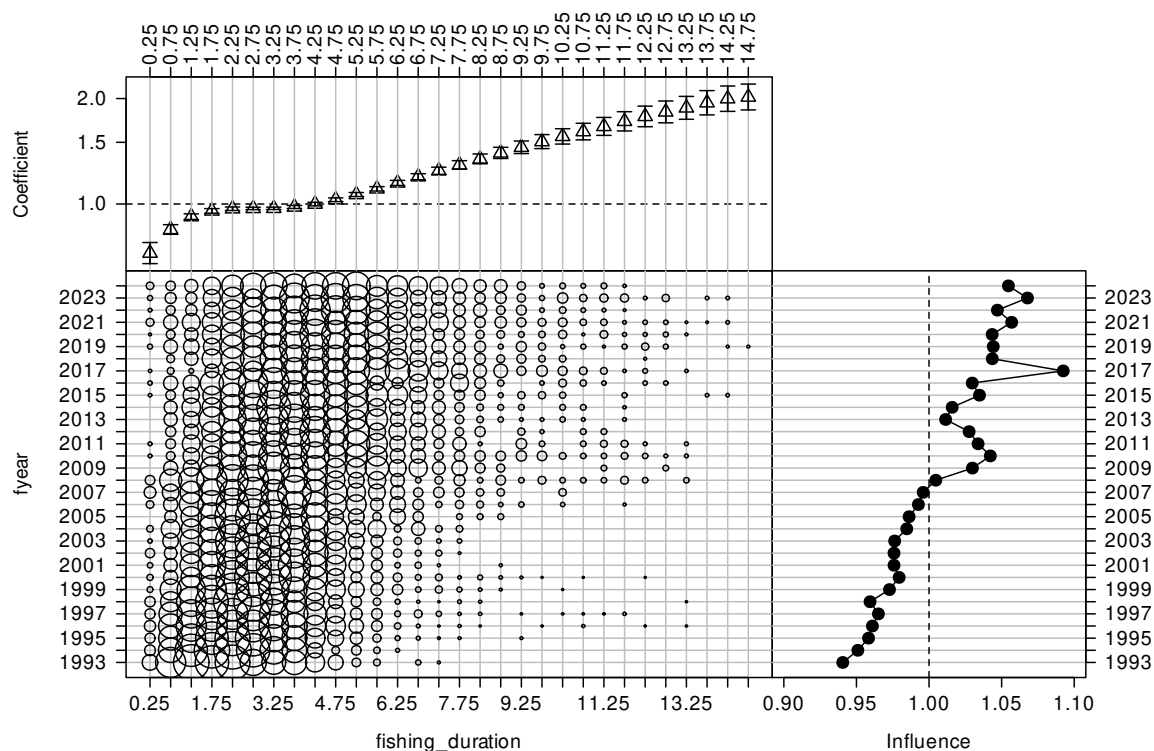


Figure D.54: CDI plot for fishing duration (h) for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

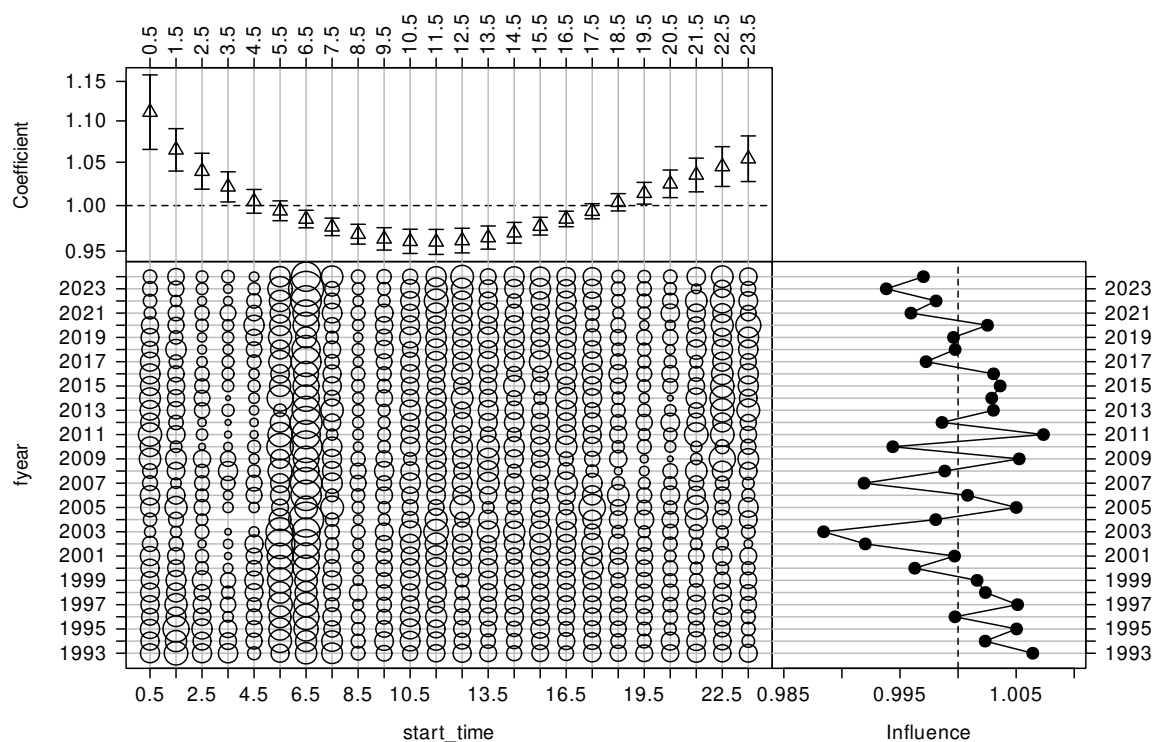


Figure D.55: CDI plot for start time for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

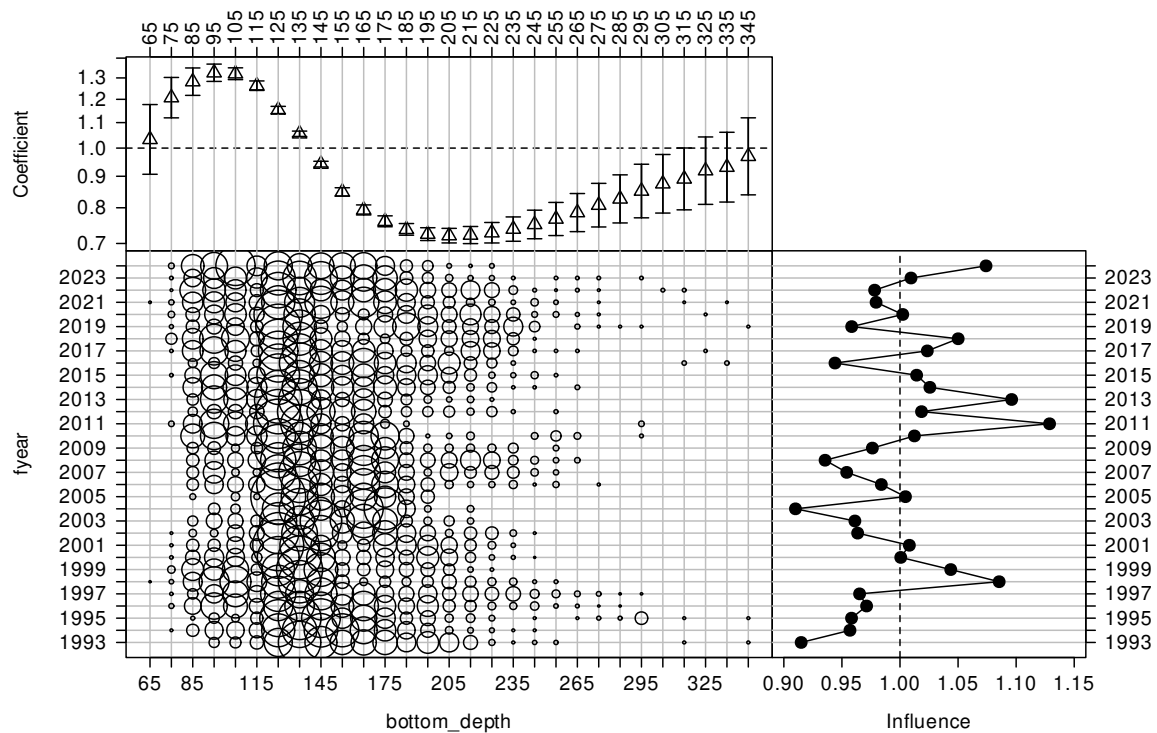


Figure D.56: CDI plot for bottom depth (m) for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

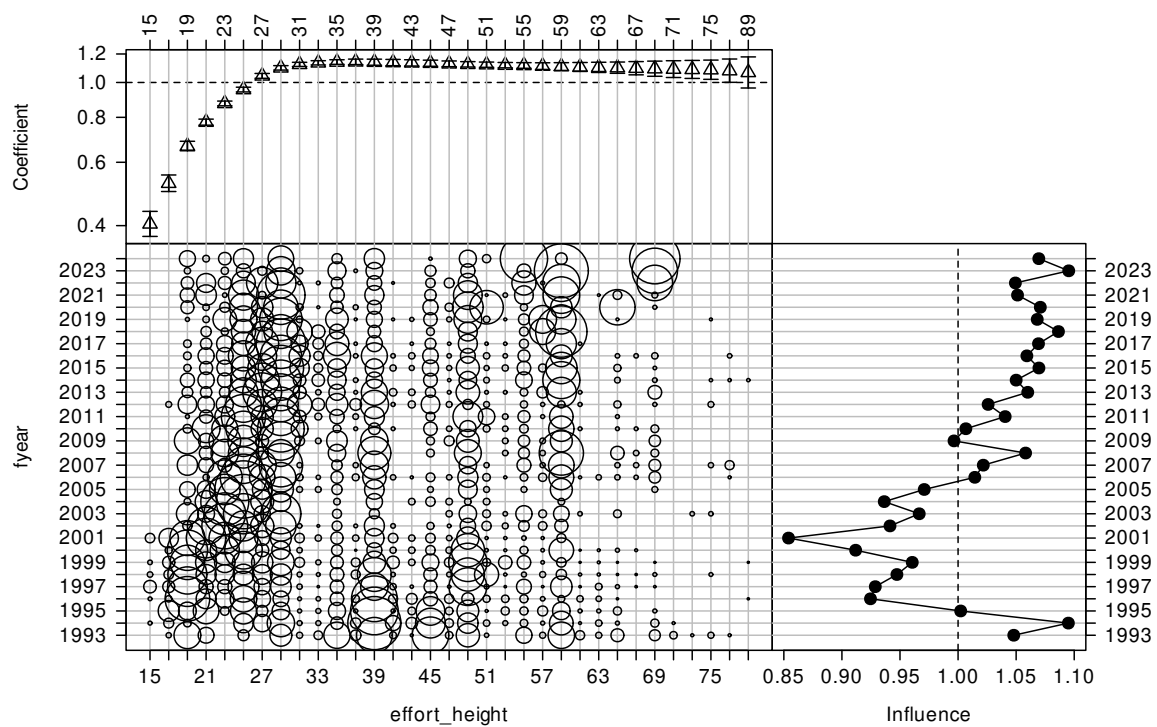


Figure D.57: CDI plot for effort height (m) for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

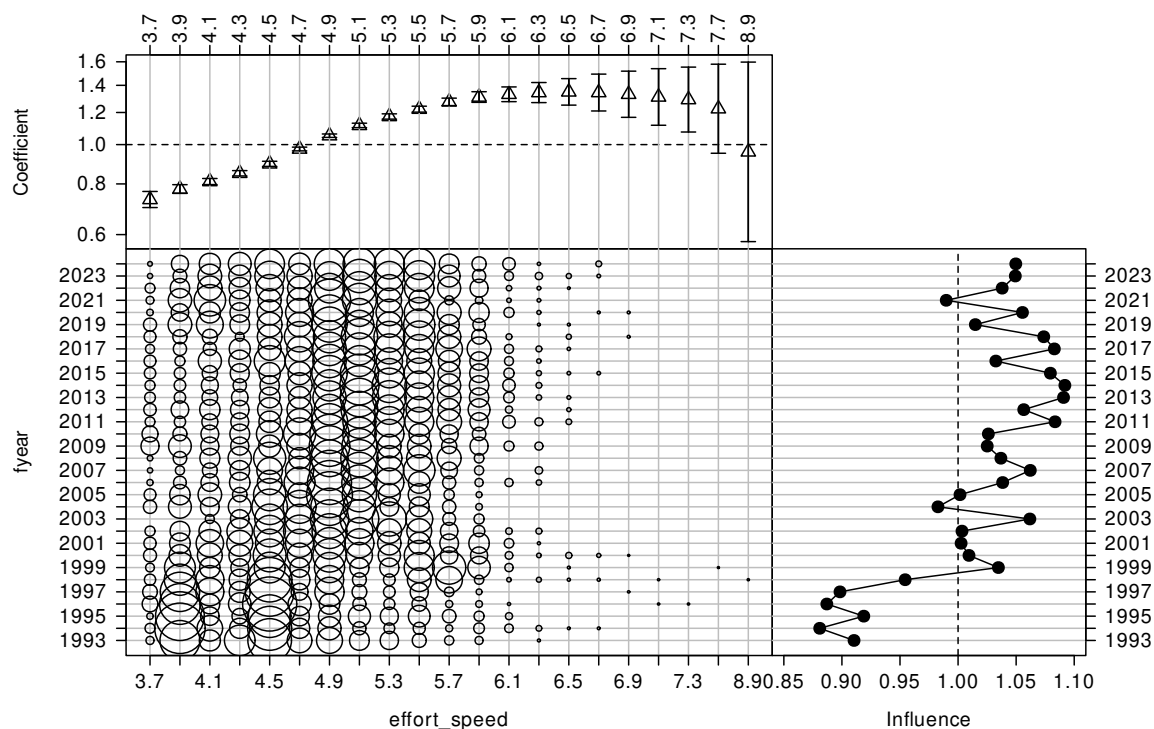


Figure D.58: CDI plot for effort speed for the lognormal model of positive catches in the JMA3 MW event (split long vessels) catch-per-unit-effort dataset.

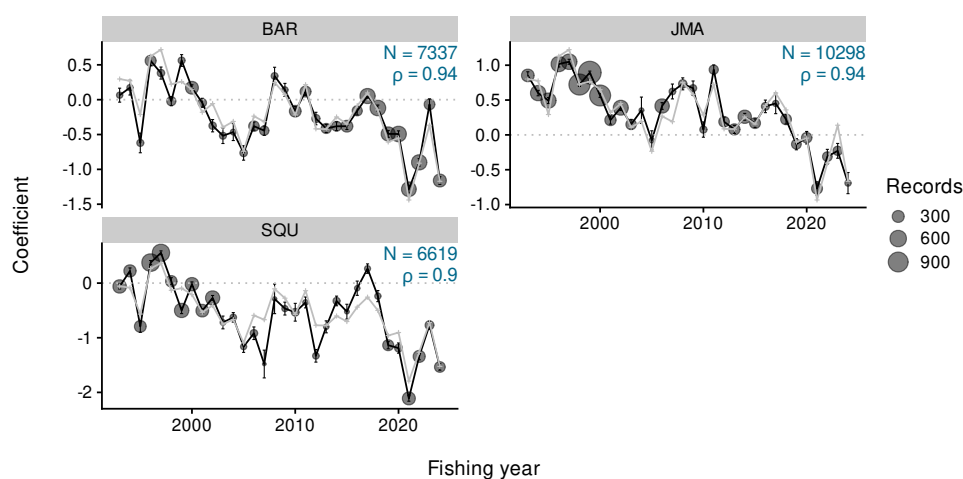


Figure D.59: Residual implied coefficients for target-year in the lognormal positive catch model for the JMA3 MW event (split long vessels) dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

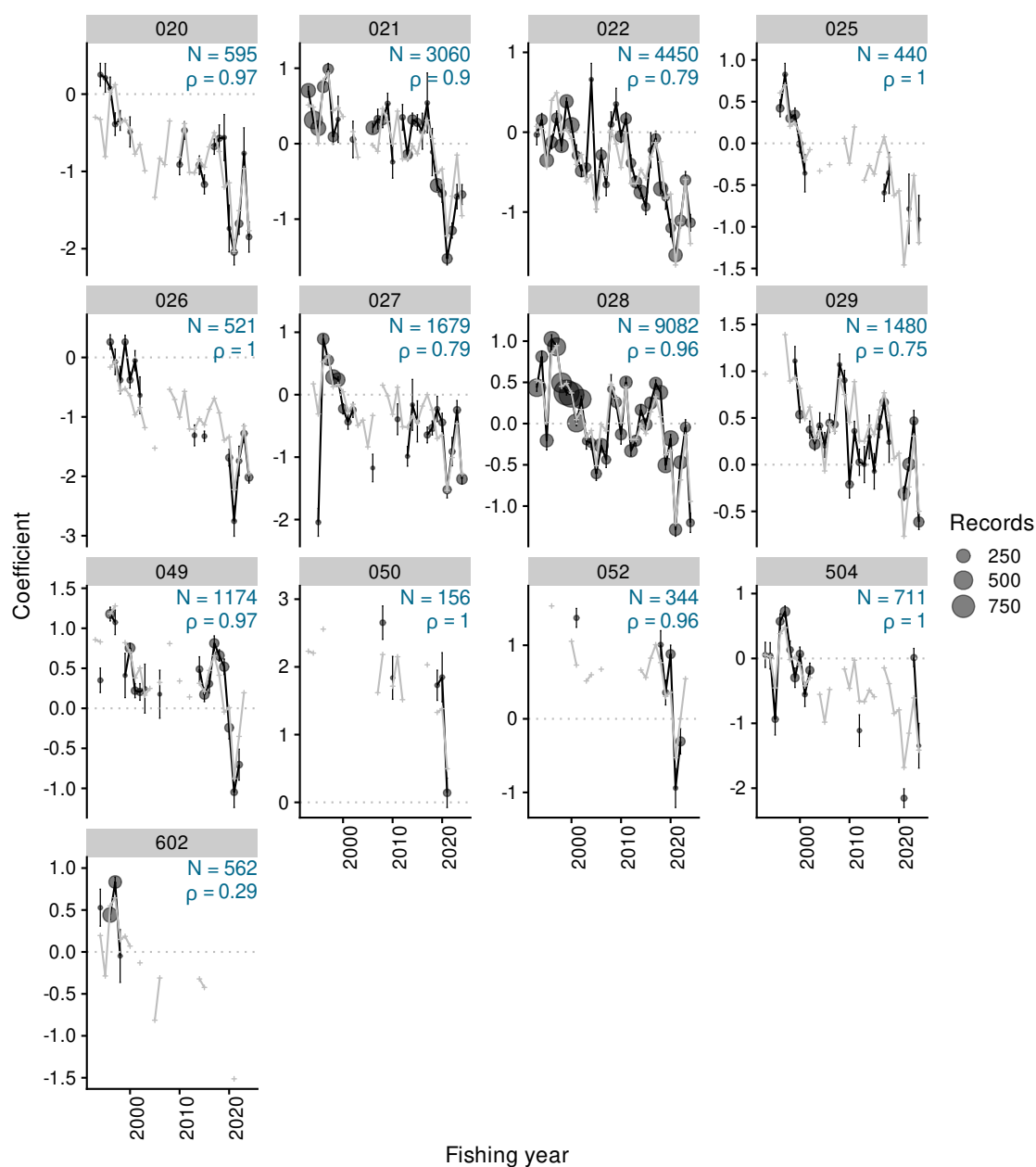


Figure D.60: Residual implied coefficients for area-year in the lognormal positive catch model for the JMA3 MW event (split long vessels) dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

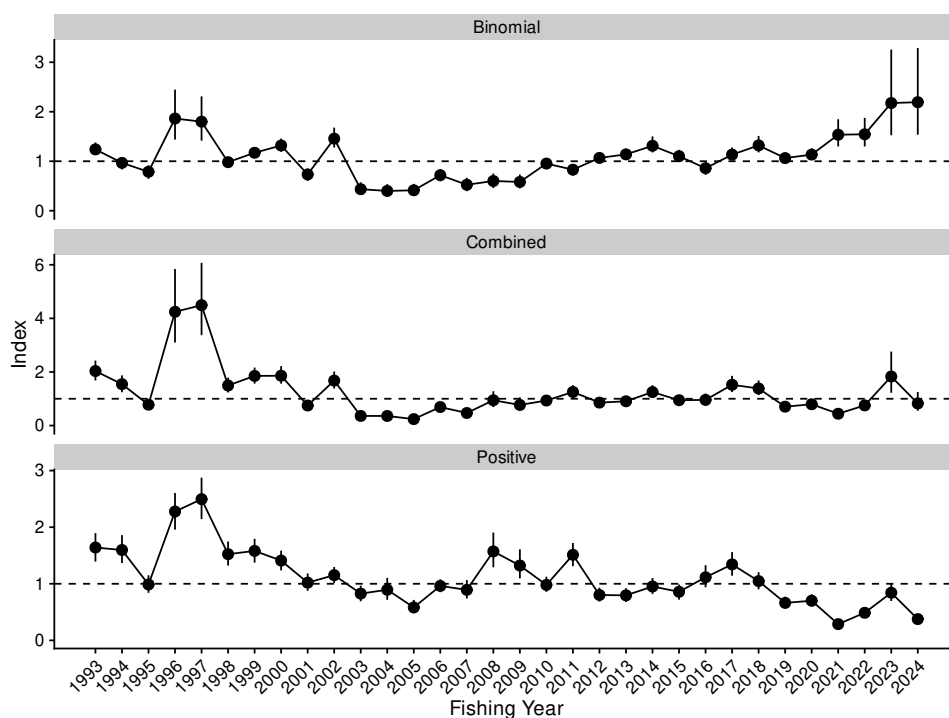


Figure D.61: Standardised indices and 95% confidence intervals for the JMA3 MW event (split long vessels) dataset.

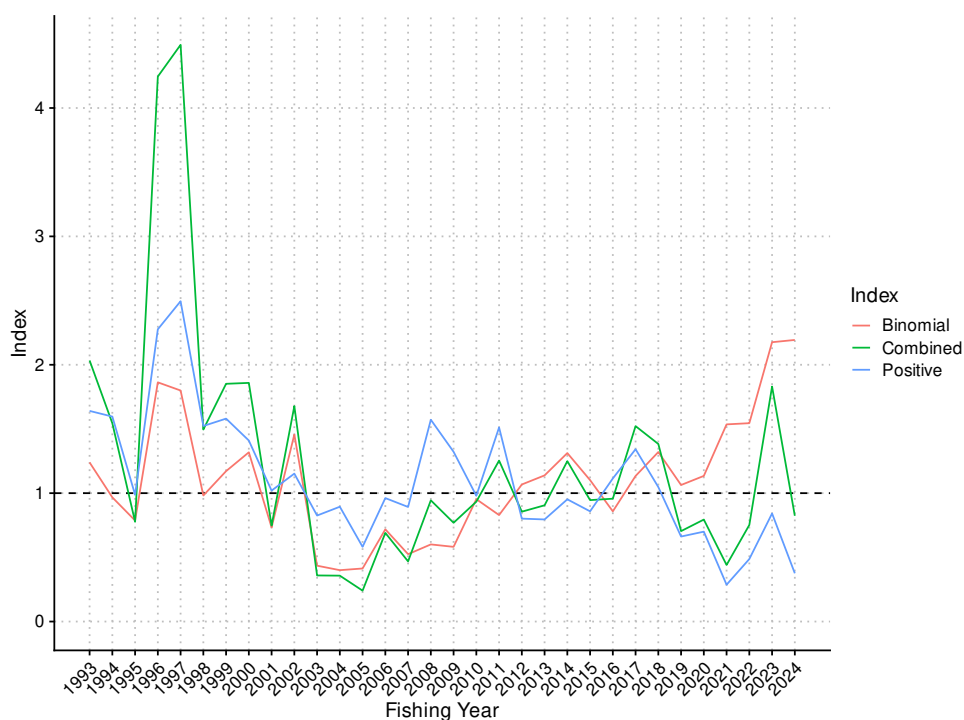


Figure D.62: Standardised indices for the JMA3 MW event (split long vessels) dataset.

Table D.12: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW event (split long vessels) series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.239	0.063	1.131	1.379	2.034	0.189	1.684	2.425	1.641	0.128	1.392	1.896
1994	0.967	0.062	0.834	1.076	1.544	0.161	1.243	1.872	1.597	0.126	1.367	1.860
1995	0.787	0.070	0.645	0.918	0.777	0.089	0.604	0.953	0.987	0.079	0.841	1.151
1996	1.863	0.258	1.438	2.448	4.245	0.699	3.100	5.840	2.276	0.165	1.956	2.603
1997	1.800	0.228	1.416	2.310	4.492	0.689	3.373	6.072	2.495	0.187	2.142	2.875
1998	0.982	0.054	0.863	1.076	1.495	0.141	1.235	1.787	1.523	0.108	1.322	1.746
1999	1.172	0.050	1.083	1.278	1.852	0.153	1.563	2.163	1.581	0.107	1.375	1.793
2000	1.318	0.068	1.192	1.458	1.859	0.167	1.563	2.217	1.410	0.089	1.236	1.585
2001	0.733	0.063	0.602	0.850	0.748	0.085	0.581	0.915	1.020	0.078	0.876	1.182
2002	1.456	0.103	1.277	1.679	1.678	0.162	1.382	2.016	1.152	0.072	1.012	1.296
2003	0.435	0.064	0.324	0.575	0.359	0.062	0.253	0.497	0.826	0.071	0.691	0.967
2004	0.400	0.064	0.286	0.537	0.357	0.067	0.243	0.507	0.894	0.099	0.716	1.105
2005	0.413	0.061	0.303	0.543	0.241	0.045	0.166	0.342	0.582	0.060	0.479	0.715
2006	0.718	0.063	0.595	0.841	0.691	0.070	0.565	0.838	0.962	0.058	0.852	1.078
2007	0.525	0.069	0.395	0.666	0.469	0.076	0.334	0.633	0.893	0.083	0.739	1.066
2008	0.601	0.075	0.458	0.753	0.944	0.151	0.688	1.281	1.572	0.157	1.291	1.906
2009	0.582	0.072	0.450	0.732	0.769	0.124	0.561	1.048	1.322	0.131	1.095	1.608
2010	0.953	0.052	0.841	1.047	0.934	0.088	0.777	1.122	0.980	0.068	0.858	1.125
2011	0.829	0.058	0.710	0.938	1.254	0.127	1.009	1.506	1.512	0.105	1.311	1.722
2012	1.067	0.058	0.954	1.182	0.856	0.083	0.695	1.020	0.802	0.063	0.685	0.931
2013	1.138	0.058	1.030	1.257	0.905	0.085	0.749	1.082	0.795	0.062	0.677	0.922
2014	1.312	0.083	1.178	1.502	1.249	0.121	1.031	1.505	0.952	0.071	0.821	1.101
2015	1.102	0.060	0.993	1.230	0.946	0.090	0.775	1.128	0.858	0.068	0.719	0.987
2016	0.858	0.065	0.727	0.979	0.957	0.116	0.740	1.196	1.115	0.099	0.938	1.328
2017	1.134	0.066	1.020	1.278	1.522	0.154	1.251	1.854	1.342	0.106	1.142	1.560
2018	1.320	0.085	1.179	1.512	1.383	0.139	1.138	1.682	1.047	0.077	0.902	1.205
2019	1.063	0.058	0.948	1.177	0.704	0.067	0.580	0.843	0.662	0.052	0.566	0.772
2020	1.134	0.060	1.027	1.262	0.794	0.074	0.664	0.955	0.700	0.055	0.600	0.814
2021	1.536	0.140	1.298	1.848	0.441	0.054	0.349	0.560	0.287	0.021	0.247	0.331
2022	1.545	0.147	1.299	1.876	0.752	0.090	0.597	0.952	0.487	0.038	0.413	0.564
2023	2.176	0.441	1.526	3.255	1.830	0.392	1.224	2.761	0.842	0.079	0.696	1.004
2024	2.193	0.447	1.537	3.287	0.824	0.179	0.552	1.255	0.376	0.032	0.314	0.441

D.3 JMA3 MW event (season day)

Table D.13: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW event (season day) CPUE series.

Series	JMA3 MW event (season day)
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	$\text{allockg_top5} \sim \text{fyear} + \text{vessel_key} + \text{target_species} + \text{stat_area} + \text{ns}(\text{SeasonDay}, 3) + \text{ns}(\log(\text{fishing_duration}), 3) + \text{ns}(\log(\text{start_time}), 3) + \text{ns}(\log(\text{bottom_depth}), 3) + \text{ns}(\log(\text{effort_height}), 3) + \text{ns}(\text{effort_speed}, 3)$
Stepwise selection	No
Positive catch distribution	Lognormal

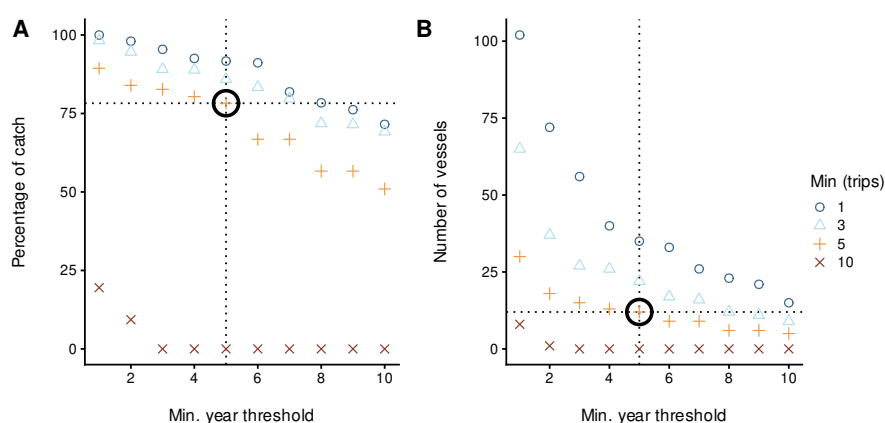


Figure D.63: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW event (season day) CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

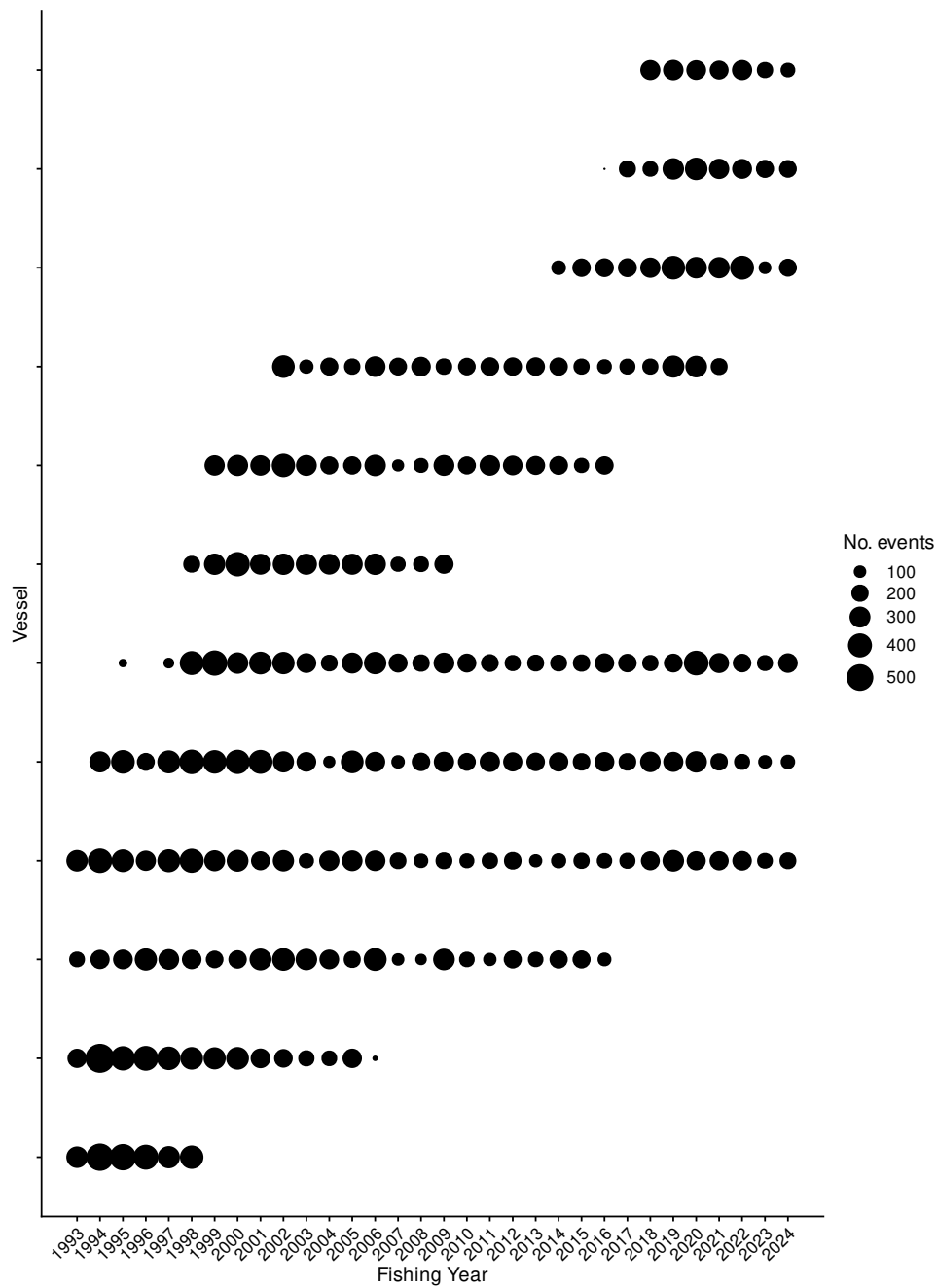


Figure D.64: Number of events by fishing year for core vessels in the JMA3 MW event (season day) series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table D.14: Summary of the JMA3 MW event (season day) dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	9582 (100%) n: 7120	5046 (100%) n: 6431	7167 (100%) n: 7634	13816 (100%) n: 8007	12174 (100%) n: 5773	12098 (100%) n: 5656	14572 (100%) n: 5261	8247 (100%) n: 3762	2001 (100%) n: 3011
Fishing speed not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13810 (100%) n: 7999	12150 (100%) n: 5767	12098 (100%) n: 5652	14570 (100%) n: 5257	8247 (100%) n: 3762	2001 (100%) n: 3010
Fishing speed lt 10kts	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
Start date not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
End date not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7967	12125 (100%) n: 5755	12098 (100%) n: 5647	14570 (100%) n: 5256	8247 (100%) n: 3762	2001 (100%) n: 3010
Start depth not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13757 (100%) n: 7960	12122 (100%) n: 5739	11950 (99%) n: 5634	14548 (100%) n: 5245	8246 (100%) n: 3759	1998 (100%) n: 3000
Headline height not null	9582 (100%) n: 7120	5046 (100%) n: 6431	7131 (100%) n: 7632	13746 (99%) n: 7811	12120 (100%) n: 5731	11948 (99%) n: 5623	14531 (100%) n: 5238	8236 (100%) n: 3755	1998 (100%) n: 2999
Fishing speed >3.5kn	9203 (96%) n: 6839	5017 (99%) n: 6143	7114 (99%) n: 7490	13660 (99%) n: 7520	12039 (99%) n: 5480	11904 (98%) n: 5399	14418 (99%) n: 5123	8176 (99%) n: 3702	1988 (99%) n: 2985
Headline height >15m	9180 (96%) n: 6818	4980 (99%) n: 6093	7064 (99%) n: 7447	13389 (97%) n: 7414	11960 (98%) n: 5394	11866 (98%) n: 5374	14363 (99%) n: 5027	8170 (99%) n: 3692	1987 (99%) n: 2978
Headline height <90m	8535 (89%) n: 6666	4946 (98%) n: 6091	7064 (99%) n: 7447	13377 (97%) n: 7403	10684 (88%) n: 5191	10849 (90%) n: 4986	14312 (98%) n: 5013	8158 (99%) n: 3682	1987 (99%) n: 2977
Fishing duration >15mins	8398 (88%) n: 6634	4929 (98%) n: 6074	7031 (98%) n: 7430	13264 (96%) n: 7374	10609 (87%) n: 5175	10833 (90%) n: 4972	14303 (98%) n: 5002	8158 (99%) n: 3679	1987 (99%) n: 2970
Fishing duration <15h	8380 (87%) n: 6616	4918 (97%) n: 6057	7006 (98%) n: 7421	13224 (96%) n: 7356	10435 (86%) n: 5144	10791 (89%) n: 4957	14263 (98%) n: 4993	8098 (98%) n: 3660	1987 (99%) n: 2970
Seabed depth >50m	8380 (87%) n: 6616	4918 (97%) n: 6057	7006 (98%) n: 7420	13224 (96%) n: 7356	10435 (86%) n: 5144	10768 (89%) n: 4954	14263 (98%) n: 4992	8098 (98%) n: 3659	1987 (99%) n: 2970
Seabed depth <350m	8344 (87%) n: 6577	4906 (97%) n: 6017	6996 (98%) n: 7243	13197 (96%) n: 7327	10398 (85%) n: 5131	10756 (89%) n: 4950	14231 (98%) n: 4969	8096 (98%) n: 3649	1982 (99%) n: 2967
Start time >0	8004 (84%) n: 6515	4803 (95%) n: 5975	6792 (95%) n: 7172	12752 (92%) n: 7235	10050 (83%) n: 5077	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3627	1958 (98%) n: 2956
SA subset	8004 (84%) n: 6515	4803 (95%) n: 5975	6792 (95%) n: 7172	12752 (92%) n: 7235	10050 (83%) n: 5077	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3627	1958 (98%) n: 2956
No effort allocation	7991 (83%) n: 6469	4743 (94%) n: 5846	6770 (94%) n: 7039	12752 (92%) n: 7235	10050 (83%) n: 5076	10538 (87%) n: 4908	13737 (94%) n: 4921	8008 (97%) n: 3623	1958 (98%) n: 2956
Core fleet selection	3053 (32%) n: 1050	3108 (62%) n: 2092	4062 (57%) n: 1942	6483 (47%) n: 1701	5882 (48%) n: 1816	7330 (61%) n: 2399	9081 (62%) n: 2270	6510 (79%) n: 2354	1728 (86%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed lt 10kts	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Start date not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
End date not null	3663 (100%) n: 3311	1681 (100%) n: 3111	528 (100%) n: 3282	570 (100%) n: 3640	4607 (100%) n: 2834	1446 (100%) n: 2416	2235 (100%) n: 2253	1800 (100%) n: 2188	2226 (100%) n: 1316
Start depth not null	3661 (100%) n: 3306	1681 (100%) n: 3109	528 (100%) n: 3279	570 (100%) n: 3636	4607 (100%) n: 2831	1445 (100%) n: 2412	2235 (100%) n: 2249	1800 (100%) n: 2188	2226 (100%) n: 1316
Headline height not null	3661 (100%) n: 3306	1681 (100%) n: 3109	528 (100%) n: 3279	570 (100%) n: 3636	4607 (100%) n: 2831	1445 (100%) n: 2412	2235 (100%) n: 2249	1800 (100%) n: 2188	2226 (100%) n: 1316
Fishing speed >3.5kn	3659 (100%) n: 3266	1671 (99%) n: 3064	526 (100%) n: 3168	570 (100%) n: 3521	4601 (100%) n: 2794	1443 (100%) n: 2380	2205 (99%) n: 2225	1751 (97%) n: 2133	2226 (100%) n: 1303
Headline height >15m	3614 (99%) n: 3243	1669 (99%) n: 3046	519 (98%) n: 3151	570 (100%) n: 3513	4601 (100%) n: 2790	1443 (100%) n: 2359	2205 (99%) n: 2208	1741 (97%) n: 2129	2225 (100%) n: 1300
Headline height <90m	3614 (99%) n: 3243	1669 (99%) n: 3046	516 (98%) n: 3150	570 (100%) n: 3513	4601 (100%) n: 2789	1443 (100%) n: 2359	2205 (99%) n: 2207	1741 (97%) n: 2129	2225 (100%) n: 1300
Fishing duration >15mins	3575 (98%) n: 3229	1669 (99%) n: 3041	516 (98%) n: 3141	570 (100%) n: 3502	4598 (100%) n: 2782	1442 (100%) n: 2354	2204 (99%) n: 2201	1741 (97%) n: 2127	2225 (100%) n: 1298
Fishing duration <15h	3574 (98%) n: 3226	1664 (99%) n: 3040	516 (98%) n: 3139	570 (100%) n: 3502	4598 (100%) n: 2780	1442 (100%) n: 2353	2192 (98%) n: 2198	1740 (97%) n: 2123	2225 (100%) n: 1297
Seabed depth >50m	3569 (97%) n: 3224	1664 (99%) n: 3040	516 (98%) n: 3139	570 (100%) n: 3502	4598 (100%) n: 2780	1442 (100%) n: 2353	2192 (98%) n: 2198	1740 (97%) n: 2123	2225 (100%) n: 1297
Seabed depth <350m	3564 (97%) n: 3222	1664 (99%) n: 3036	516 (98%) n: 3135	570 (100%) n: 3501	4598 (100%) n: 2779	1442 (100%) n: 2351	2192 (98%) n: 2196	1722 (96%) n: 2121	2225 (100%) n: 1296
Start time >0	3500 (96%) n: 3198	1639 (98%) n: 3028	509 (96%) n: 3120	556 (98%) n: 3459	4508 (98%) n: 2766	1402 (97%) n: 2334	2166 (97%) n: 2185	1660 (92%) n: 2109	2181 (98%) n: 1283
SA subset	3500 (96%) n: 3198	1639 (98%) n: 3028	509 (96%) n: 3120	556 (98%) n: 3459	4508 (98%) n: 2766	1402 (97%) n: 2334	2166 (97%) n: 2185	1660 (92%) n: 2109	2181 (98%) n: 1283
No effort allocation	3500 (96%) n: 3196	1638 (97%) n: 2489	507 (96%) n: 2363	555 (97%) n: 2582	4508 (98%) n: 2593	1399 (97%) n: 1705	2162 (97%) n: 1590	1654 (92%) n: 1991	2181 (98%) n: 1263
Core fleet selection	3322 (91%) n: 2598	1466 (87%) n: 1905	495 (94%) n: 1725	551 (97%) n: 2103	4445 (96%) n: 2204	1245 (86%) n: 1109	1750 (78%) n: 1226	1256 (70%) n: 1810	2077 (93%) n: 1194

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5024 (100%) n: 1678	4301 (100%) n: 2307
Fishing speed not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5024 (100%) n: 1678	4301 (100%) n: 2307
Fishing speed lt 10kts	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Start date not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
End date not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Start depth not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Headline height not null	3399 (100%) n: 1436	2681 (100%) n: 1486	3488 (100%) n: 1247	4348 (100%) n: 1486	3632 (100%) n: 1446	2513 (100%) n: 1552	4142 (100%) n: 1370	5008 (100%) n: 1675	4301 (100%) n: 2303
Fishing speed >3.5kn	3389 (100%) n: 1414	2668 (99%) n: 1465	3486 (100%) n: 1229	4347 (100%) n: 1456	3621 (100%) n: 1382	2507 (100%) n: 1506	4141 (100%) n: 1359	4995 (99%) n: 1625	4293 (100%) n: 2269
Headline height >15m	3341 (98%) n: 1397	2668 (99%) n: 1464	3486 (100%) n: 1229	4347 (100%) n: 1456	3618 (100%) n: 1380	2507 (100%) n: 1506	4102 (99%) n: 1356	4995 (99%) n: 1625	4293 (100%) n: 2263
Headline height <90m	3341 (98%) n: 1397	2668 (99%) n: 1463	3486 (100%) n: 1229	4347 (100%) n: 1456	3618 (100%) n: 1380	2507 (100%) n: 1506	4102 (99%) n: 1356	4994 (99%) n: 1624	4293 (100%) n: 2263
Fishing duration >15mins	3339 (98%) n: 1396	2668 (99%) n: 1459	3482 (100%) n: 1224	4347 (100%) n: 1451	3618 (100%) n: 1379	2507 (100%) n: 1501	4102 (99%) n: 1354	4994 (99%) n: 1624	4293 (100%) n: 2260
Fishing duration <15h	3339 (98%) n: 1394	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2507 (100%) n: 1500	4102 (99%) n: 1354	4994 (99%) n: 1624	4279 (99%) n: 2257
Seabed depth >50m	3339 (98%) n: 1394	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2507 (100%) n: 1500	4102 (99%) n: 1354	4994 (99%) n: 1624	4279 (99%) n: 2257
Seabed depth <350m	3339 (98%) n: 1392	2668 (99%) n: 1457	3482 (100%) n: 1224	4346 (100%) n: 1450	3618 (100%) n: 1379	2506 (100%) n: 1494	4102 (99%) n: 1354	4994 (99%) n: 1623	4279 (99%) n: 2256
Start time >0	3297 (97%) n: 1384	2658 (99%) n: 1453	3439 (99%) n: 1217	4181 (96%) n: 1440	3556 (98%) n: 1371	2454 (98%) n: 1486	4034 (97%) n: 1350	4979 (99%) n: 1617	4279 (99%) n: 2252
SA subset	3297 (97%) n: 1384	2658 (99%) n: 1453	3439 (99%) n: 1217	4181 (96%) n: 1440	3556 (98%) n: 1371	2454 (98%) n: 1486	4034 (97%) n: 1350	4979 (99%) n: 1617	4279 (99%) n: 2252
No effort allocation	3297 (97%) n: 1384	2657 (99%) n: 1390	3438 (99%) n: 1216	4181 (96%) n: 1438	3556 (98%) n: 1371	2431 (97%) n: 1450	4034 (97%) n: 1337	4979 (99%) n: 1616	4279 (99%) n: 2252
Core fleet selection	3273 (96%) n: 1303	2573 (96%) n: 1344	3375 (97%) n: 1169	4171 (96%) n: 1422	3544 (98%) n: 1363	2385 (95%) n: 1412	3996 (96%) n: 1213	4965 (99%) n: 1599	4126 (96%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Fishing speed not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Fishing speed lt 10kts	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
Start date not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3041 (100%) n: 1343
End date not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Start depth not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Headline height not null	4461 (100%) n: 2542	5242 (100%) n: 1919	4625 (100%) n: 1800	4762 (100%) n: 1038	3025 (99%) n: 1342
Fishing speed >3.5kn	4458 (100%) n: 2430	5242 (100%) n: 1919	4624 (100%) n: 1794	4760 (100%) n: 1037	3025 (99%) n: 1342
Headline height >15m	4451 (100%) n: 2426	5242 (100%) n: 1917	4624 (100%) n: 1792	4760 (100%) n: 1035	3014 (99%) n: 1336
Headline height <90m	4451 (100%) n: 2426	5242 (100%) n: 1917	4624 (100%) n: 1792	4760 (100%) n: 1035	3014 (99%) n: 1336
Fishing duration >15mins	4451 (100%) n: 2421	5195 (99%) n: 1912	4624 (100%) n: 1785	4759 (100%) n: 1032	3014 (99%) n: 1331
Fishing duration <15h	4451 (100%) n: 2421	5191 (99%) n: 1910	4624 (100%) n: 1785	4756 (100%) n: 1031	3014 (99%) n: 1330
Seabed depth >50m	4451 (100%) n: 2421	5191 (99%) n: 1910	4624 (100%) n: 1784	4756 (100%) n: 1031	3014 (99%) n: 1330
Seabed depth <350m	4451 (100%) n: 2419	5191 (99%) n: 1910	4624 (100%) n: 1783	4756 (100%) n: 1030	3014 (99%) n: 1329
Start time >0	4449 (100%) n: 2415	5026 (96%) n: 1902	4607 (100%) n: 1781	4746 (100%) n: 1029	3013 (99%) n: 1326
SA subset	4449 (100%) n: 2415	5026 (96%) n: 1902	4607 (100%) n: 1781	4746 (100%) n: 1029	3013 (99%) n: 1326
No effort allocation	4449 (100%) n: 2414	5026 (96%) n: 1898	4607 (100%) n: 1775	4746 (100%) n: 1029	3013 (99%) n: 1306
Core fleet selection	3994 (90%) n: 2235	4852 (93%) n: 1744	4257 (92%) n: 1603	4664 (98%) n: 953	2862 (94%) n: 1157

Table D.15: Summary of the JMA3 MW event (season day) dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	3 053.25	50.10
1994	5	40	2 092	5 319.38	3 108.26	34.56
1995	6	38	1 942	5 295.32	4 062.46	37.54
1996	5	31	1 701	4 954.40	6 482.66	59.67
1997	6	23	1 816	5 499.75	5 882.38	52.75
1998	7	36	2 399	6 517.62	7 330.38	49.48
1999	7	29	2 270	6 685.70	9 080.71	58.33
2000	7	34	2 354	7 038.89	6 509.72	60.54
2001	7	29	2 174	7 230.32	1 727.70	29.62
2002	8	32	2 598	8 281.02	3 322.19	41.15
2003	8	34	1 905	6 719.95	1 465.71	21.52
2004	8	23	1 725	6 488.50	495.38	10.09
2005	8	28	2 103	7 303.95	551.40	9.94
2006	8	33	2 204	8 642.28	4 445.49	34.48
2007	7	27	1 109	4 762.03	1 245.18	24.89
2008	7	28	1 226	5 773.53	1 750.48	18.43
2009	7	38	1 810	8 965.45	1 255.82	13.31
2010	6	25	1 194	5 190.56	2 077.08	38.36
2011	6	21	1 303	5 820.35	3 272.59	33.00
2012	6	27	1 344	5 844.70	2 572.85	31.70
2013	6	25	1 169	4 960.32	3 374.93	42.86
2014	7	36	1 422	6 230.98	4 171.12	46.84
2015	7	37	1 363	6 244.58	3 544.22	41.60
2016	8	48	1 412	6 318.30	2 385.11	25.99
2017	6	29	1 213	6 426.98	3 995.89	47.82
2018	7	33	1 599	7 557.02	4 965.42	52.47
2019	7	36	2 156	9 997.48	4 126.08	36.83
2020	7	44	2 235	10 344.52	3 993.53	34.54
2021	7	32	1 744	7 955.15	4 852.39	63.65
2022	6	35	1 603	7 543.75	4 257.34	63.32
2023	6	25	953	4 692.92	4 664.04	88.98
2024	6	34	1 157	5 419.63	2 862.00	85.13

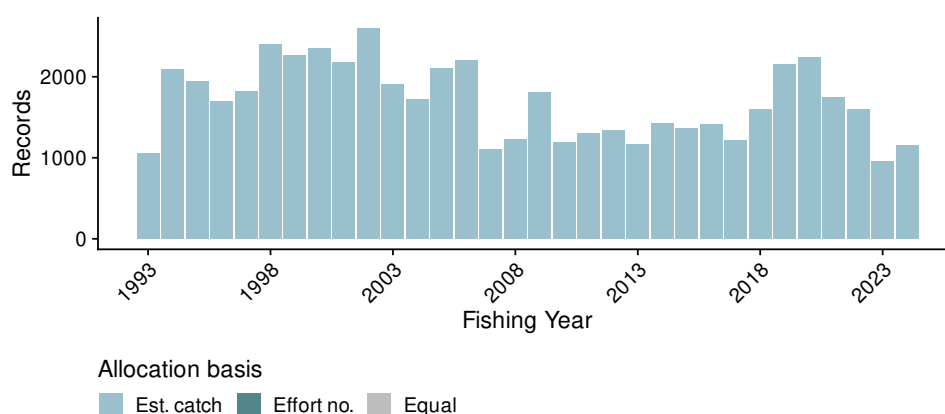


Figure D.65: The allocation approach used for attributing catches to records in the JMA3 MW event (season day) catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.16: Summary table for occurrence of positive catch in the JMA3 MW event (season day) series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	73 549.72	0.00	0.00	*
fyear	31	66 062.59	10.26	10.26	*
vessel_key	11	65 796.24	10.66	0.39	*
target_species	2	46 895.55	36.36	25.70	*
stat_area	12	43 207.54	41.41	5.05	*
ns(SeasonDay, 3)	3	42 475.70	42.41	1.00	*
ns(log(fishing_duration), 3)	3	42 428.16	42.48	0.07	*
ns(log(start_time), 3)	3	42 324.64	42.63	0.15	*
ns(log(bottom_depth), 3)	3	41 569.79	43.67	1.03	*
ns(log(effort_height), 3)	3	41 558.56	43.69	0.02	*
ns(effort_speed, 3)	3	41 046.90	44.39	0.70	*

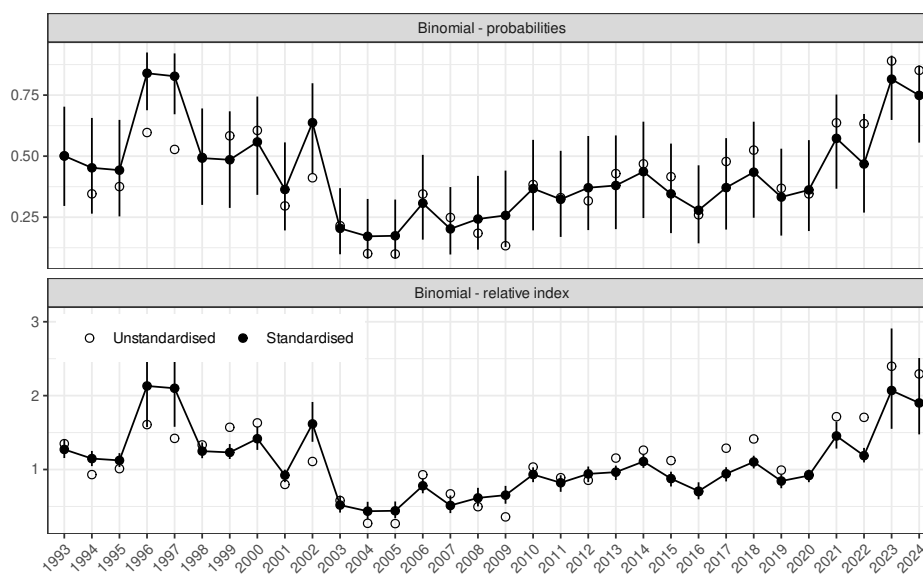


Figure D.66: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW event (season day) dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

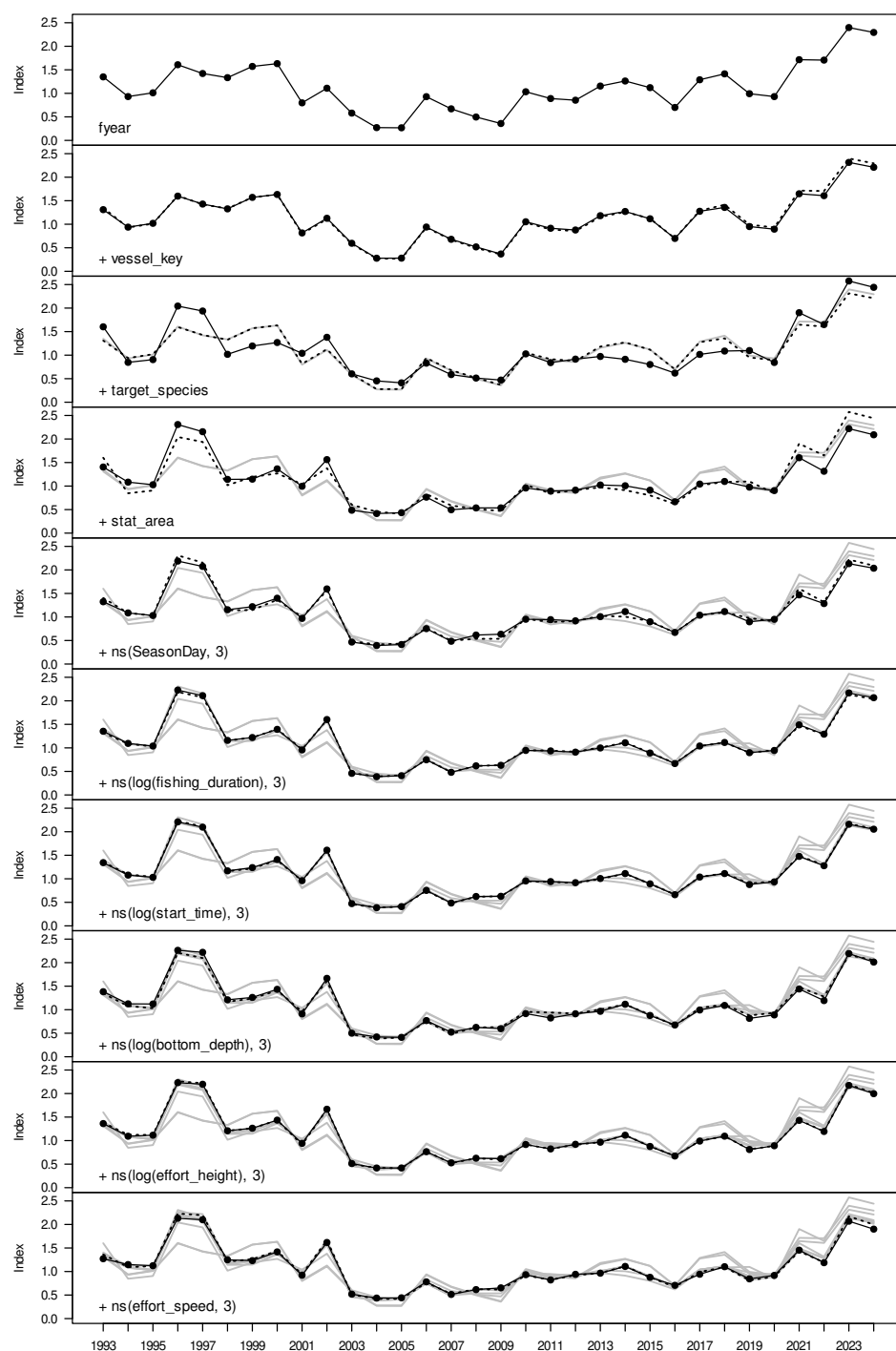


Figure D.67: Step plot for occurrence of catch in the JMA3 MW event (season day) dataset.

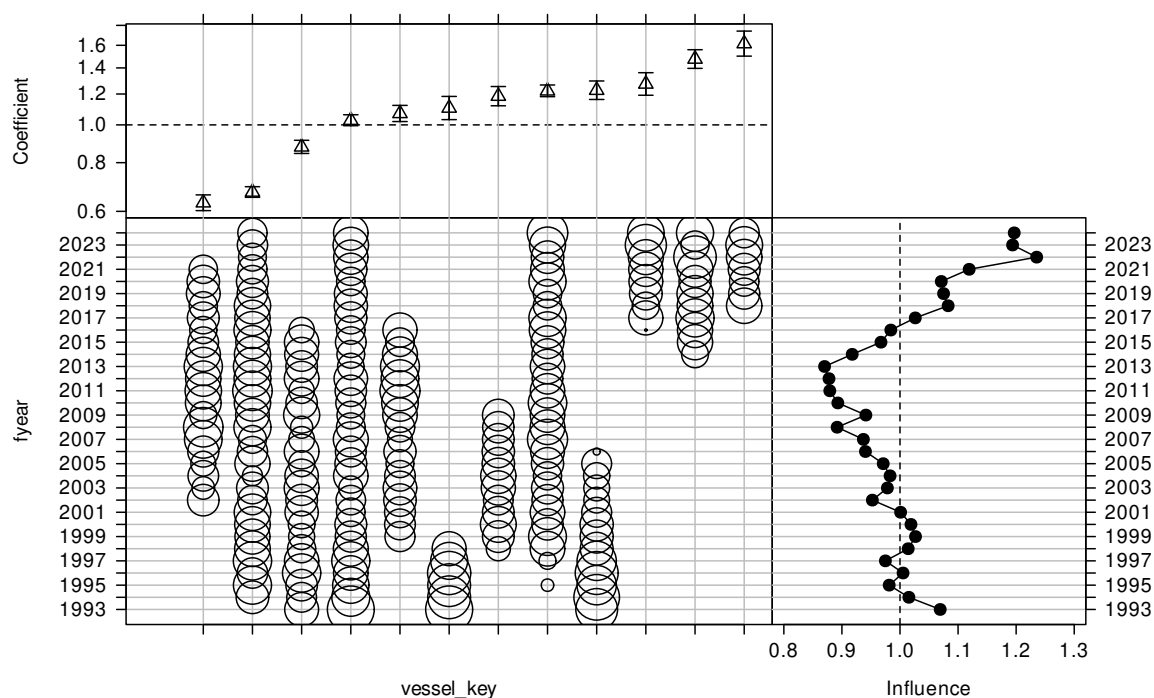


Figure D.68: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

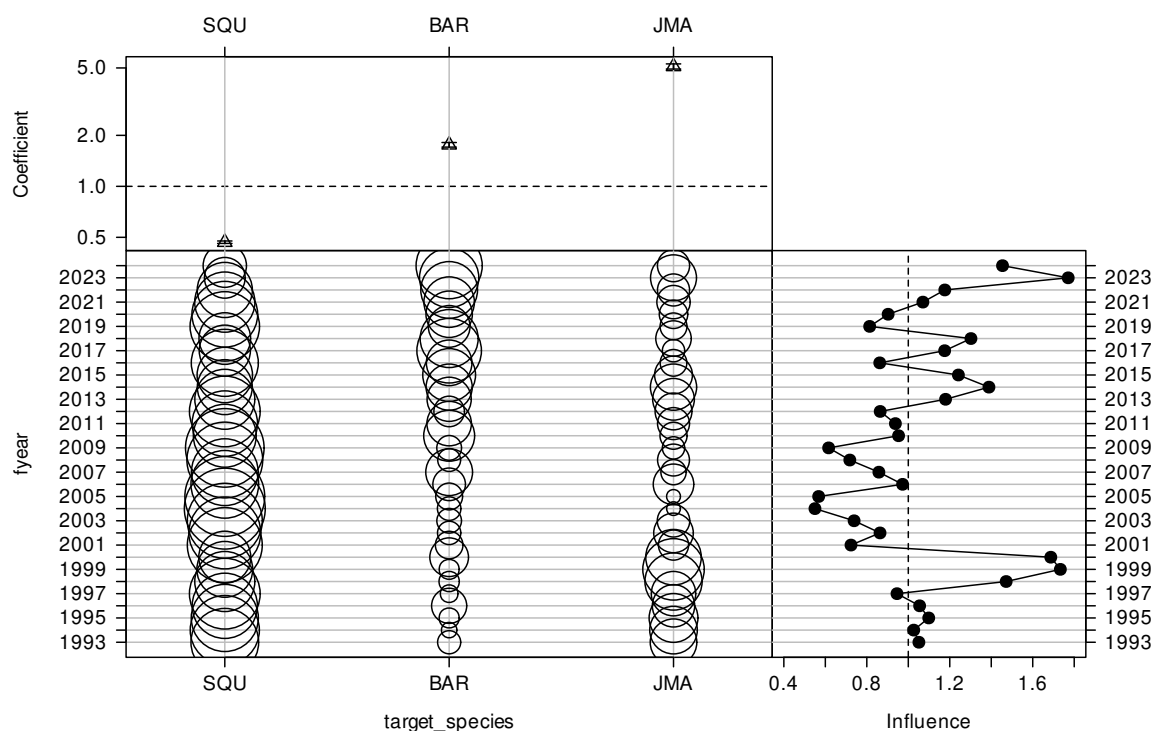


Figure D.69: CDI plot for target species for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

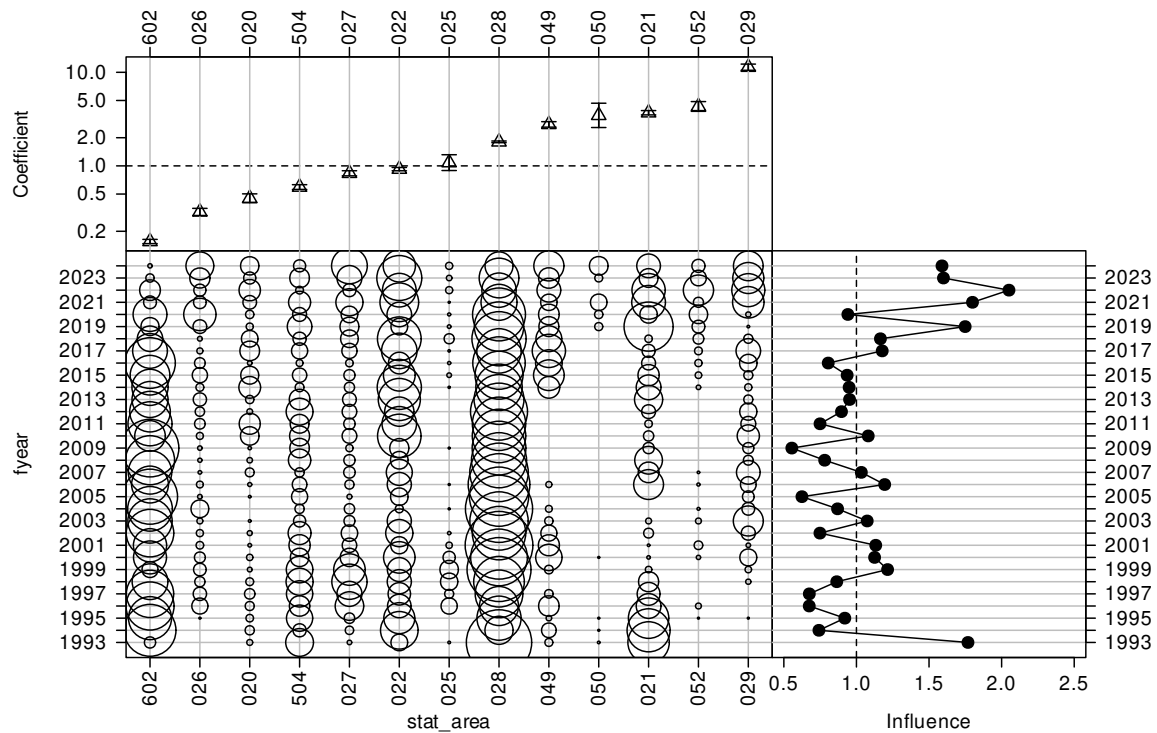


Figure D.70: CDI plot for statistical area for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

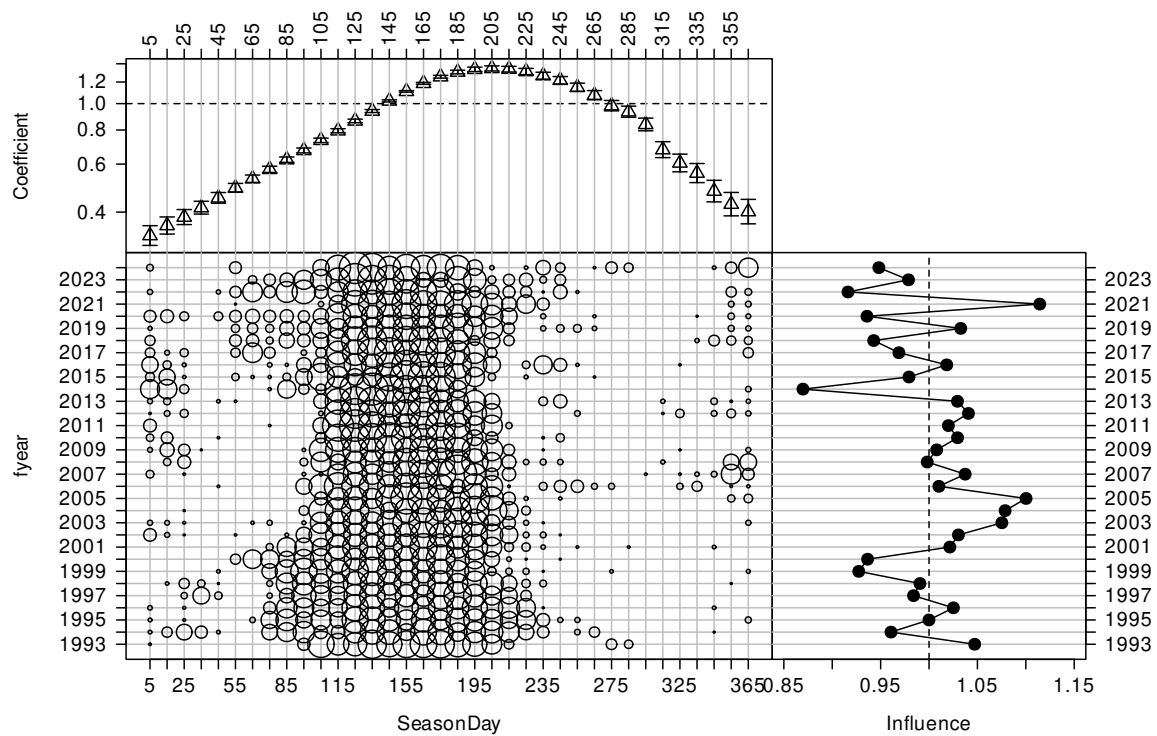


Figure D.71: CDI plot for SeasonDay for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

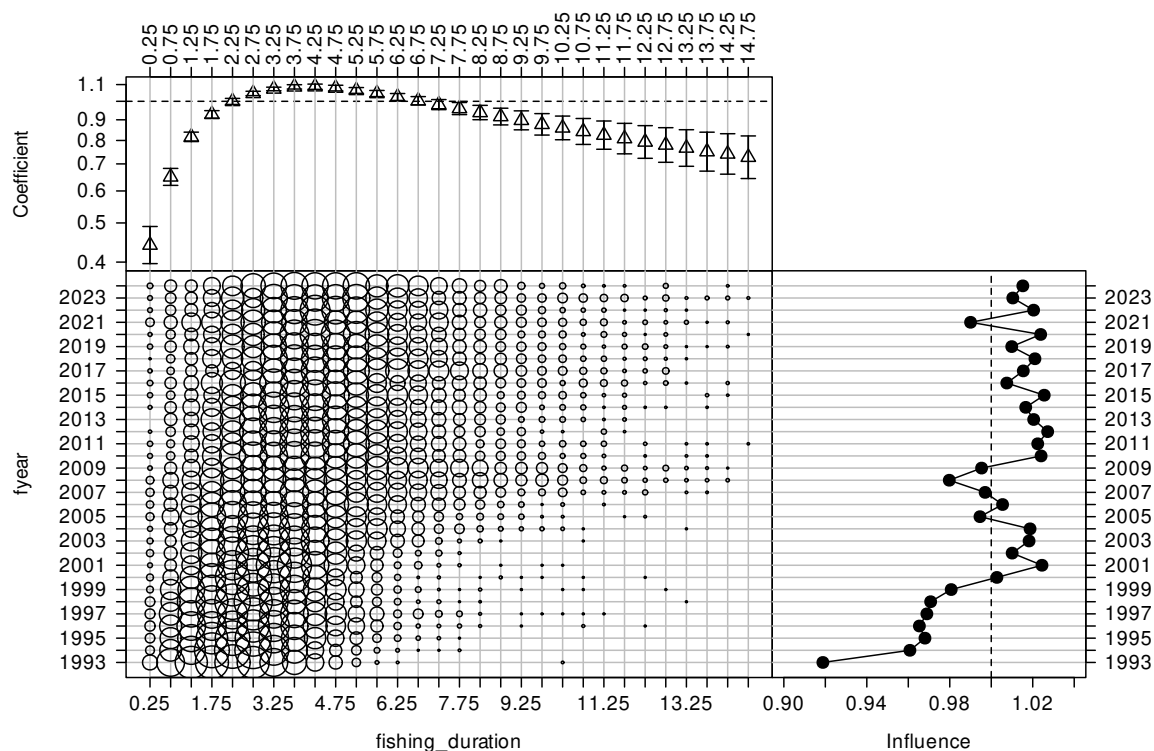


Figure D.72: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

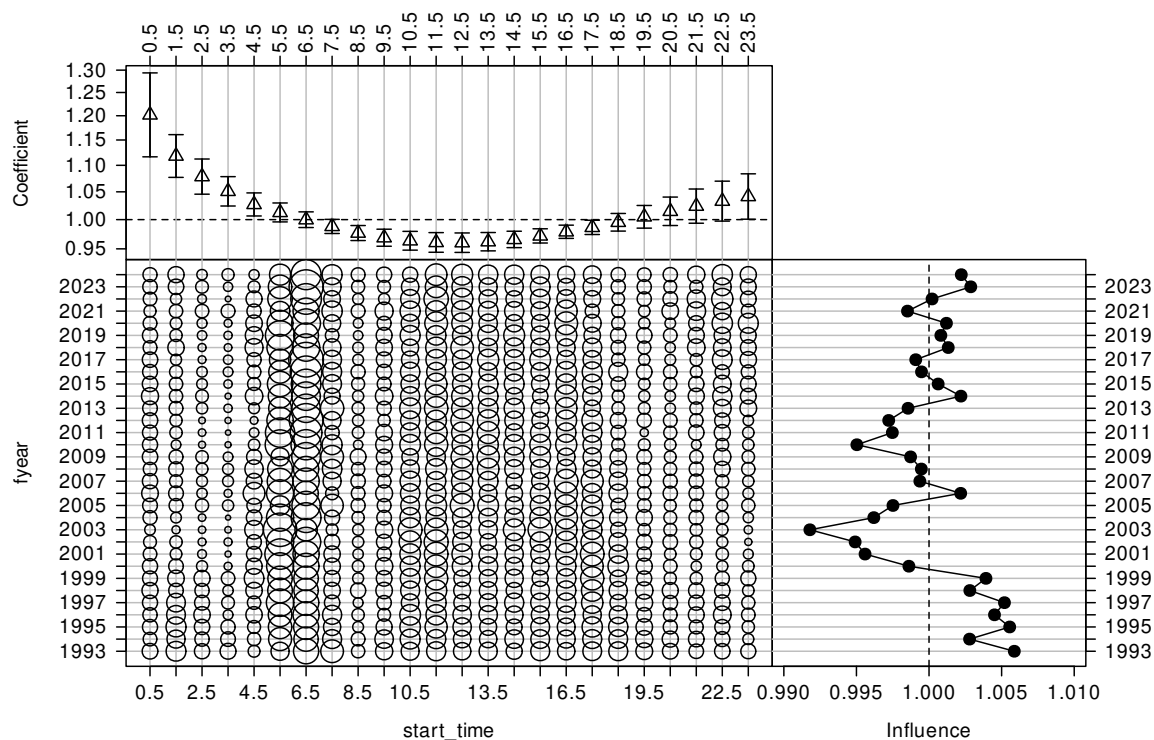


Figure D.73: CDI plot for start time for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

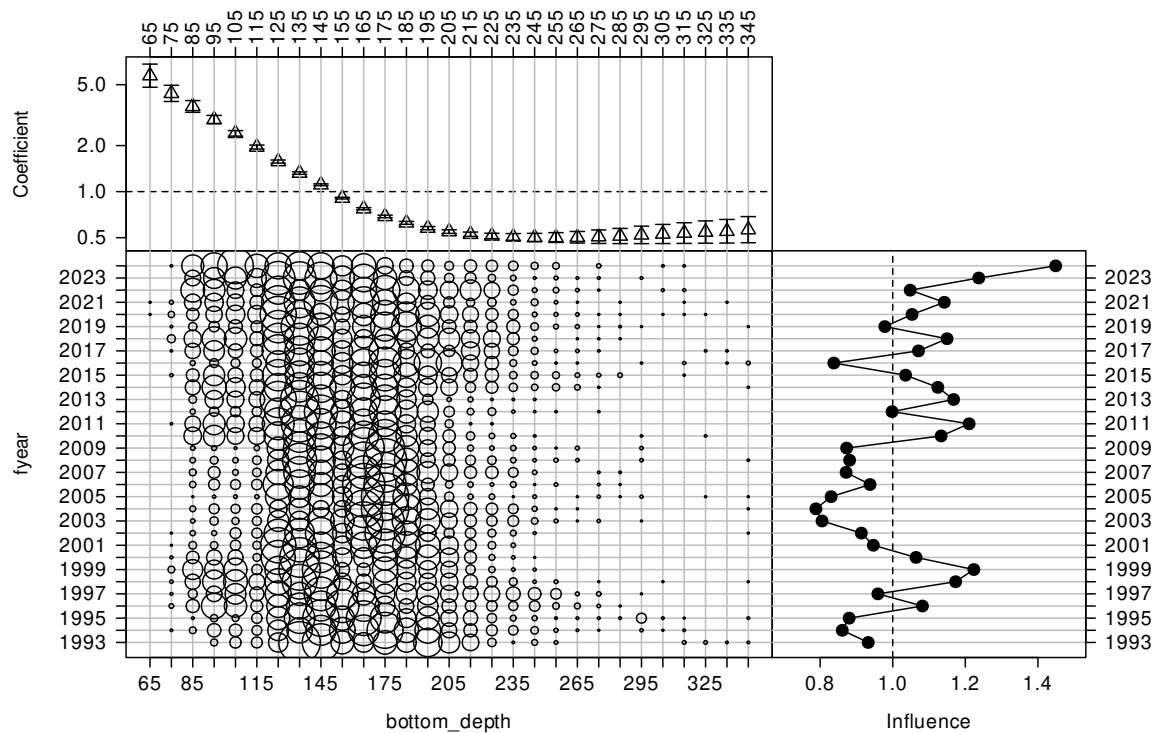


Figure D.74: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

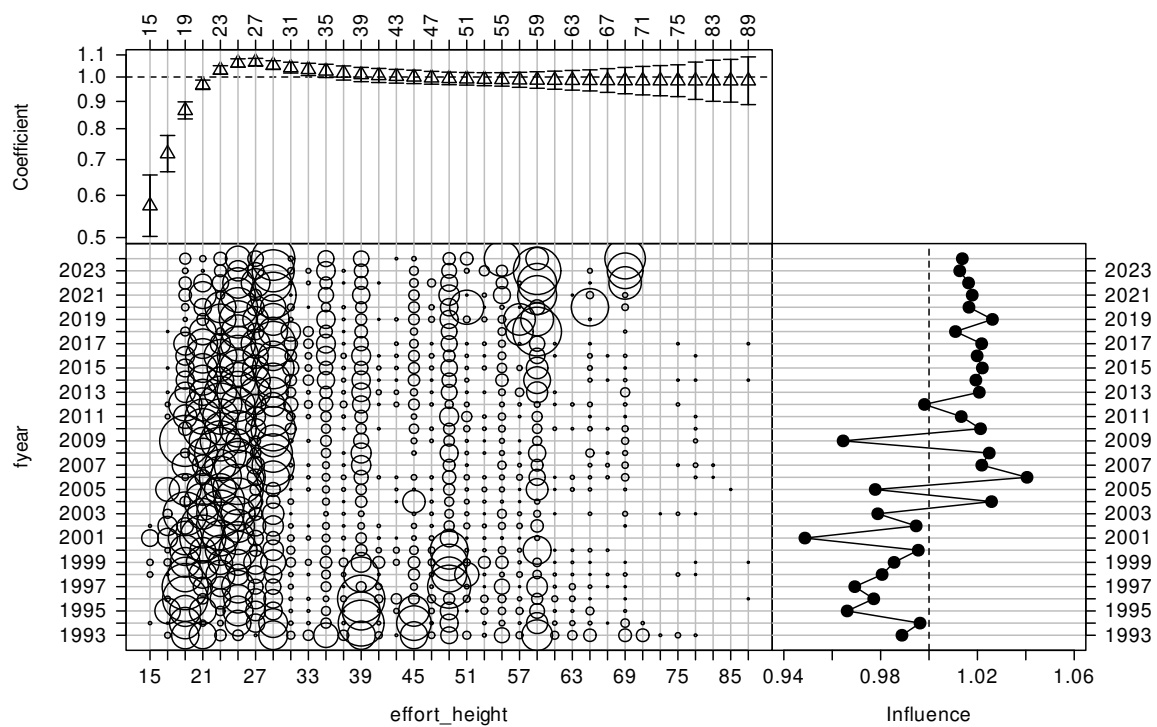


Figure D.75: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

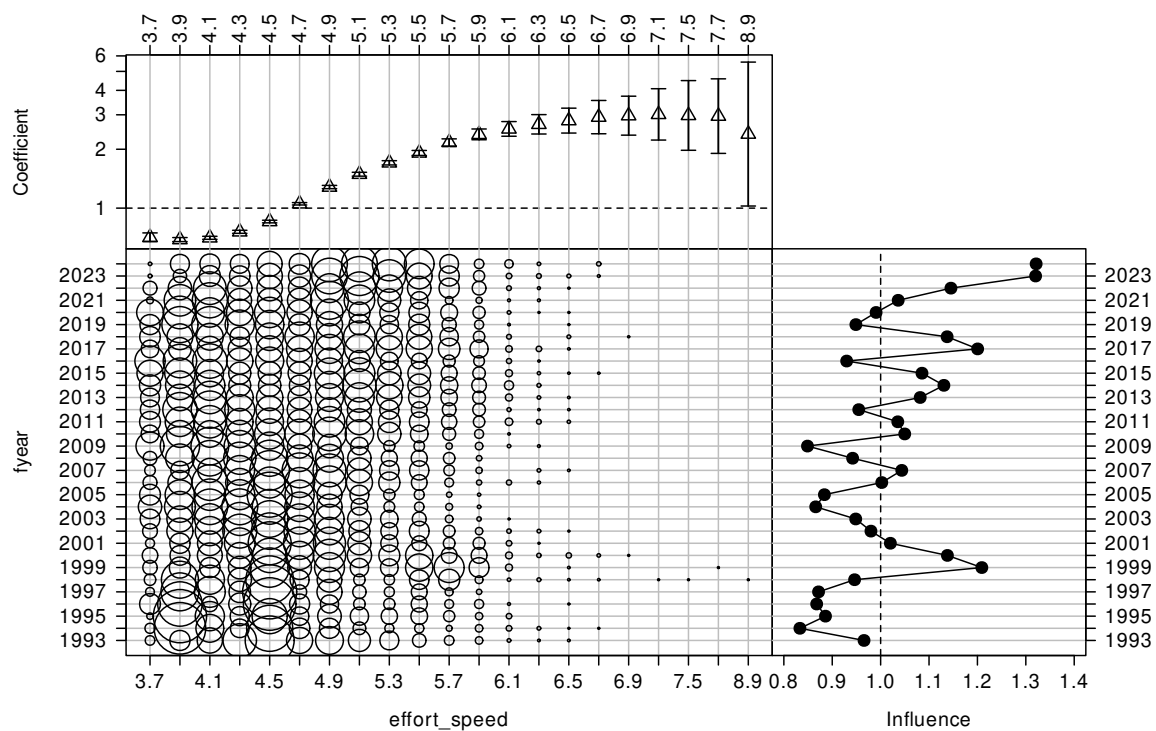


Figure D.76: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW event (season day) catch-per-unit-effort dataset.

Table D.17: Summary table for the lognormal model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	85 754.07	0.00	0.00	*
fyear	31	83 653.55	9.26	9.26	*
vessel_key	11	83 059.48	11.74	2.48	*
target_species	2	80 391.64	21.72	9.99	*
stat_area	12	79 890.48	23.55	1.83	*
ns(SeasonDay, 3)	3	79 637.70	24.43	0.88	*
ns(log(fishing_duration), 3)	3	79 567.17	24.69	0.26	*
ns(log(start_time), 3)	3	79 414.15	25.23	0.54	*
ns(log(bottom_depth), 3)	3	79 197.07	25.97	0.75	*
ns(log(effort_height), 3)	3	79 122.72	26.24	0.27	*
ns(effort_speed, 3)	3	78 966.96	26.78	0.53	*

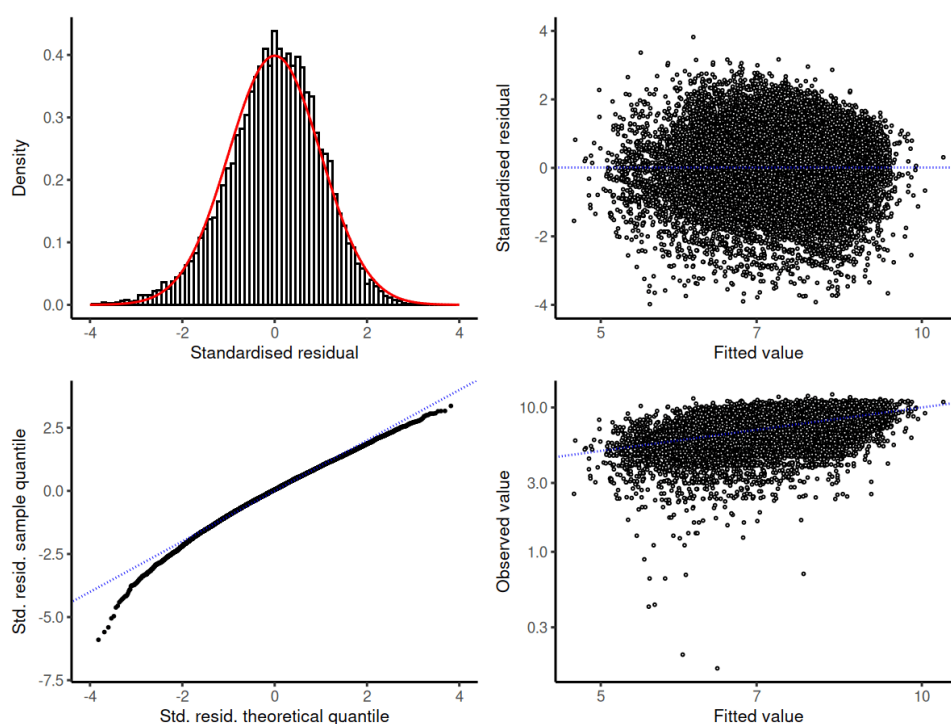


Figure D.77: Diagnostic plots for the selected lognormal model for positive catches in the JMA3 MW event (season day) dataset.

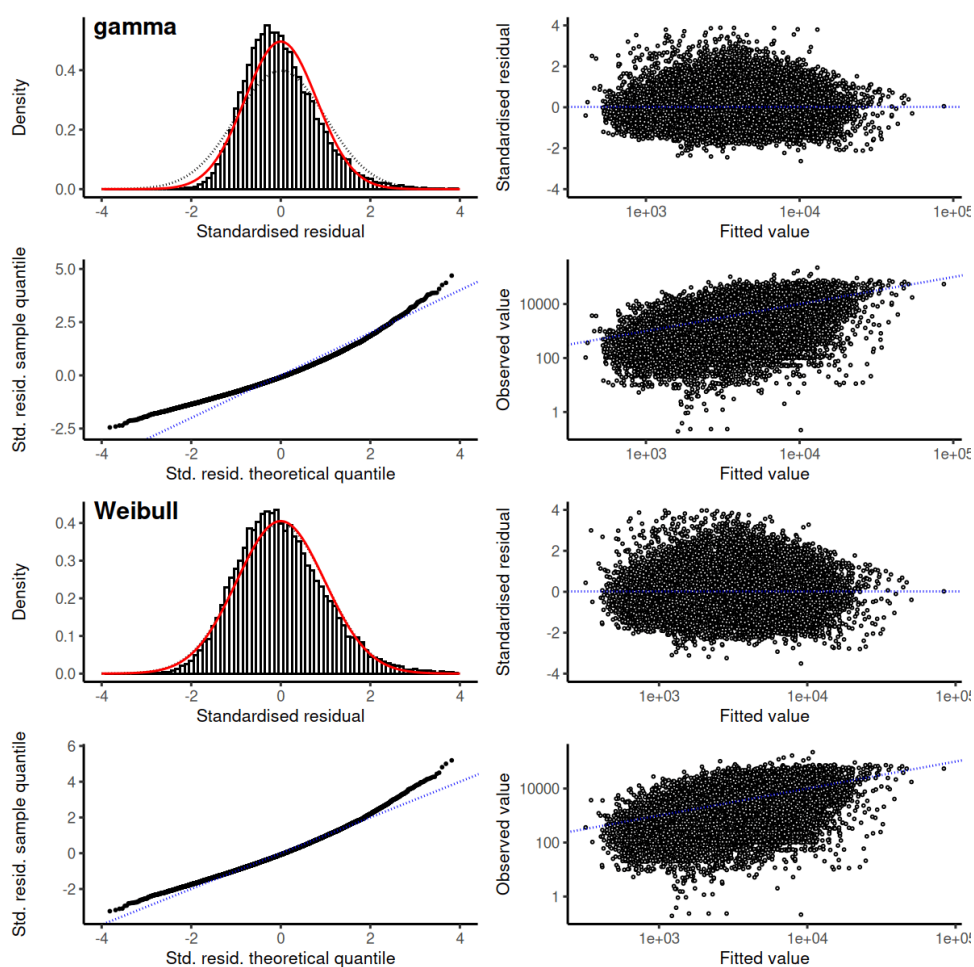


Figure D.78: Diagnostic plots for the alternative gamma and Weibull models considered for positive catches in the JMA3 MW event (season day) dataset.

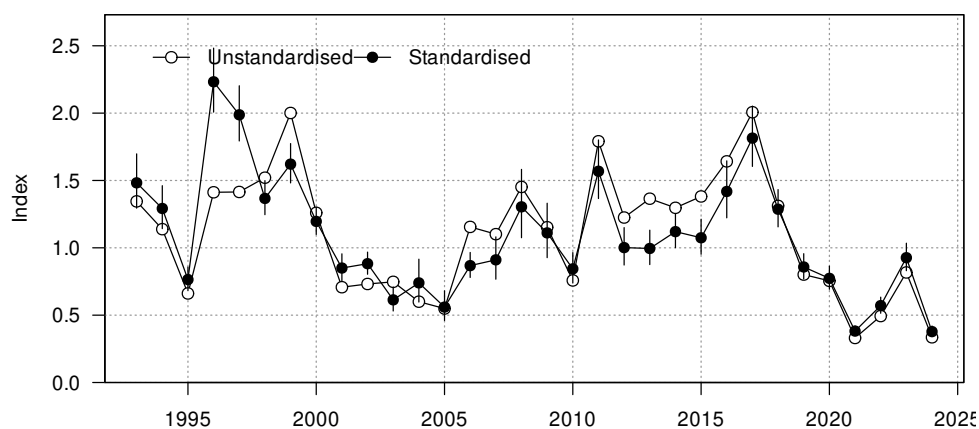


Figure D.79: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the lognormal model for the JMA3 MW event (season day) dataset.

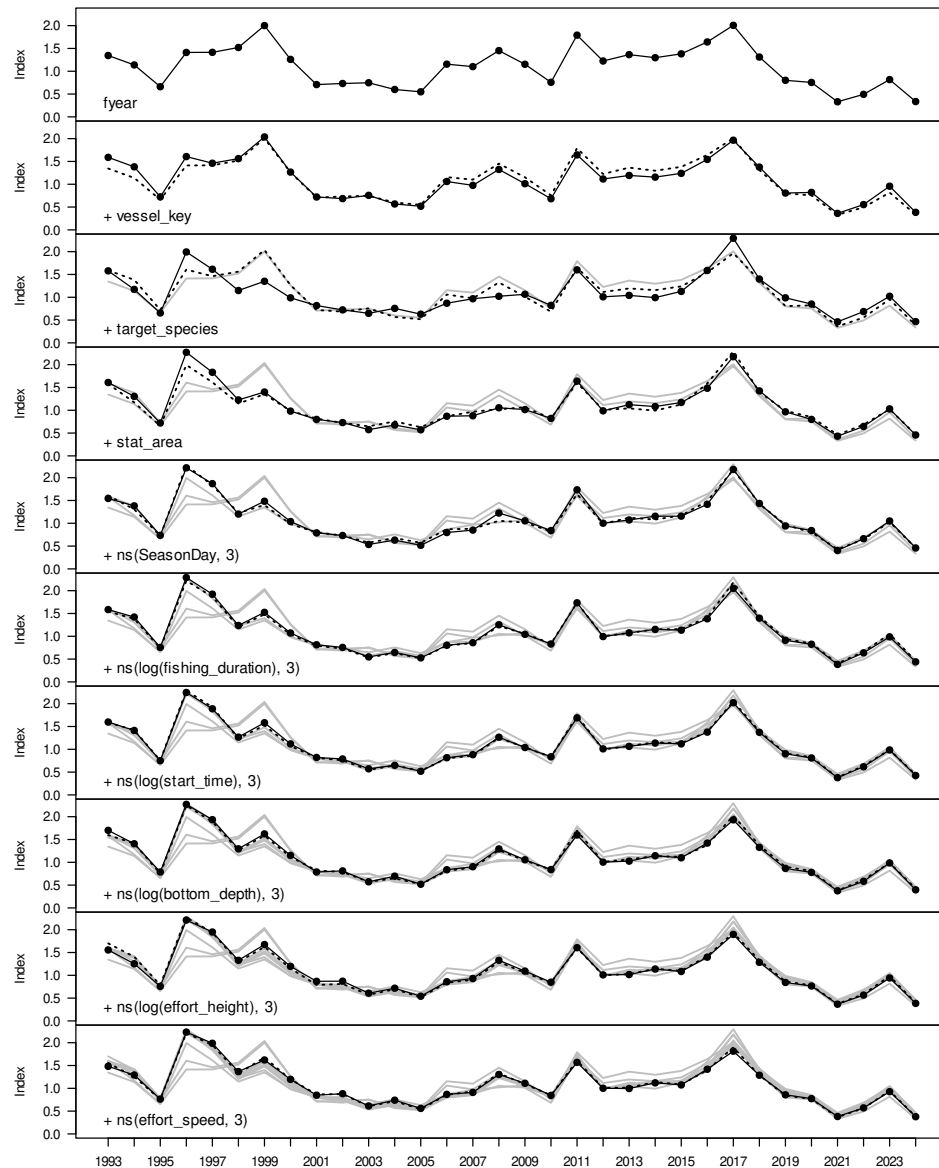


Figure D.80: Changes to the JMA3 MW event (season day) positive catch index as terms are successively entered into the lognormal model.

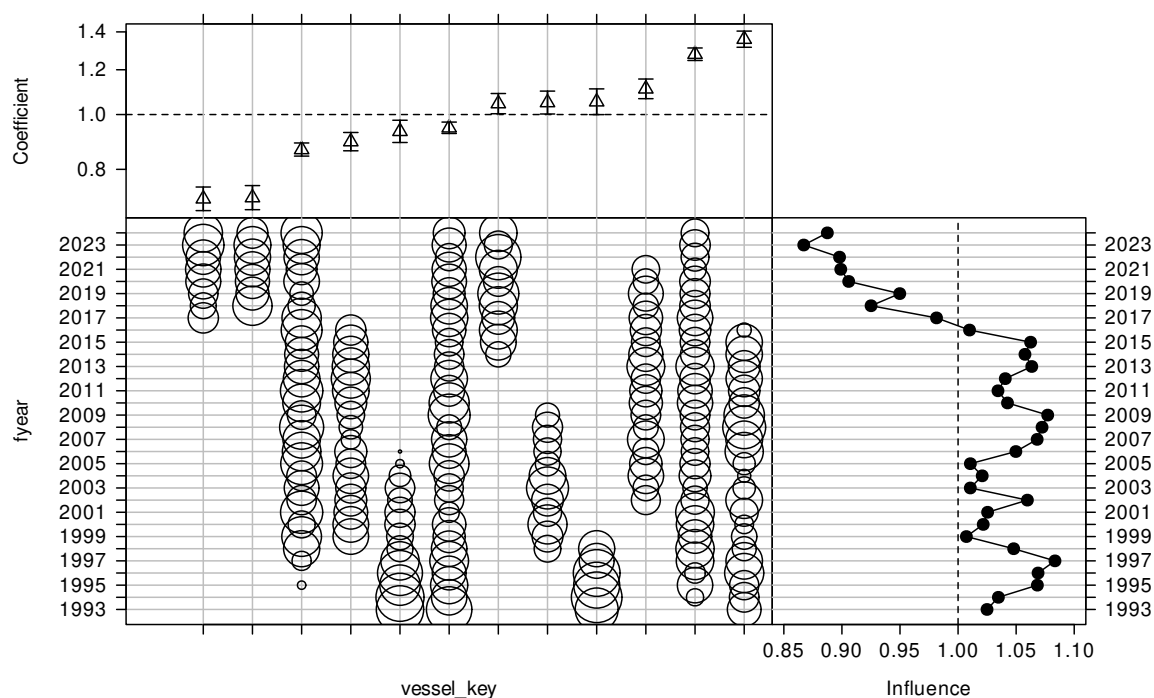


Figure D.81: CDI plot for vessel key for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

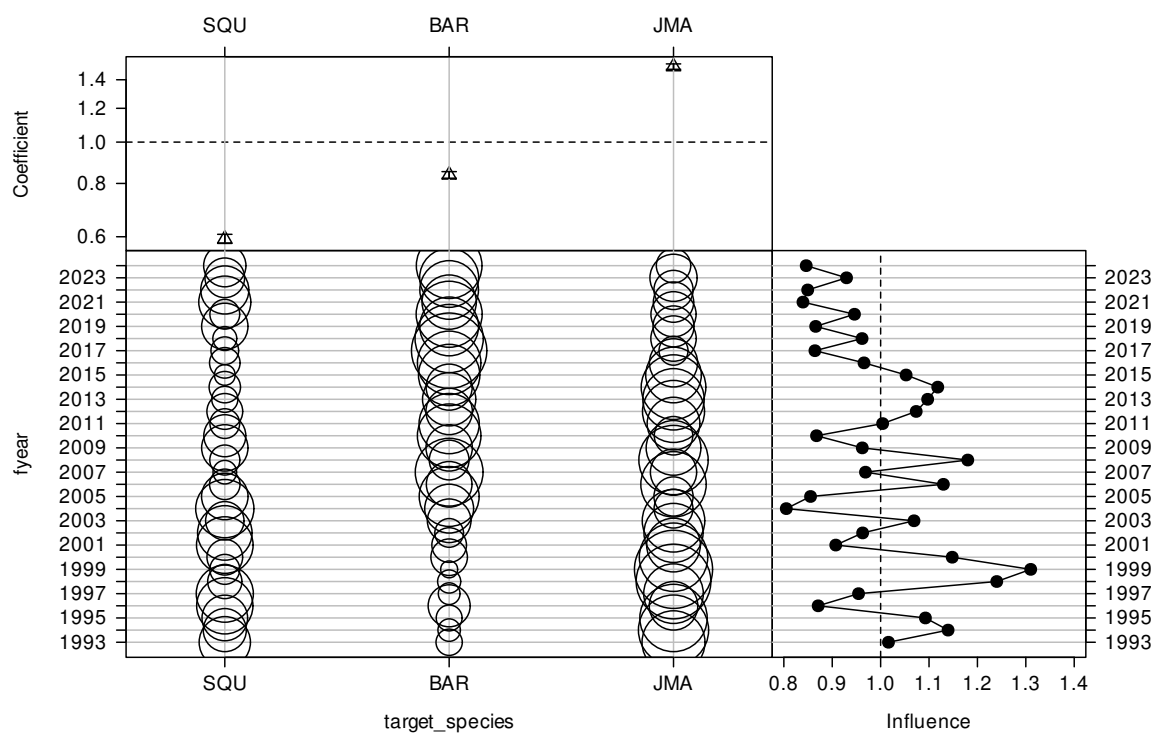


Figure D.82: CDI plot for target species for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

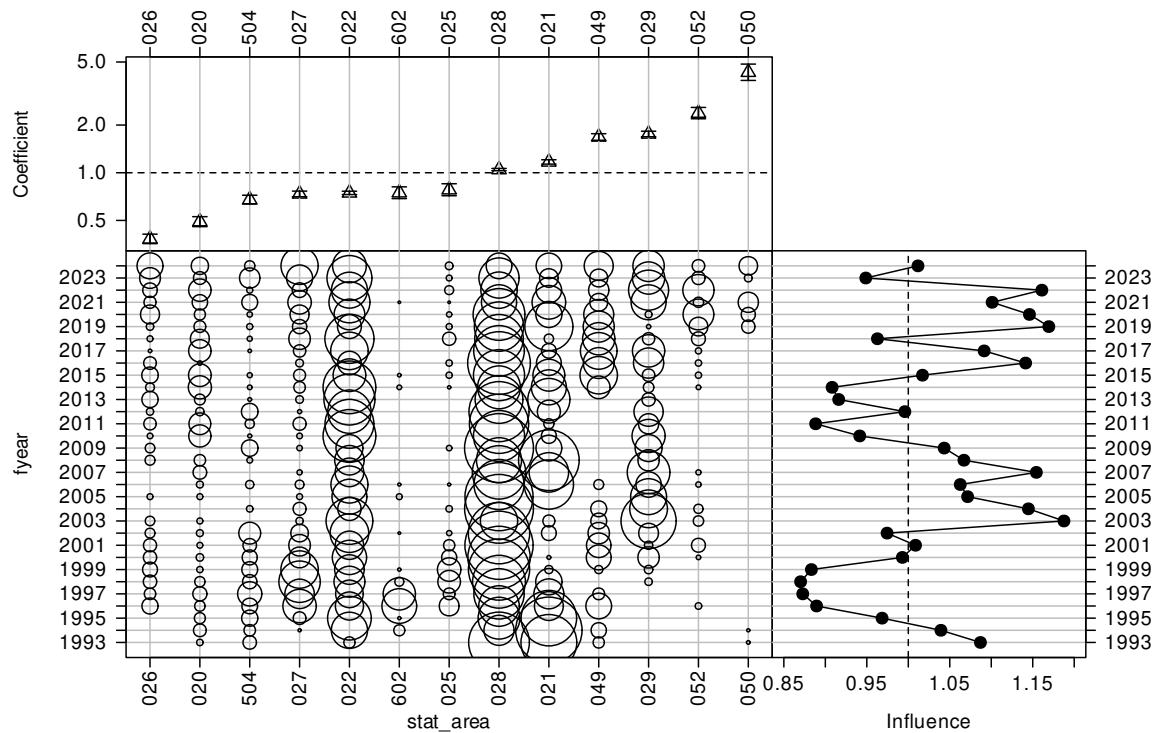


Figure D.83: CDI plot for statistical area for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

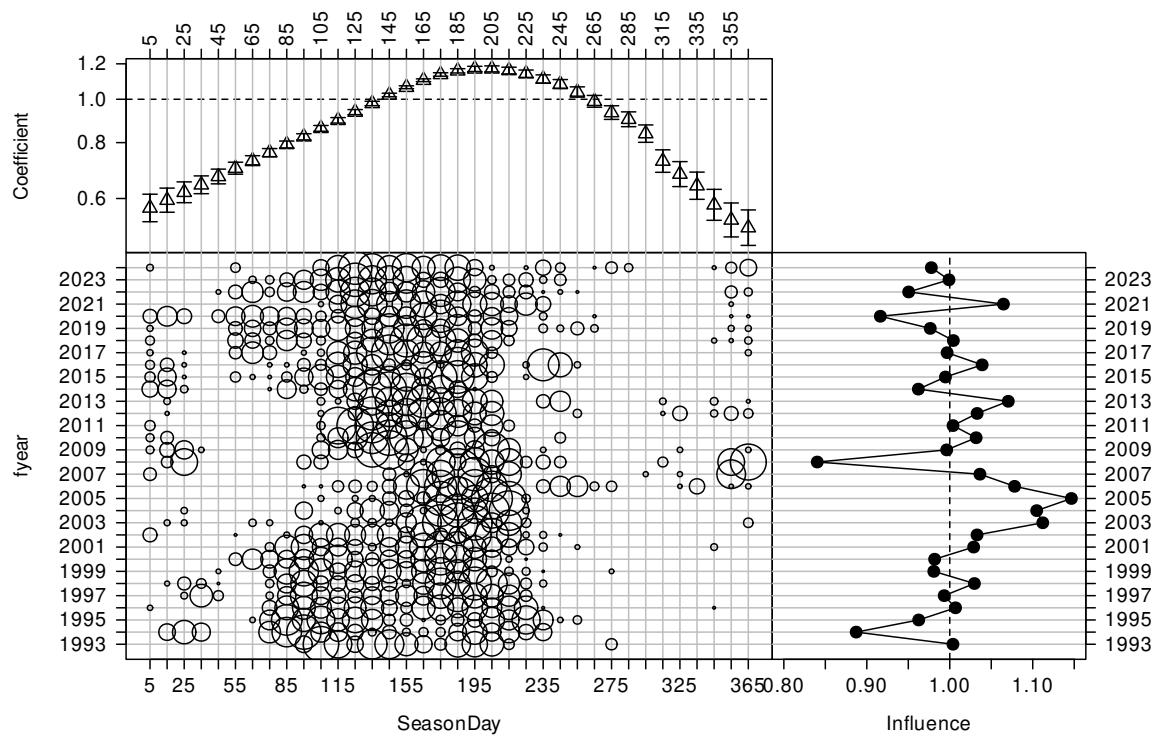


Figure D.84: CDI plot for SeasonDay for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

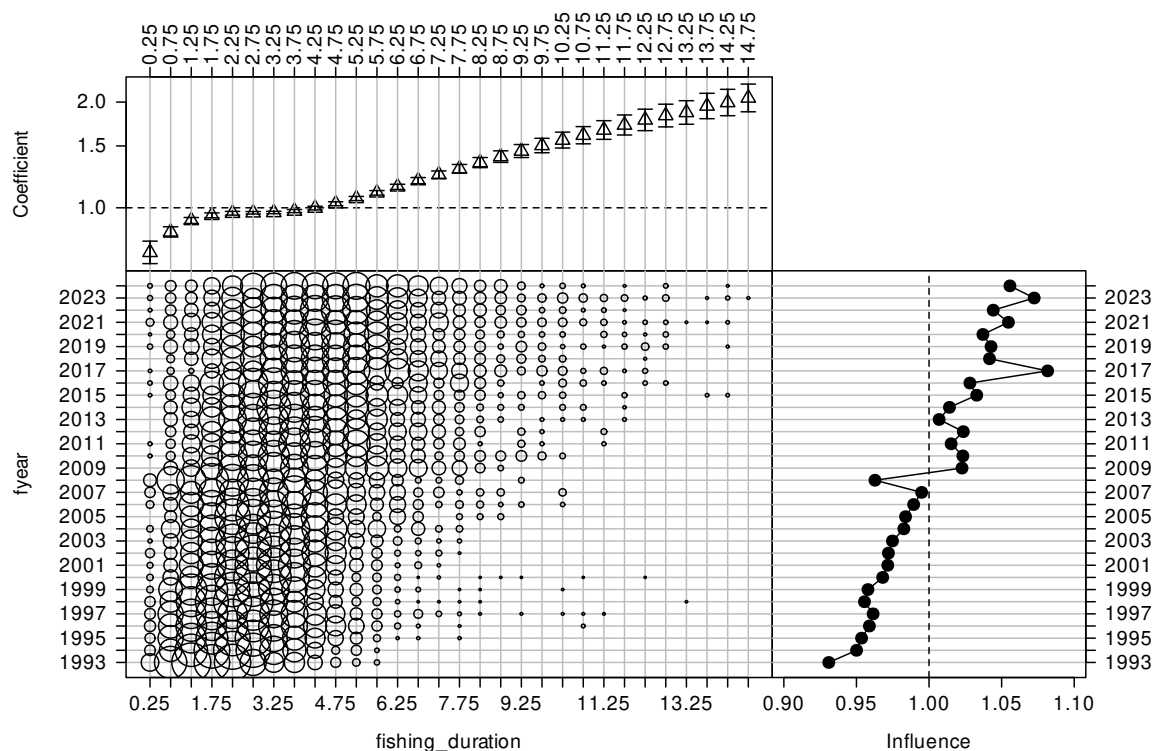


Figure D.85: CDI plot for fishing duration (h) for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

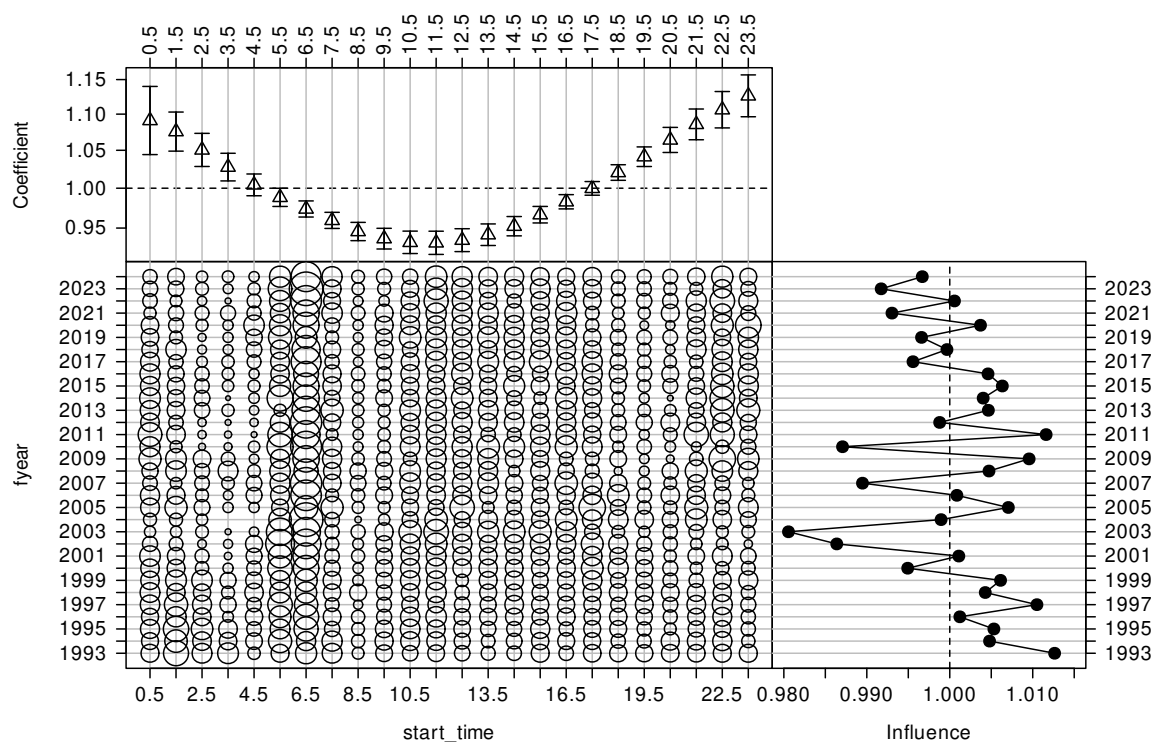


Figure D.86: CDI plot for start time for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

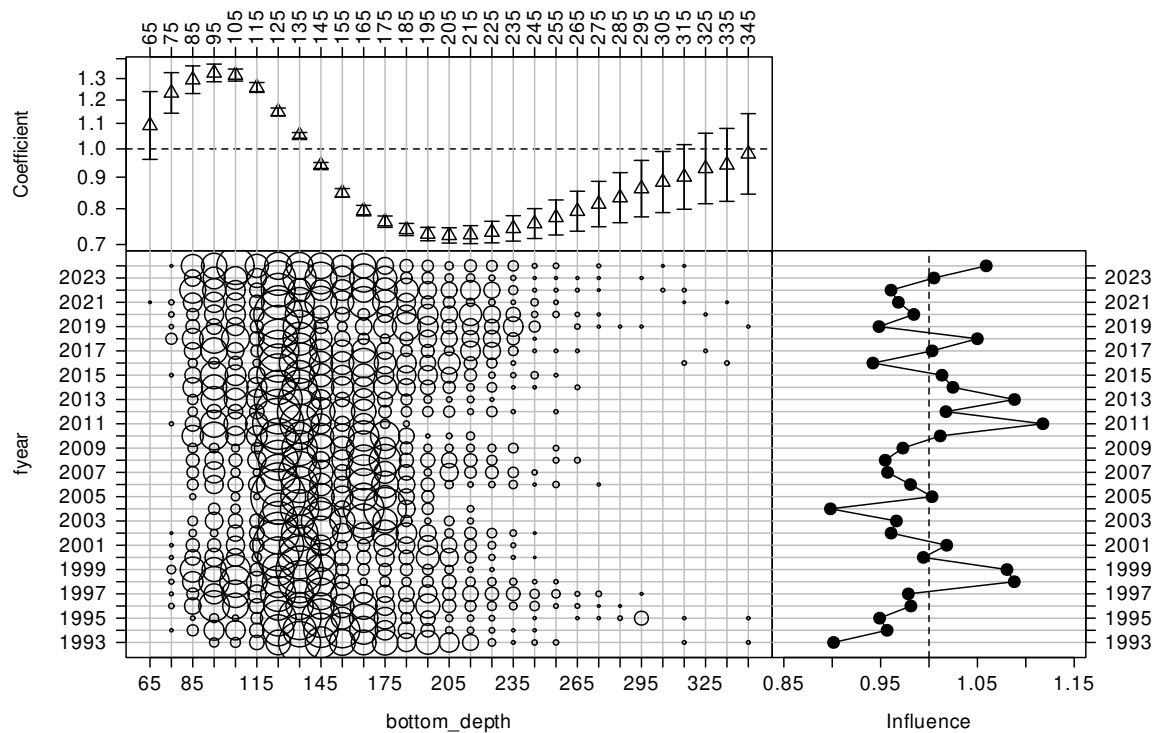


Figure D.87: CDI plot for bottom depth (m) for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

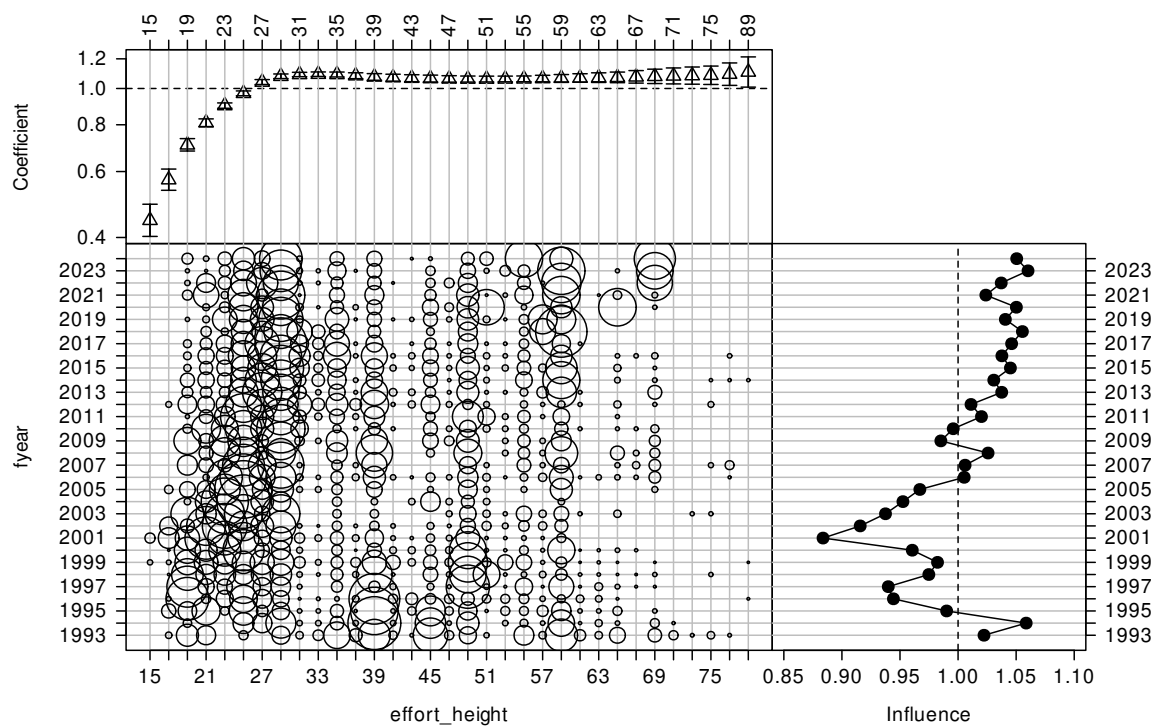


Figure D.88: CDI plot for effort height (m) for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

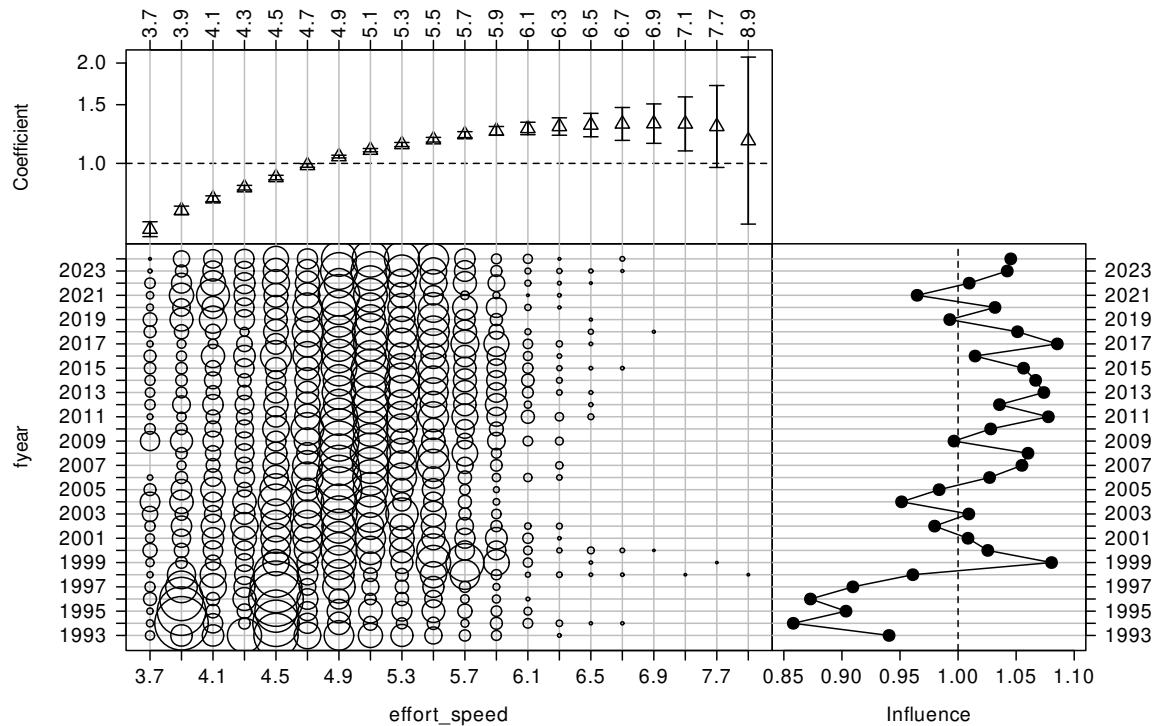


Figure D.89: CDI plot for effort speed for the lognormal model of positive catches in the JMA3 MW event (season day) catch-per-unit-effort dataset.

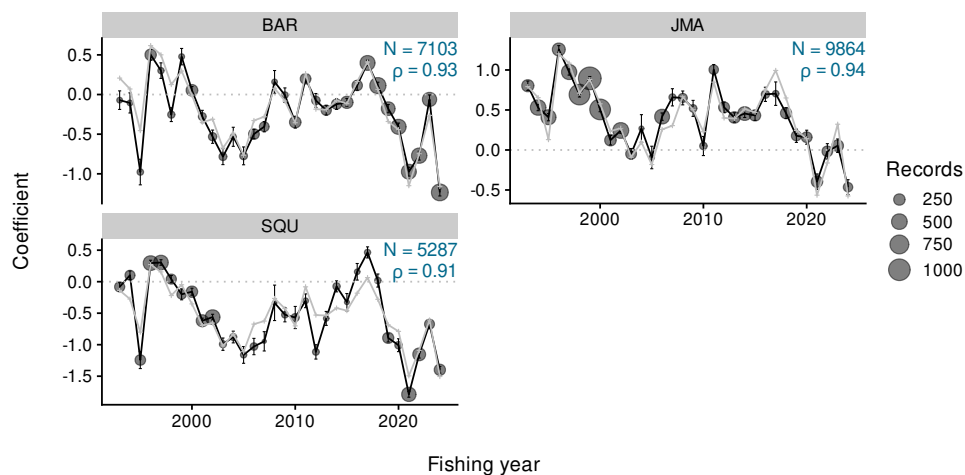


Figure D.90: Residual implied coefficients for target-year in the lognormal positive catch model for the JMA3 MW event (season day) dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

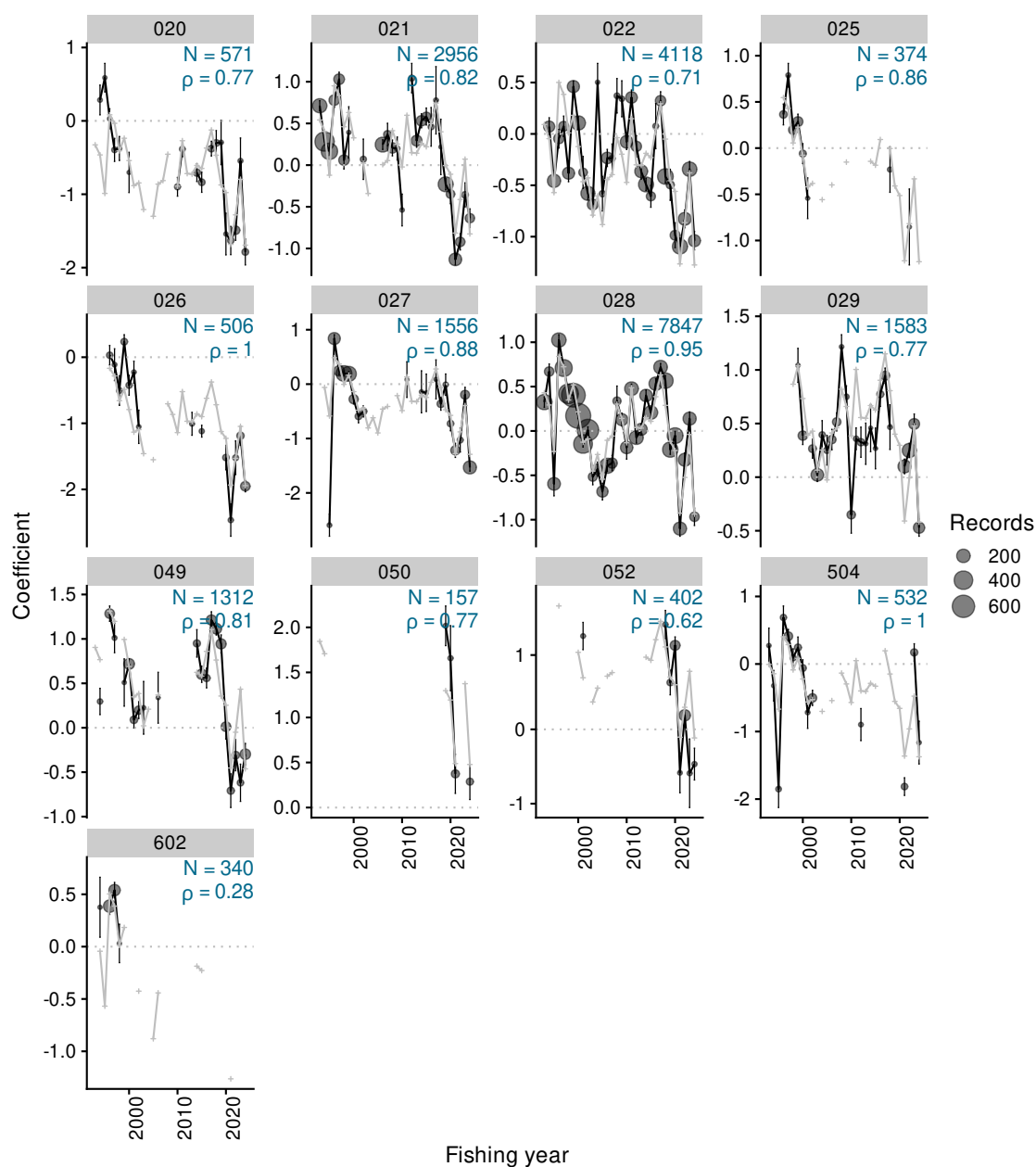


Figure D.91: Residual implied coefficients for area-year in the lognormal positive catch model for the JMA3 MW event (season day) dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

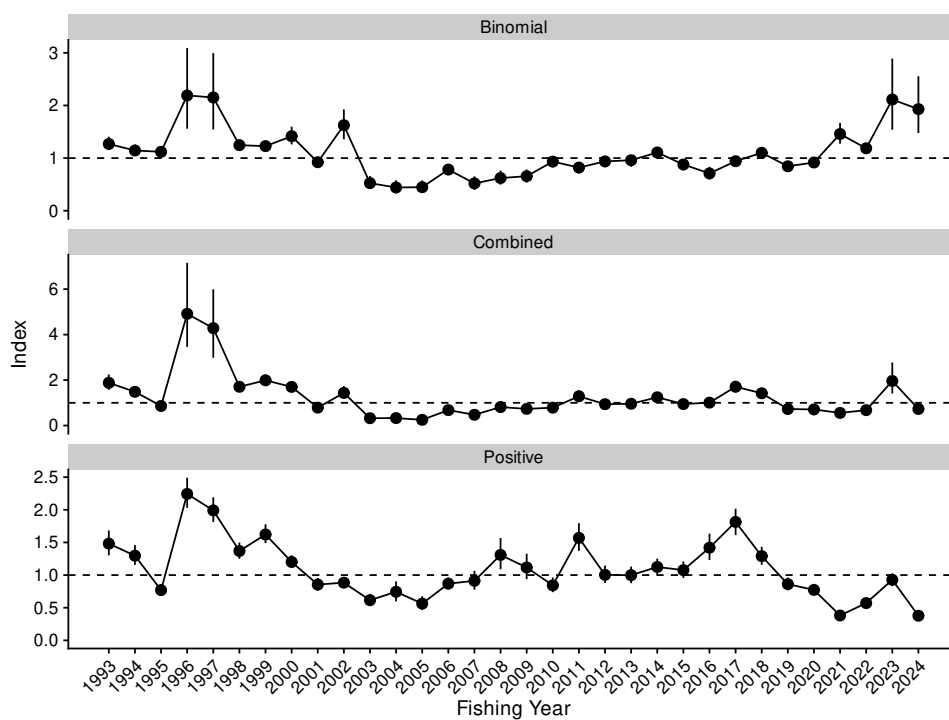


Figure D.92: Standardised indices and 95% confidence intervals for the JMA3 MW event (season day) dataset.

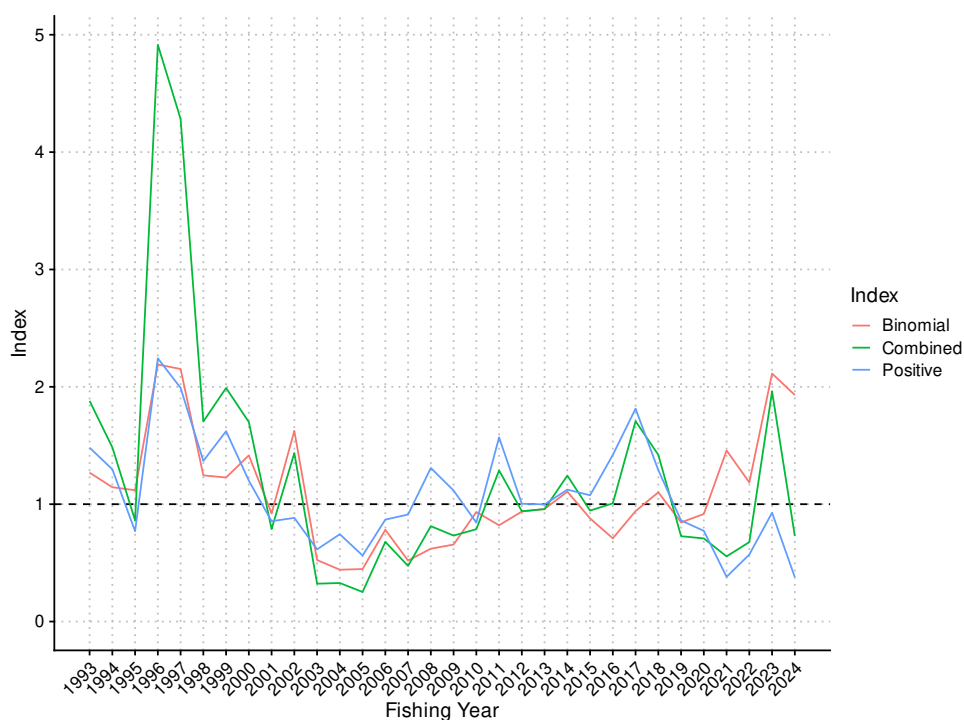


Figure D.93: Standardised indices for the JMA3 MW event (season day) dataset.

Table D.18: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW event (season day) series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.269	0.065	1.153	1.407	1.880	0.172	1.573	2.246	1.482	0.097	1.302	1.683
1994	1.144	0.054	1.047	1.258	1.485	0.115	1.269	1.720	1.297	0.077	1.156	1.460
1995	1.119	0.047	1.035	1.220	0.862	0.060	0.753	0.989	0.770	0.044	0.690	0.862
1996	2.190	0.391	1.559	3.091	4.914	0.943	3.459	7.157	2.243	0.118	2.031	2.492
1997	2.152	0.370	1.545	2.994	4.283	0.767	2.984	5.991	1.991	0.096	1.814	2.192
1998	1.246	0.052	1.154	1.359	1.705	0.106	1.513	1.929	1.369	0.063	1.250	1.499
1999	1.227	0.051	1.135	1.336	1.990	0.120	1.770	2.242	1.622	0.073	1.490	1.777
2000	1.416	0.086	1.260	1.596	1.700	0.121	1.478	1.951	1.201	0.049	1.110	1.304
2001	0.922	0.041	0.835	0.996	0.788	0.060	0.670	0.905	0.855	0.050	0.761	0.956
2002	1.625	0.145	1.358	1.924	1.435	0.145	1.170	1.738	0.884	0.041	0.807	0.966
2003	0.524	0.063	0.413	0.660	0.323	0.046	0.242	0.422	0.615	0.045	0.538	0.713
2004	0.442	0.063	0.331	0.578	0.328	0.054	0.233	0.446	0.744	0.078	0.597	0.903
2005	0.447	0.060	0.339	0.575	0.252	0.043	0.179	0.346	0.563	0.054	0.466	0.676
2006	0.782	0.053	0.678	0.886	0.679	0.057	0.570	0.793	0.869	0.047	0.779	0.963
2007	0.519	0.065	0.398	0.653	0.474	0.071	0.347	0.624	0.912	0.073	0.778	1.066
2008	0.621	0.068	0.496	0.762	0.813	0.121	0.597	1.071	1.309	0.122	1.090	1.567
2009	0.656	0.063	0.535	0.784	0.733	0.098	0.558	0.942	1.116	0.099	0.938	1.327
2010	0.934	0.052	0.823	1.026	0.787	0.071	0.650	0.928	0.843	0.057	0.738	0.962
2011	0.820	0.055	0.709	0.926	1.288	0.124	1.061	1.547	1.569	0.108	1.371	1.795
2012	0.937	0.052	0.828	1.033	0.940	0.087	0.774	1.113	1.003	0.068	0.880	1.147
2013	0.959	0.057	0.837	1.059	0.958	0.081	0.810	1.127	0.998	0.065	0.875	1.131
2014	1.107	0.047	1.020	1.206	1.244	0.088	1.081	1.425	1.124	0.063	1.006	1.252
2015	0.879	0.054	0.766	0.977	0.945	0.081	0.792	1.111	1.076	0.065	0.957	1.210
2016	0.709	0.062	0.593	0.834	1.007	0.115	0.794	1.243	1.420	0.103	1.231	1.635
2017	0.941	0.050	0.832	1.029	1.707	0.133	1.447	1.970	1.814	0.103	1.612	2.017
2018	1.101	0.045	1.016	1.193	1.420	0.095	1.247	1.618	1.290	0.070	1.157	1.432
2019	0.844	0.049	0.744	0.936	0.727	0.059	0.613	0.845	0.861	0.050	0.766	0.963
2020	0.917	0.044	0.823	0.995	0.708	0.054	0.611	0.823	0.773	0.043	0.695	0.865
2021	1.458	0.100	1.274	1.668	0.555	0.047	0.473	0.656	0.381	0.019	0.344	0.417
2022	1.186	0.050	1.093	1.288	0.677	0.046	0.594	0.773	0.571	0.030	0.516	0.634
2023	2.113	0.345	1.540	2.891	1.960	0.347	1.412	2.773	0.927	0.050	0.831	1.027
2024	1.930	0.275	1.476	2.556	0.729	0.113	0.544	0.988	0.378	0.019	0.340	0.416

D.4 JMA3 MW process daily

Table D.19: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW process daily CPUE series.

Series	JMA3 MW process daily
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Day
Core fleet years	5
Core fleet trips	5
Default model	$\text{prockg} \sim \text{fyear} + \text{vessel_key} + \text{target_species} + \text{stat_area} + \text{month} + \text{ns}(\log(\text{fishing_duration}), 3) + \text{ns}(\text{bottom_depth}, 3)$
Stepwise selection	No
Positive catch distribution	Gamma

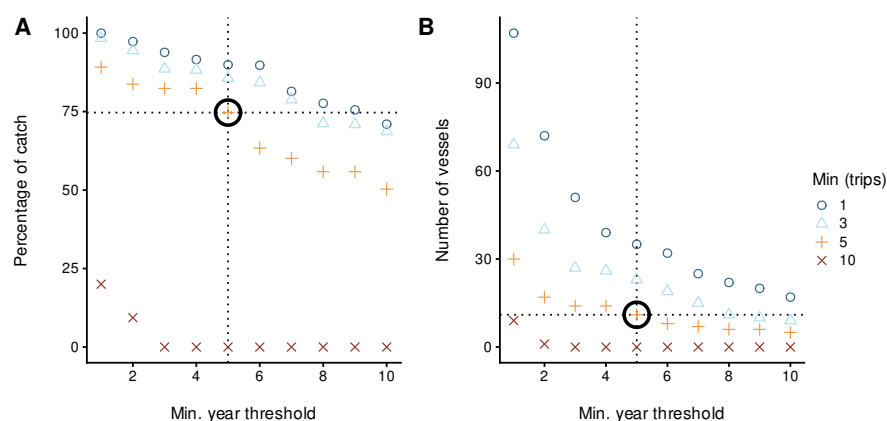


Figure D.94: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW process daily CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

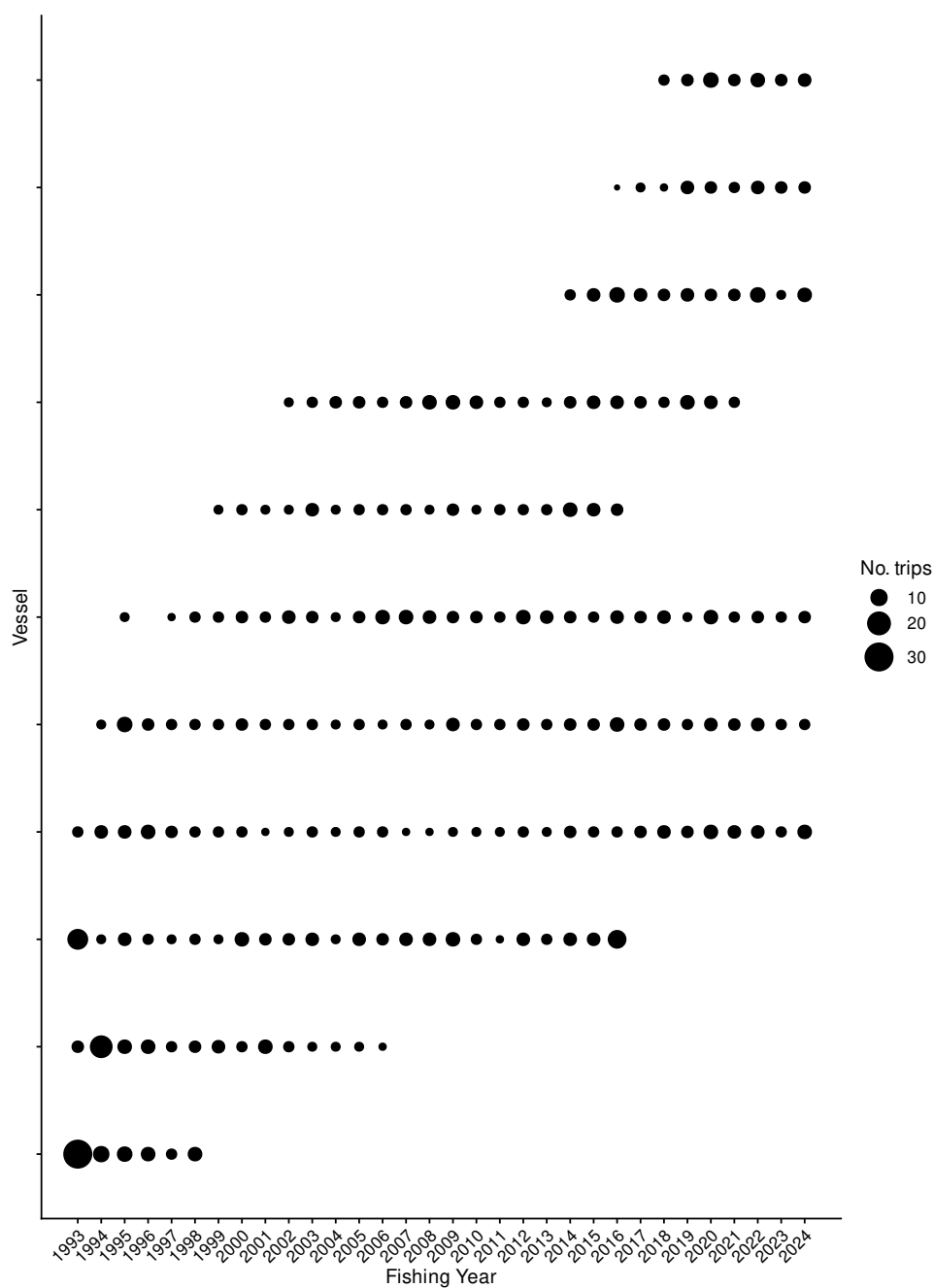


Figure D.95: Number of trips by fishing year for core vessels in the JMA3 MW process daily series. The area of the circles is proportional to the number of trips undertaken by a vessel in a fishing year.

Table D.20: Summary of the JMA3 MW process daily dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next page)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	9888 (100%) n: 2379	5001 (100%) n: 2115	6900 (100%) n: 2567	13647 (100%) n: 2815	10815 (100%) n: 1947	11540 (100%) n: 1783	11822 (100%) n: 1733	8139 (100%) n: 1239	1753 (100%) n: 1021
Fishing duration is not NA	9888 (100%) n: 2379	5001 (100%) n: 2115	6900 (100%) n: 2567	13647 (100%) n: 2815	10815 (100%) n: 1947	11540 (100%) n: 1783	11822 (100%) n: 1733	8139 (100%) n: 1239	1753 (100%) n: 1021
Positive fishing duration	9888 (100%) n: 2379	5001 (100%) n: 2115	6900 (100%) n: 2567	13647 (100%) n: 2815	10815 (100%) n: 1947	11540 (100%) n: 1783	11822 (100%) n: 1733	8139 (100%) n: 1239	1753 (100%) n: 1021
Less than 24 hrs fished	9771 (99%) n: 2358	4994 (100%) n: 2102	6855 (99%) n: 2561	13513 (99%) n: 2797	10535 (97%) n: 1919	11250 (97%) n: 1761	11655 (99%) n: 1723	7985 (98%) n: 1225	1753 (100%) n: 1021
Bottom depth <350m	9662 (98%) n: 2330	4967 (99%) n: 2079	6778 (98%) n: 2495	13403 (98%) n: 2777	10424 (96%) n: 1905	11121 (96%) n: 1755	11520 (97%) n: 1706	7934 (97%) n: 1217	1734 (99%) n: 1014
Core fleet selection	4126 (42%) n: 351	3407 (68%) n: 606	3995 (58%) n: 582	7230 (53%) n: 573	5203 (48%) n: 536	6333 (55%) n: 657	7260 (61%) n: 586	5184 (64%) n: 594	1369 (78%) n: 623
Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	3461 (100%) n: 1083	1497 (100%) n: 1066	446 (100%) n: 1123	509 (100%) n: 1099	4520 (100%) n: 958	1322 (100%) n: 895	2073 (100%) n: 877	1783 (100%) n: 805	2465 (100%) n: 498
Fishing duration is not NA	3461 (100%) n: 1083	1497 (100%) n: 1066	446 (100%) n: 1123	509 (100%) n: 1099	4520 (100%) n: 958	1322 (100%) n: 895	2073 (100%) n: 877	1783 (100%) n: 805	2465 (100%) n: 498
Positive fishing duration	3461 (100%) n: 1083	1497 (100%) n: 1066	446 (100%) n: 1123	509 (100%) n: 1099	4520 (100%) n: 958	1322 (100%) n: 895	2073 (100%) n: 877	1783 (100%) n: 805	2465 (100%) n: 498
Less than 24 hrs fished	3447 (100%) n: 1079	1496 (100%) n: 1055	446 (100%) n: 1115	508 (100%) n: 1089	4516 (100%) n: 950	1319 (100%) n: 878	2073 (100%) n: 850	1774 (99%) n: 771	2465 (100%) n: 497
Bottom depth <350m	3446 (100%) n: 1076	1496 (100%) n: 1055	446 (100%) n: 1111	508 (100%) n: 1087	4516 (100%) n: 950	1295 (98%) n: 875	2073 (100%) n: 849	1774 (99%) n: 771	2465 (100%) n: 496
Core fleet selection	2758 (80%) n: 731	1009 (67%) n: 640	371 (83%) n: 671	476 (94%) n: 684	4303 (95%) n: 615	1073 (81%) n: 497	1553 (75%) n: 500	1276 (72%) n: 564	2363 (96%) n: 427

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	3387 (100%) n: 511	2435 (100%) n: 538	3399 (100%) n: 450	4167 (100%) n: 518	3506 (100%) n: 488	2249 (100%) n: 555	3890 (100%) n: 553	5002 (100%) n: 559	4049 (100%) n: 703
Fishing duration is not NA	3387 (100%) n: 511	2435 (100%) n: 538	3399 (100%) n: 450	4167 (100%) n: 518	3506 (100%) n: 488	2249 (100%) n: 555	3890 (100%) n: 553	5002 (100%) n: 559	4049 (100%) n: 703
Positive fishing duration	3387 (100%) n: 511	2435 (100%) n: 538	3399 (100%) n: 450	4167 (100%) n: 518	3506 (100%) n: 488	2249 (100%) n: 555	3890 (100%) n: 553	5002 (100%) n: 559	4049 (100%) n: 703
Less than 24 hrs fished	3363 (99%) n: 506	2433 (100%) n: 532	3376 (99%) n: 446	4165 (100%) n: 514	3467 (99%) n: 478	2153 (96%) n: 545	3808 (98%) n: 543	4823 (96%) n: 545	3962 (98%) n: 682
Bottom depth <350m	3363 (99%) n: 505	2433 (100%) n: 531	3376 (99%) n: 446	4165 (100%) n: 514	3467 (99%) n: 477	2153 (96%) n: 545	3808 (98%) n: 543	4823 (96%) n: 544	3960 (98%) n: 681
Core fleet selection	3345 (99%) n: 454	2339 (96%) n: 495	3334 (98%) n: 408	4146 (99%) n: 502	3456 (99%) n: 473	2113 (94%) n: 522	3774 (97%) n: 467	4815 (96%) n: 537	3888 (96%) n: 669

Filter	2020	2021	2022	2023	2024
Ungroomed data	4577 (100%) n: 798	4989 (100%) n: 638	4402 (100%) n: 602	4302 (100%) n: 393	2669 (100%) n: 487
Fishing duration is not NA	4577 (100%) n: 798	4989 (100%) n: 638	4402 (100%) n: 602	4302 (100%) n: 393	2669 (100%) n: 487
Positive fishing duration	4577 (100%) n: 798	4989 (100%) n: 638	4402 (100%) n: 602	4302 (100%) n: 393	2669 (100%) n: 487
Less than 24 hrs fished	4519 (99%) n: 784	4939 (99%) n: 622	4390 (100%) n: 599	4188 (97%) n: 389	2586 (97%) n: 477
Bottom depth <350m	4519 (99%) n: 784	4939 (99%) n: 621	4390 (100%) n: 596	4185 (97%) n: 388	2586 (97%) n: 477
Core fleet selection	4249 (93%) n: 737	4848 (97%) n: 571	4124 (94%) n: 530	4111 (96%) n: 359	2489 (93%) n: 406

Table D.21: Summary of the JMA3 MW process daily dataset after core fleet selection. ‘Records’ indicates the number of rows (days) in the dataset, and ‘Records caught’ indicates the percentage of days with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	351	2 740.52	4 125.74	76.35
1994	5	39	606	5 452.37	3 406.72	52.97
1995	6	38	582	5 455.22	3 995.16	51.72
1996	5	30	573	5 345.48	7 229.85	76.96
1997	6	22	536	5 397.02	5 202.93	76.87
1998	6	28	657	6 090.05	6 332.81	64.38
1999	6	24	586	6 078.17	7 259.65	81.57
2000	6	29	594	5 811.35	5 183.88	76.26
2001	6	25	623	6 306.56	1 369.49	67.09
2002	7	28	731	7 401.40	2 757.74	67.99
2003	7	32	640	6 920.04	1 008.93	31.56
2004	7	23	671	7 547.55	371.03	37.70
2005	7	31	684	8 144.13	476.14	31.43
2006	7	29	615	7 292.73	4 303.31	58.70
2007	6	28	497	6 157.58	1 073.14	39.03
2008	6	27	500	6 851.62	1 553.04	34.60
2009	6	33	564	7 630.20	1 275.62	46.45
2010	6	25	427	5 374.40	2 362.63	74.94
2011	6	21	454	5 906.85	3 345.16	67.40
2012	6	30	495	6 004.30	2 339.13	65.45
2013	6	24	408	4 994.40	3 333.71	75.25
2014	7	37	502	6 330.90	4 145.81	79.28
2015	7	37	473	6 295.67	3 456.36	76.32
2016	8	49	522	6 265.05	2 113.03	56.90
2017	6	29	467	6 286.20	3 773.73	80.94
2018	7	32	537	7 520.80	4 815.16	83.43
2019	7	36	669	9 684.25	3 888.36	88.34
2020	7	44	737	10 253.60	4 249.15	79.38
2021	7	33	571	7 747.30	4 847.59	91.94
2022	6	38	530	7 379.57	4 124.46	86.60
2023	6	25	359	4 667.58	4 111.38	93.31
2024	6	34	406	5 254.67	2 489.40	90.39

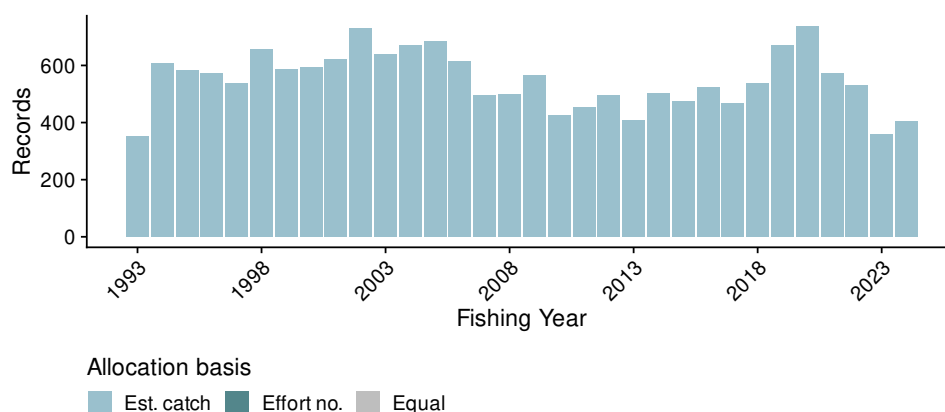


Figure D.96: The allocation approach used for attributing catches to records in the JMA3 MW process daily catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.22: Summary table for occurrence of positive catch in the JMA3 MW process daily series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	22 418.05	0.00	0.00	*
fyear	31	19 756.91	12.15	12.15	*
vessel_key	10	19 704.32	12.47	0.32	*
target_species	2	17 813.47	20.93	8.45	*
stat_area	12	15 470.87	31.48	10.56	*
month	11	15 026.14	33.56	2.08	*
ns(log(fishing_duration), 3)	3	14 702.47	35.04	1.47	*
ns(bottom_depth, 3)	3	14 659.64	35.25	0.22	*

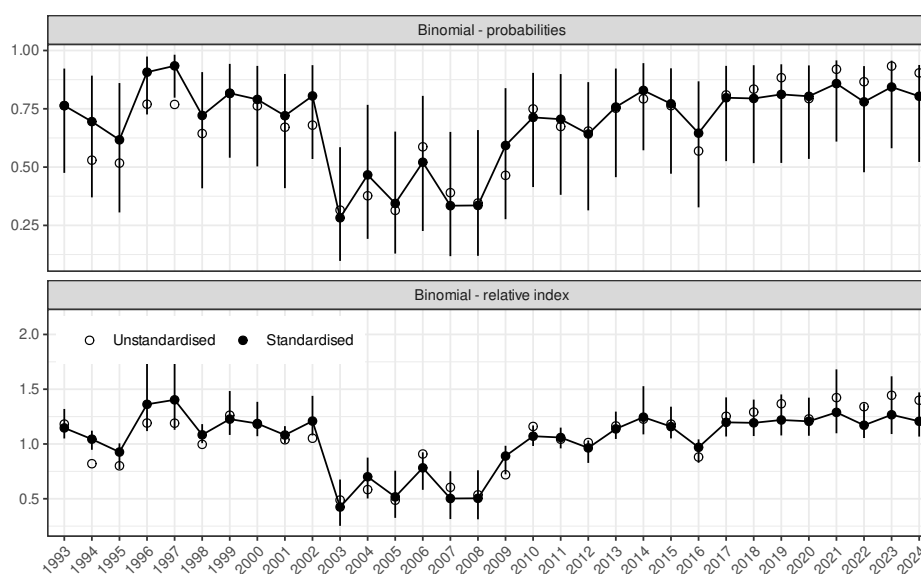


Figure D.97: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW process daily dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

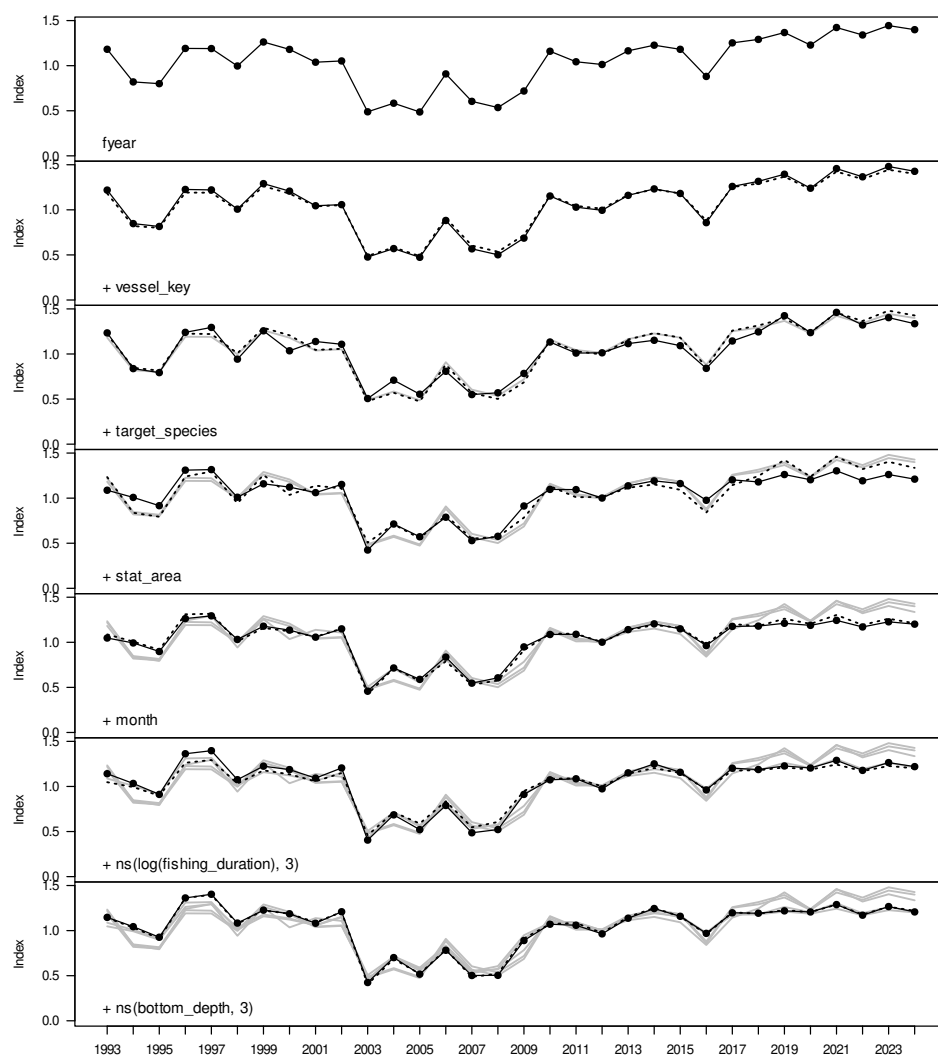


Figure D.98: Step plot for occurrence of catch in the JMA3 MW process daily dataset.

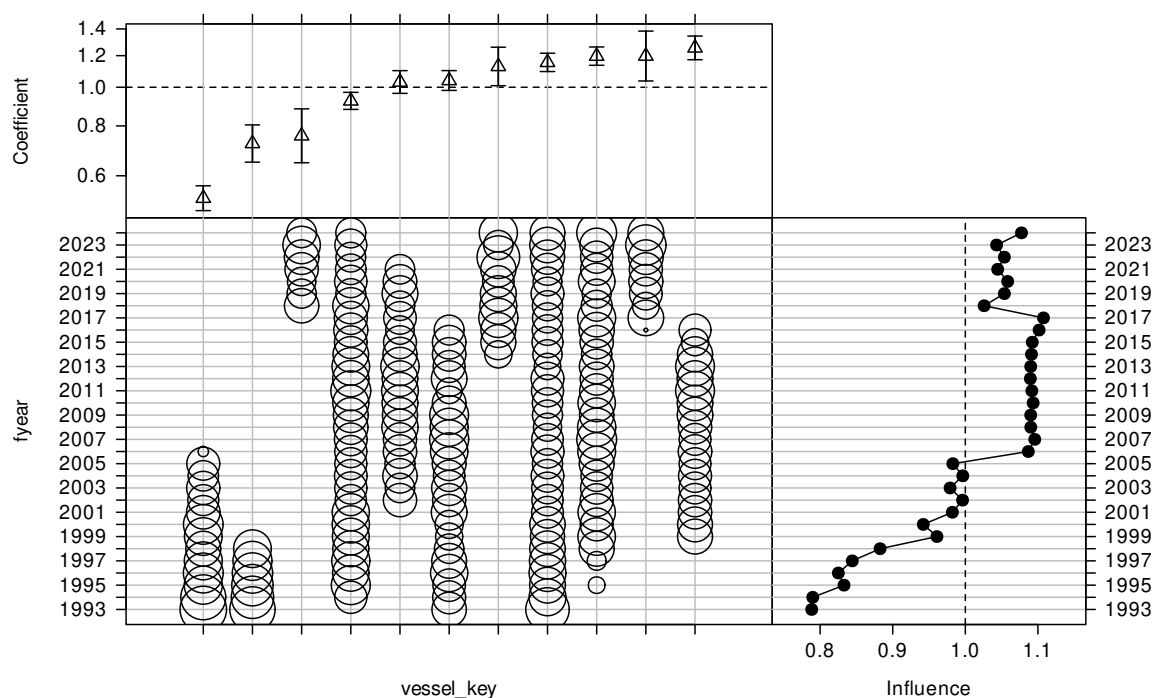


Figure D.99: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW process daily catch-per-unit-effort dataset.

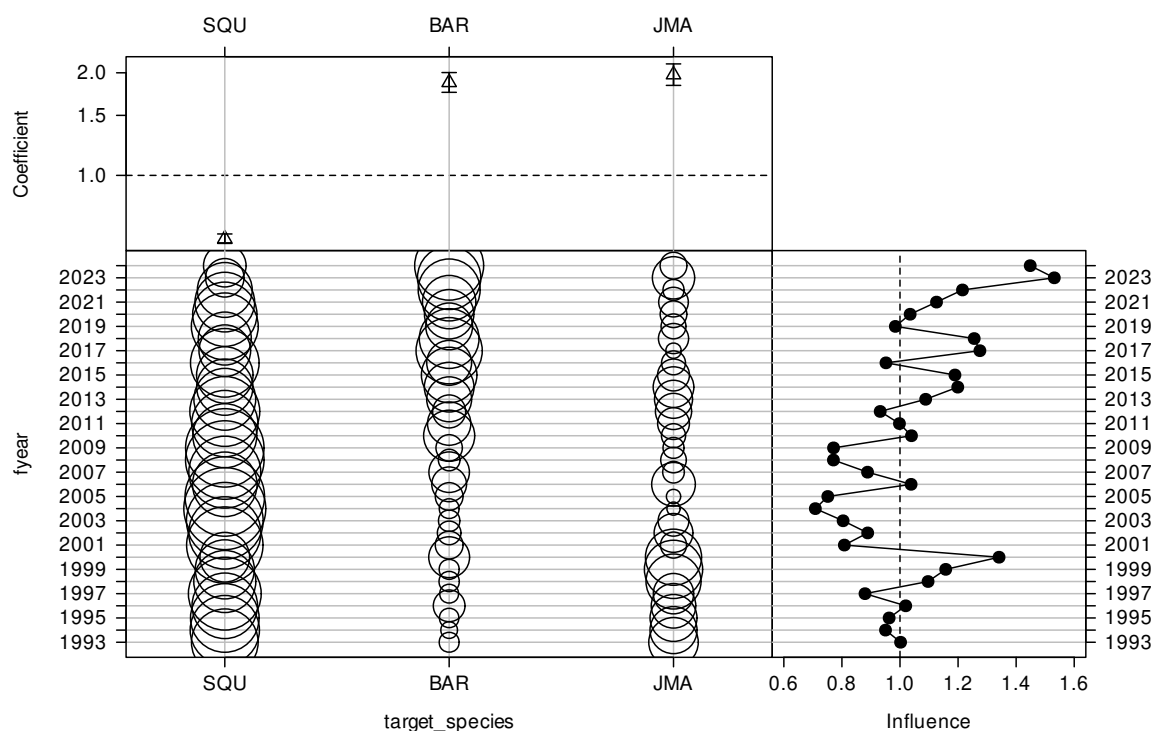


Figure D.100: CDI plot for target species for the occurrence of positive catch in the JMA3 MW process daily catch-per-unit-effort dataset.

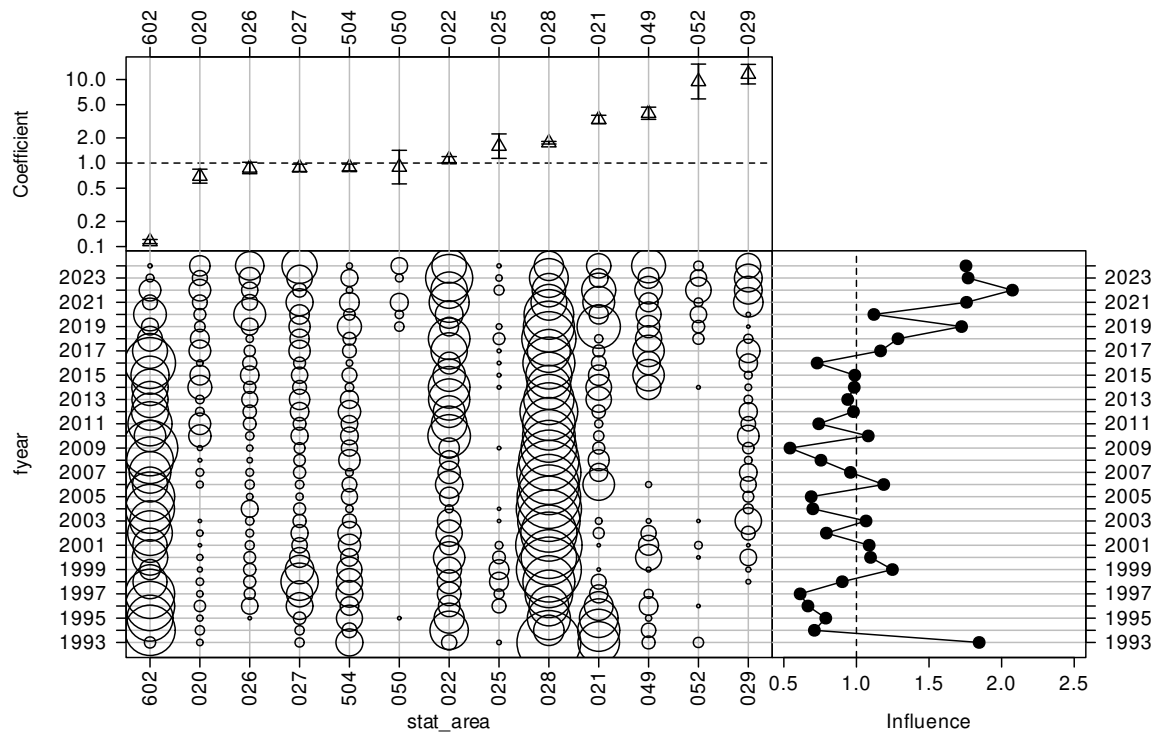


Figure D.101: CDI plot for statistical area for the occurrence of positive catch in the JMA3 MW process daily catch-per-unit-effort dataset.

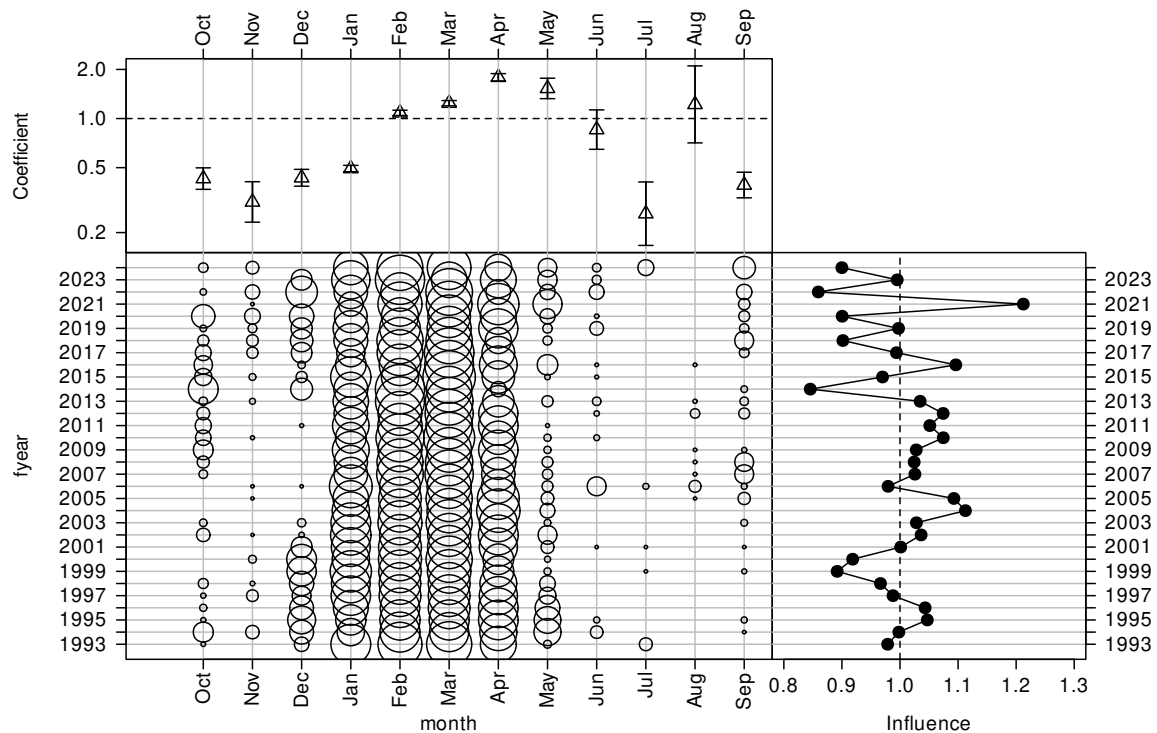


Figure D.102: CDI plot for month for the occurrence of positive catch in the JMA3 MW process daily catch-per-unit-effort dataset.

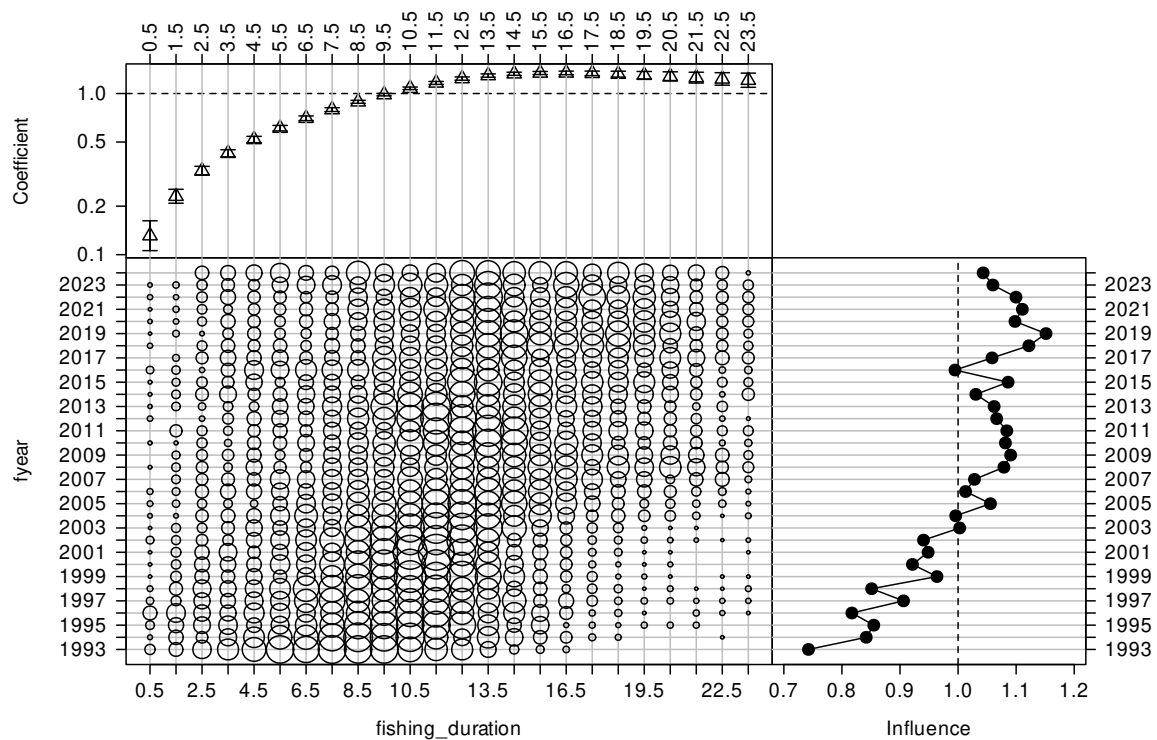


Figure D.103: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW process daily catch-per-unit-effort dataset.

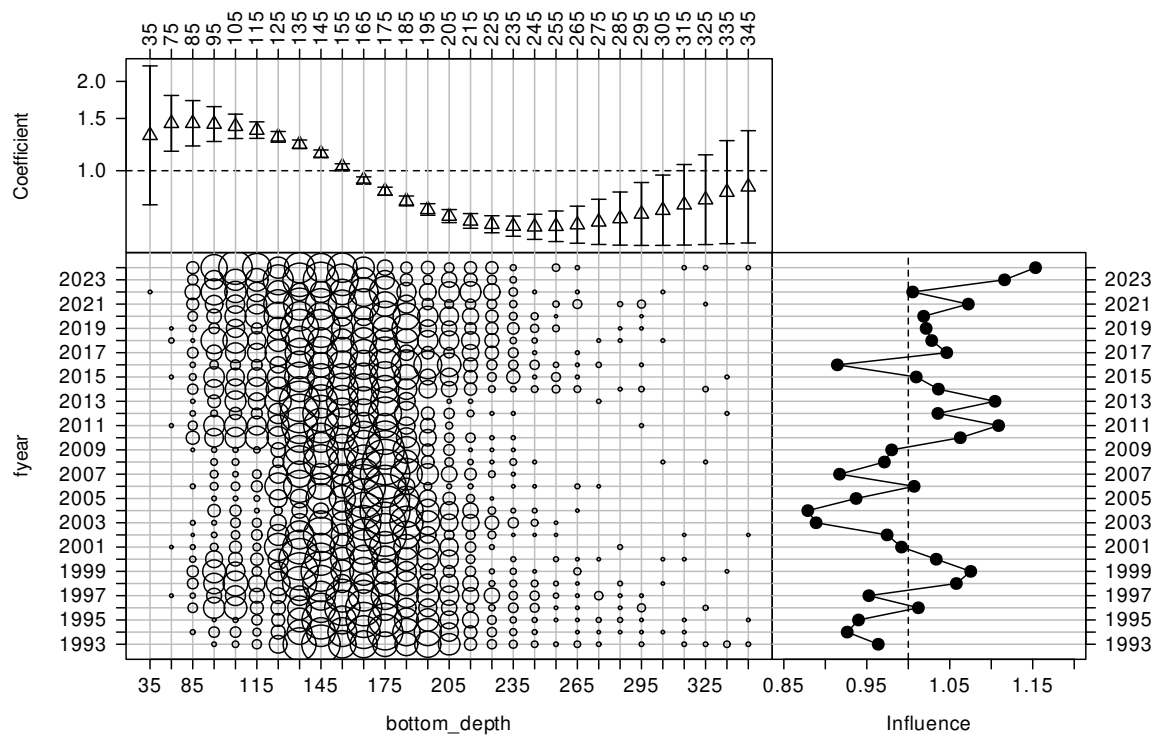


Figure D.104: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW process daily catch-per-unit-effort dataset.

Table D.23: Summary table for the gamma model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	227 820.9	0.00	0.00	*
fyear	31	226 884.6	6.06	6.06	*
vessel_key	10	226 662.6	7.48	1.42	*
target_species	2	224 654.3	18.61	11.14	*
stat_area	12	224 152.9	21.33	2.71	*
month	11	223 813.3	23.15	1.82	*
ns(log(fishing_duration), 3)	3	223 817.1	23.16	0.01	*
ns(bottom_depth, 3)	3	223 774.2	23.41	0.24	*

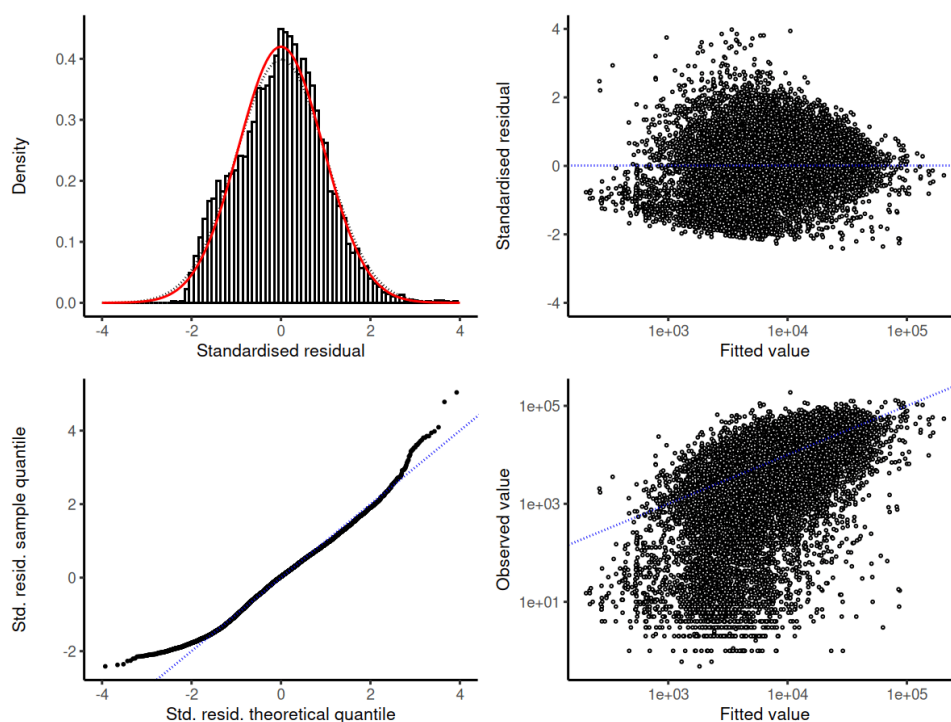


Figure D.105: Diagnostic plots for the selected gamma model for positive catches in the JMA3 MW process daily dataset.

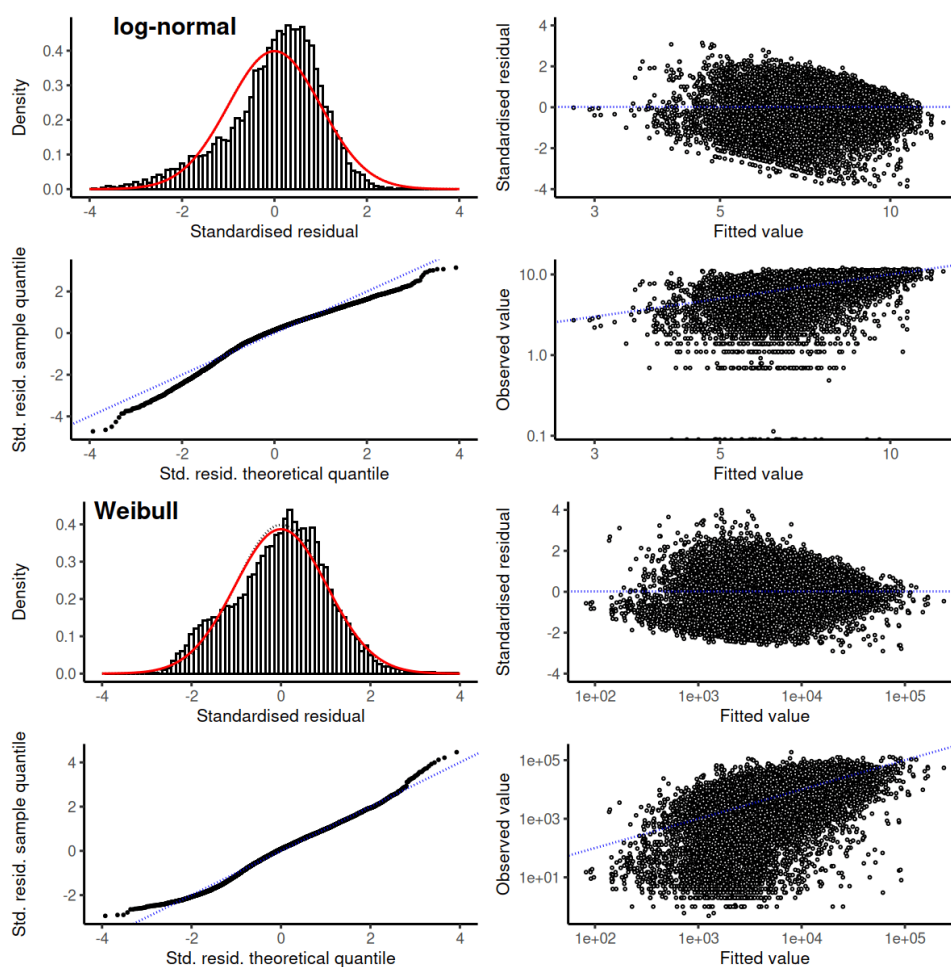


Figure D.106: Diagnostic plots for the alternative log-normal and Weibull models considered for positive catches in the JMA3 MW process daily dataset.

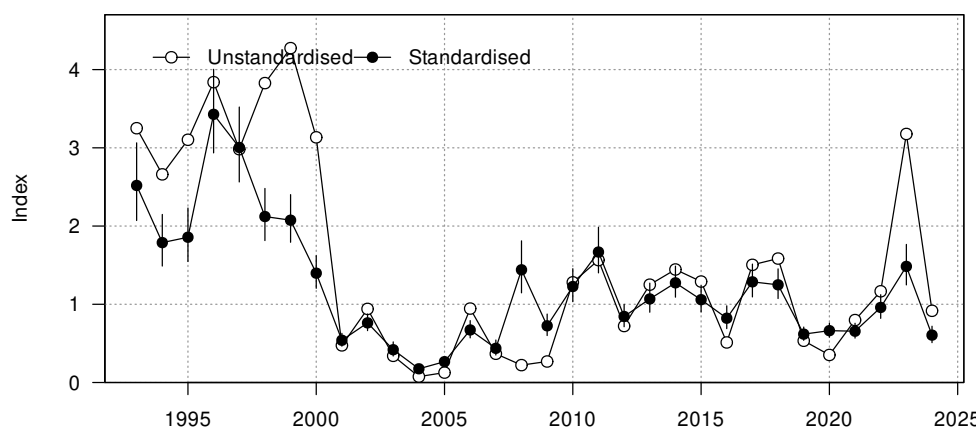


Figure D.107: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the gamma model for the JMA3 MW process daily dataset.

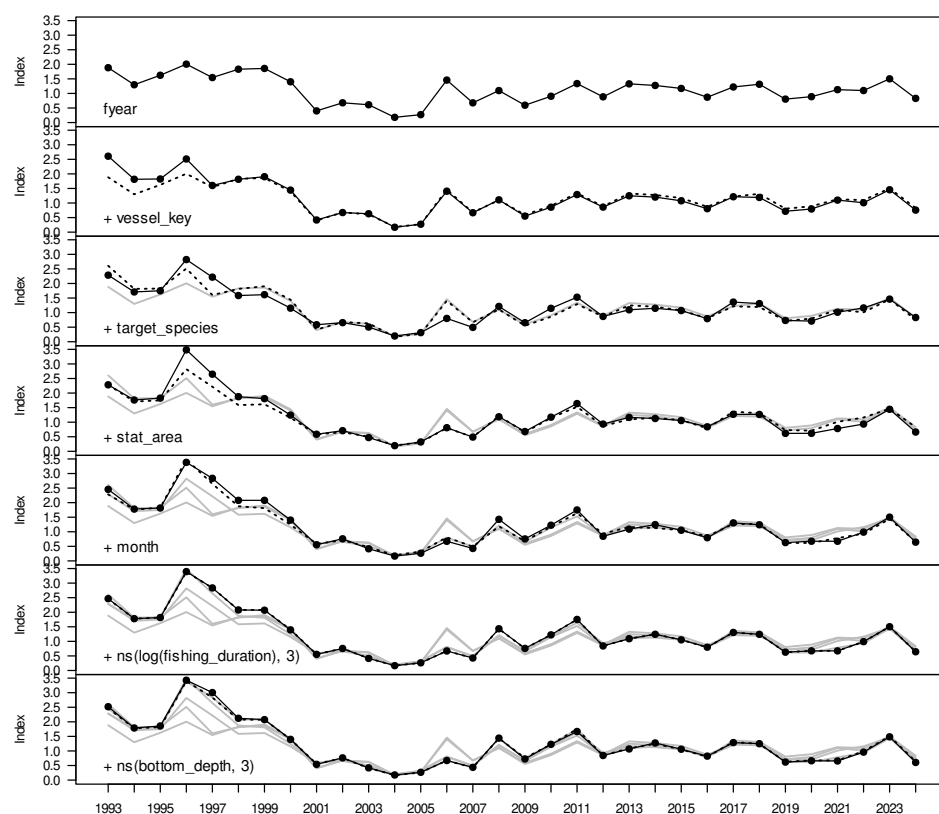


Figure D.108: Changes to the JMA3 MW process daily positive catch index as terms are successively entered into the gamma model.

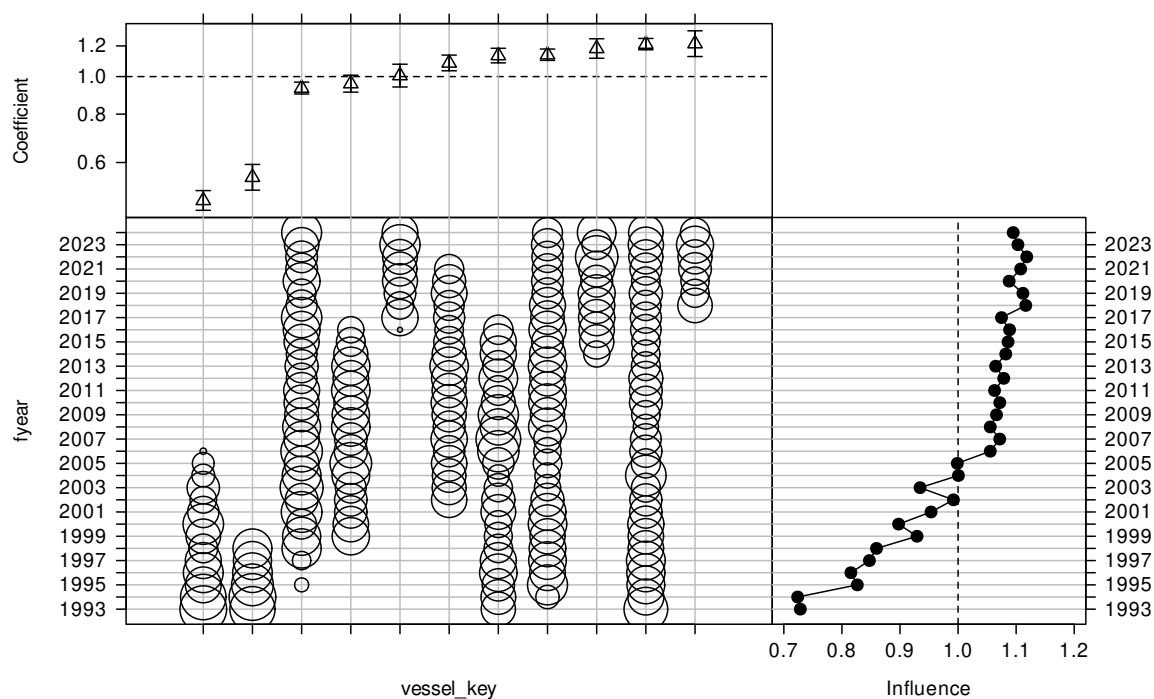


Figure D.109: CDI plot for vessel key for the gamma model of positive catches in the JMA3 MW process daily catch-per-unit-effort dataset.

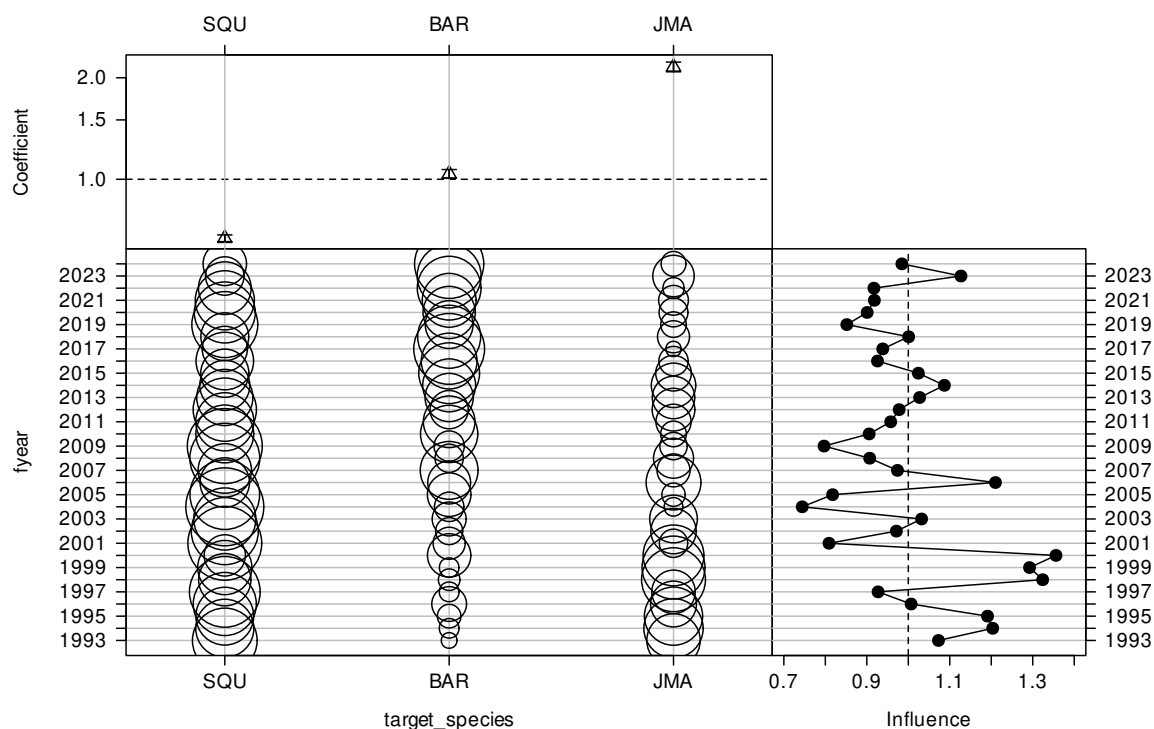


Figure D.110: CDI plot for target species for the gamma model of positive catches in the JMA3 MW process daily catch-per-unit-effort dataset.

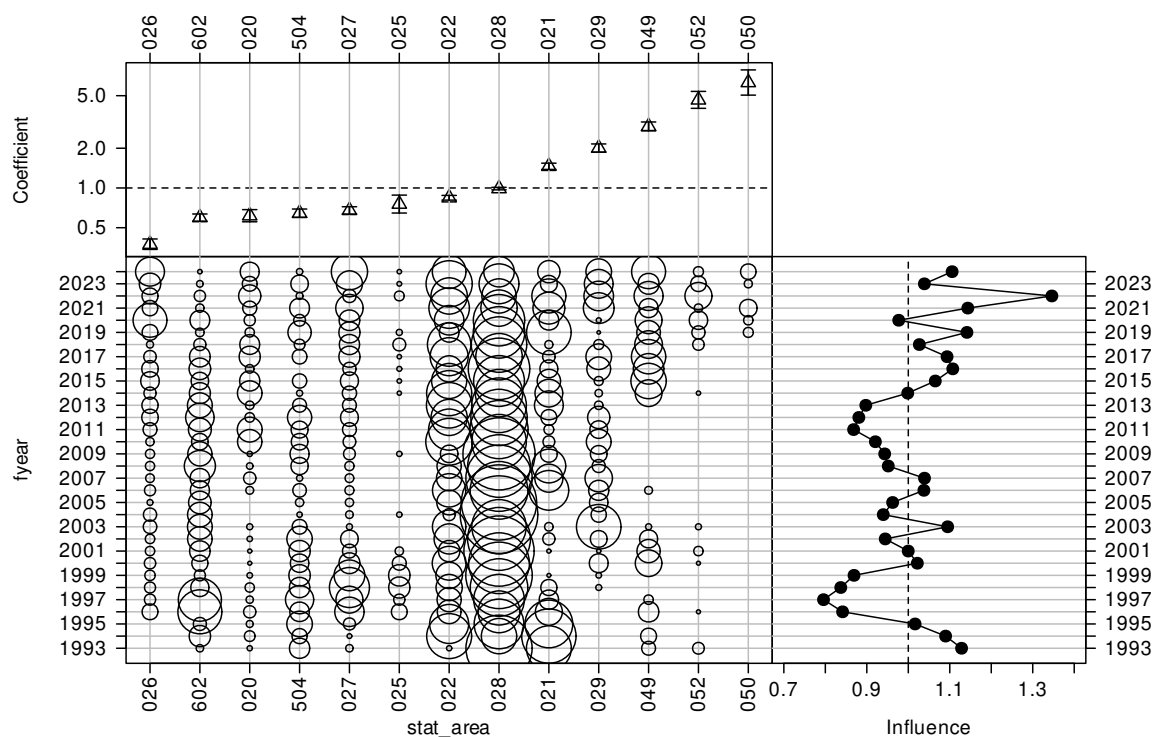


Figure D.111: CDI plot for statistical area for the gamma model of positive catches in the JMA3 MW process daily catch-per-unit-effort dataset.

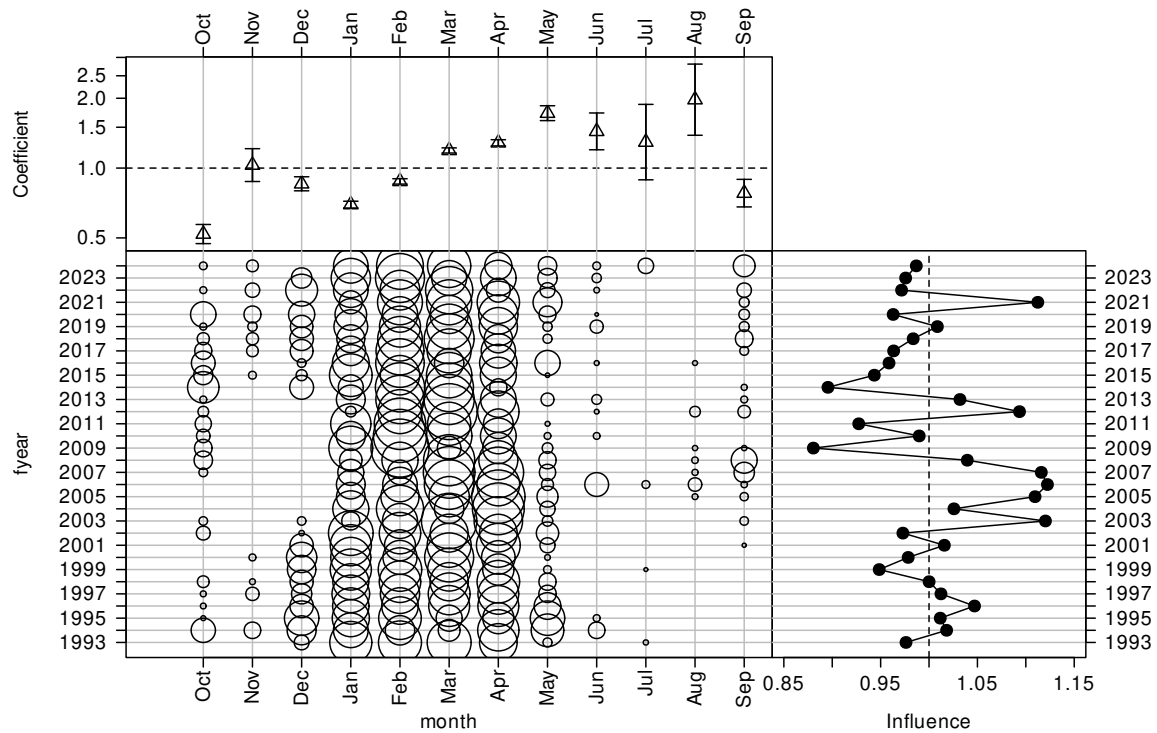


Figure D.112: CDI plot for month for the gamma model of positive catches in the JMA3 MW process daily catch-per-unit-effort dataset.

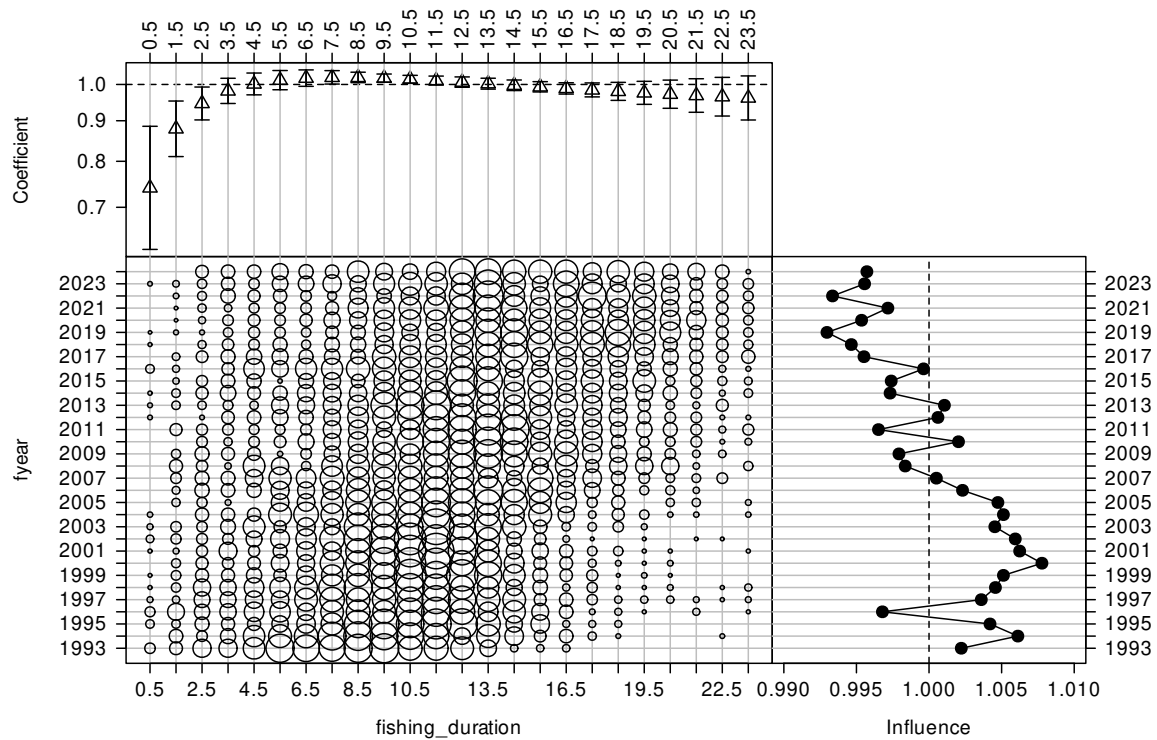


Figure D.113: CDI plot for fishing duration (h) for the gamma model of positive catches in the JMA3 MW process daily catch-per-unit-effort dataset.

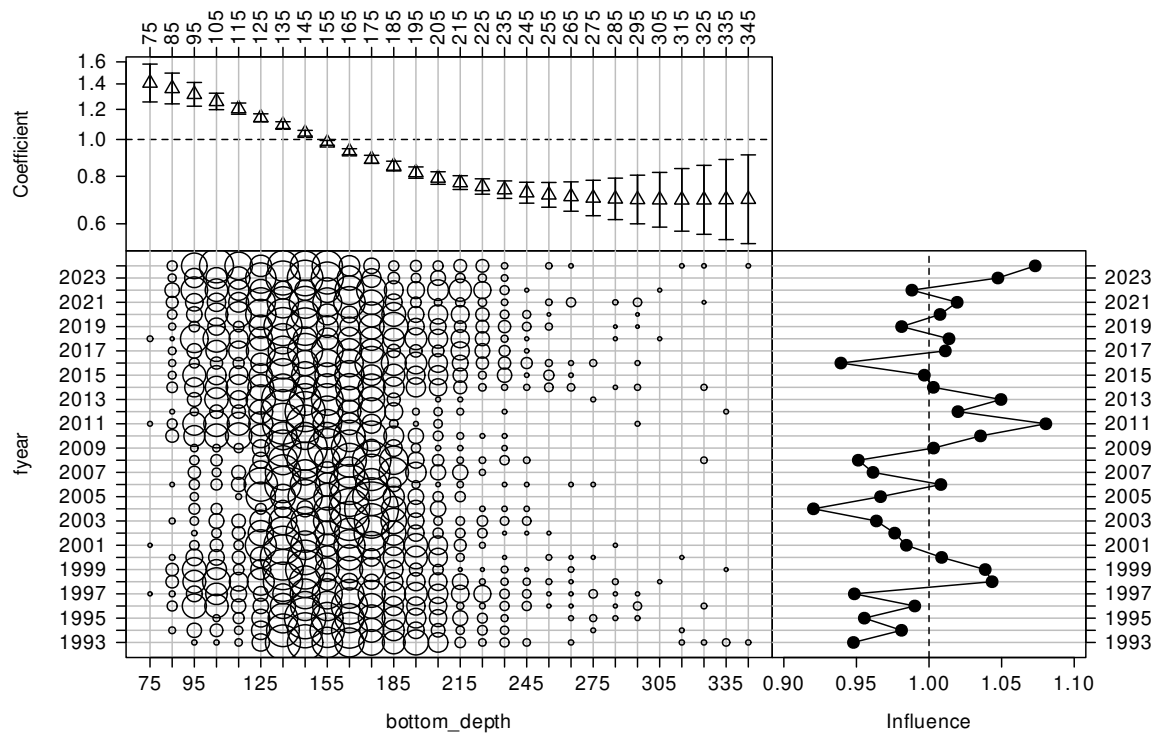


Figure D.114: CDI plot for bottom depth (m) for the gamma model of positive catches in the JMA3 MW process daily catch-per-unit-effort dataset.

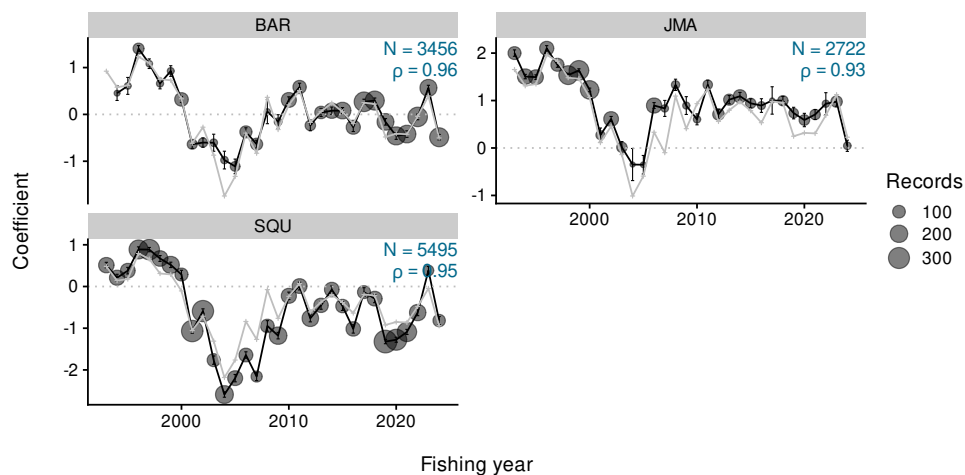


Figure D.115: Residual implied coefficients for target-year in the gamma positive catch model for the JMA3 MW process daily dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

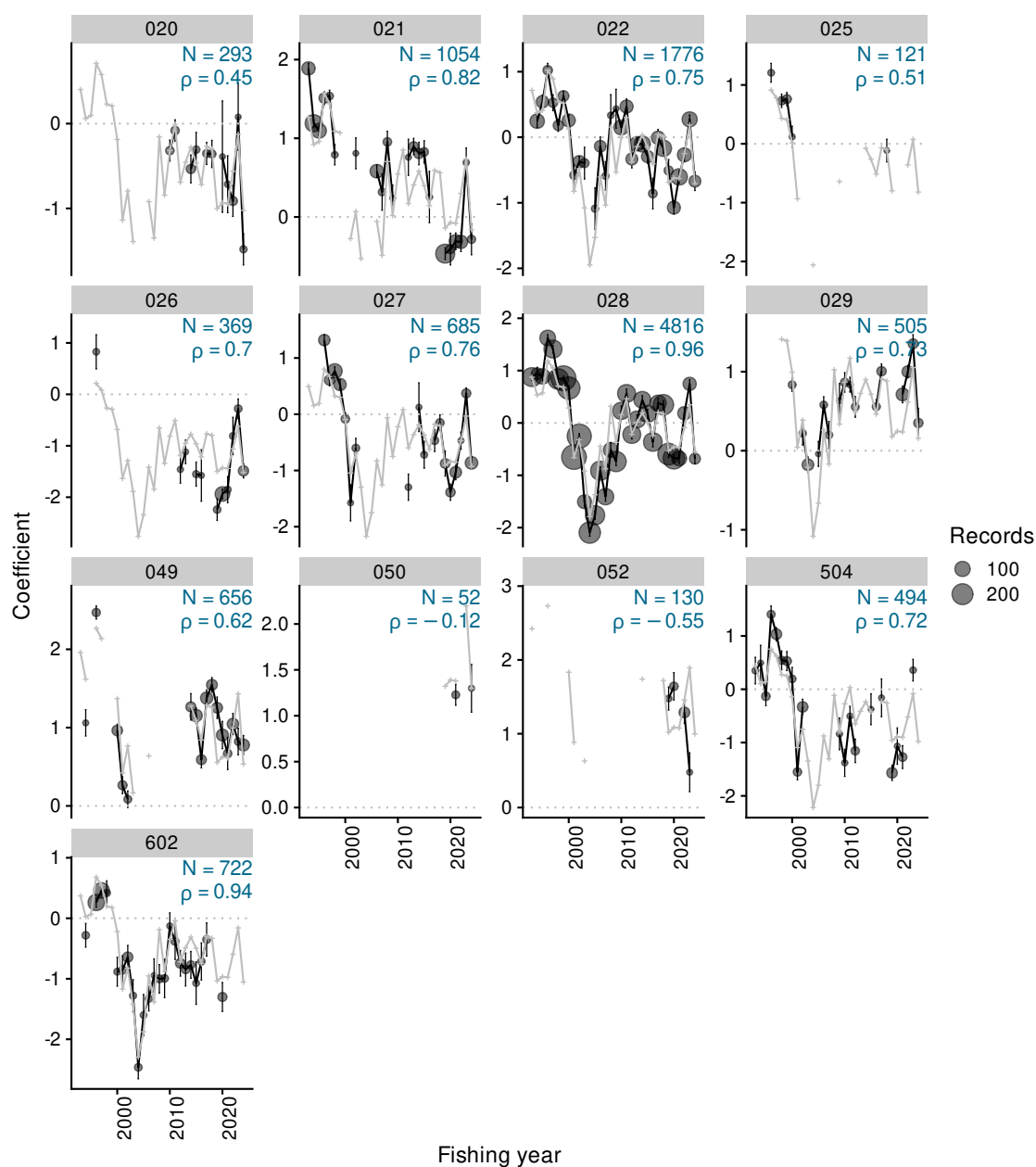


Figure D.116: Residual implied coefficients for area-year in the gamma positive catch model for the JMA3 MW process daily dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

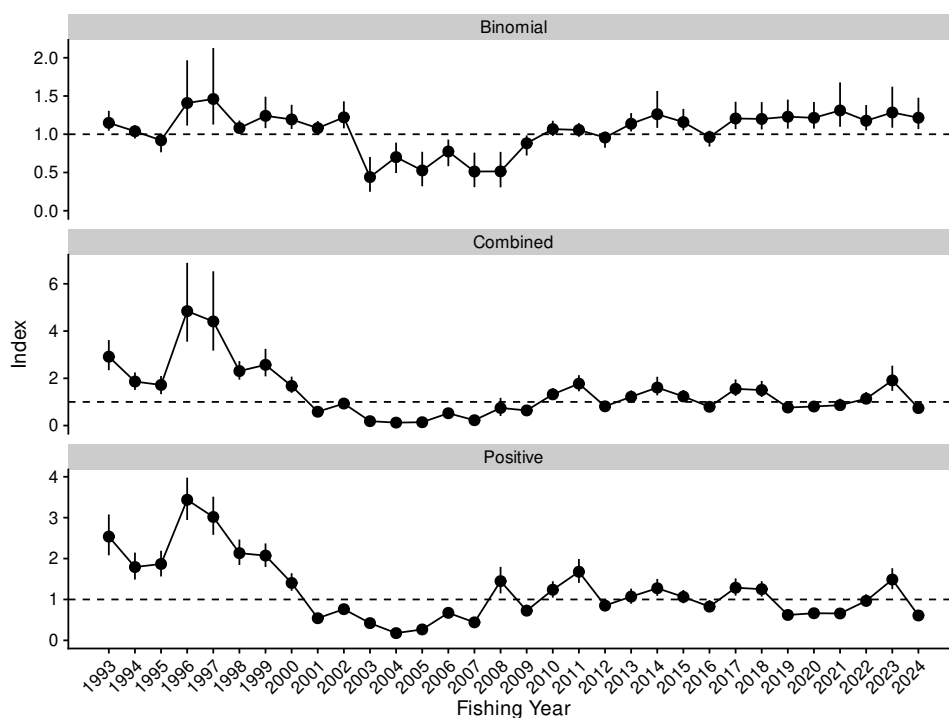


Figure D.117: Standardised indices and 95% confidence intervals for the JMA3 MW process daily dataset.

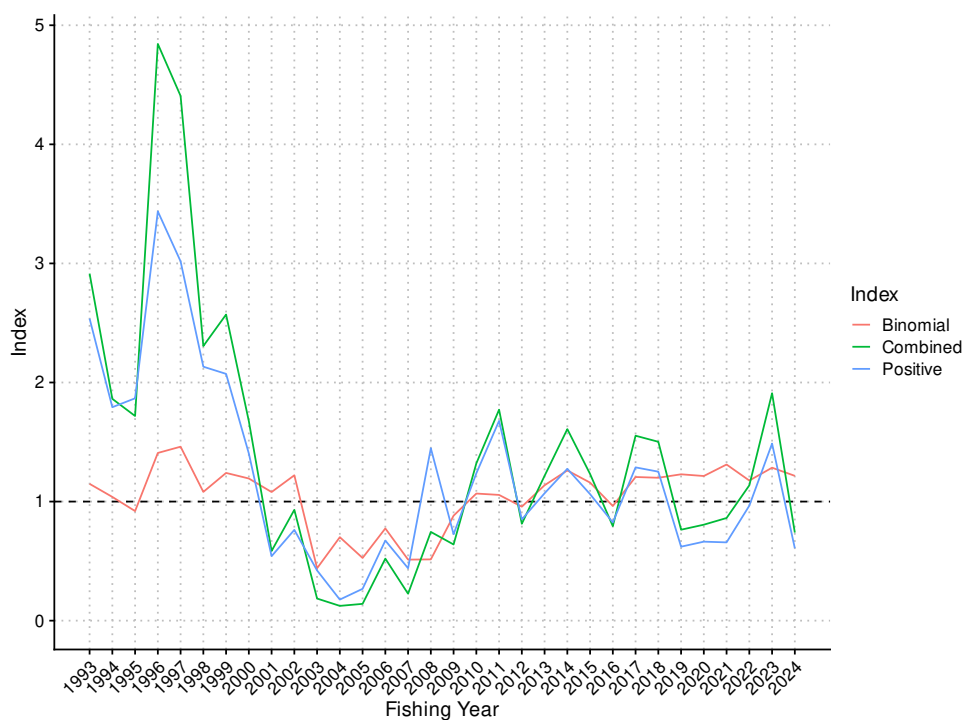


Figure D.118: Standardised indices for the JMA3 MW process daily dataset.

Table D.24: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW process daily series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.149	0.066	1.046	1.306	2.915	0.325	2.343	3.617	2.537	0.255	2.080	3.078
1994	1.039	0.044	0.944	1.118	1.863	0.189	1.507	2.248	1.793	0.168	1.487	2.146
1995	0.920	0.062	0.764	1.006	1.719	0.196	1.329	2.096	1.867	0.160	1.562	2.191
1996	1.408	0.218	1.113	1.967	4.843	0.851	3.550	6.887	3.437	0.264	2.943	3.978
1997	1.461	0.255	1.127	2.127	4.407	0.857	3.171	6.530	3.017	0.238	2.581	3.513
1998	1.081	0.044	1.008	1.179	2.306	0.200	1.943	2.727	2.133	0.159	1.842	2.465
1999	1.241	0.105	1.080	1.491	2.571	0.297	2.082	3.247	2.072	0.147	1.793	2.370
2000	1.194	0.081	1.069	1.385	1.675	0.174	1.386	2.070	1.404	0.110	1.212	1.642
2001	1.080	0.042	1.008	1.173	0.585	0.046	0.503	0.685	0.541	0.038	0.470	0.619
2002	1.221	0.090	1.077	1.430	0.931	0.099	0.764	1.150	0.762	0.055	0.661	0.877
2003	0.440	0.116	0.248	0.702	0.186	0.051	0.100	0.300	0.422	0.044	0.341	0.512
2004	0.701	0.102	0.493	0.891	0.124	0.022	0.082	0.167	0.177	0.017	0.147	0.213
2005	0.526	0.115	0.320	0.770	0.141	0.035	0.080	0.219	0.267	0.028	0.219	0.327
2006	0.774	0.089	0.583	0.930	0.521	0.078	0.375	0.682	0.673	0.052	0.577	0.782
2007	0.513	0.115	0.308	0.760	0.226	0.060	0.127	0.361	0.440	0.048	0.349	0.538
2008	0.514	0.118	0.305	0.770	0.745	0.196	0.405	1.172	1.448	0.165	1.149	1.796
2009	0.882	0.067	0.723	0.985	0.640	0.078	0.497	0.802	0.726	0.069	0.599	0.869
2010	1.067	0.051	0.978	1.176	1.321	0.125	1.091	1.579	1.237	0.102	1.045	1.445
2011	1.056	0.046	0.966	1.146	1.772	0.174	1.450	2.132	1.678	0.148	1.406	1.988
2012	0.957	0.054	0.823	1.033	0.814	0.089	0.643	0.990	0.850	0.077	0.711	1.013
2013	1.137	0.061	1.036	1.277	1.216	0.126	0.992	1.487	1.070	0.094	0.896	1.265
2014	1.262	0.123	1.083	1.565	1.609	0.201	1.276	2.065	1.275	0.105	1.089	1.502
2015	1.159	0.072	1.051	1.332	1.232	0.125	1.014	1.504	1.062	0.083	0.907	1.232
2016	0.963	0.053	0.839	1.047	0.794	0.080	0.641	0.956	0.825	0.073	0.697	0.984
2017	1.206	0.091	1.067	1.425	1.553	0.178	1.254	1.953	1.287	0.108	1.094	1.515
2018	1.200	0.091	1.063	1.421	1.502	0.173	1.209	1.886	1.251	0.096	1.070	1.447
2019	1.229	0.097	1.073	1.452	0.764	0.084	0.624	0.953	0.621	0.042	0.541	0.704
2020	1.215	0.089	1.074	1.422	0.806	0.082	0.671	0.993	0.663	0.043	0.580	0.750
2021	1.311	0.148	1.097	1.678	0.862	0.119	0.672	1.137	0.657	0.046	0.571	0.753
2022	1.177	0.084	1.051	1.382	1.137	0.127	0.922	1.418	0.966	0.077	0.825	1.127
2023	1.284	0.137	1.085	1.622	1.910	0.272	1.466	2.534	1.487	0.131	1.252	1.764
2024	1.216	0.105	1.067	1.478	0.740	0.095	0.587	0.958	0.608	0.054	0.510	0.721

D.5 JMA3 MW pred JMD event no weights

Table D.25: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW pred JMD event no weights CPUE series.

Series	JMA3 MW pred JMD event no weights
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	pred_catch_JMD ~ fyear + target_species + vessel_key + month + start_obs_fma + ns(log(fishing_duration), 3) + ns(log(start_time), 3) + ns(log(bottom_depth), 3) + ns(log(effort_height), 3) + ns(effort_speed, 3)
Stepwise selection	No
Positive catch distribution	Weibull

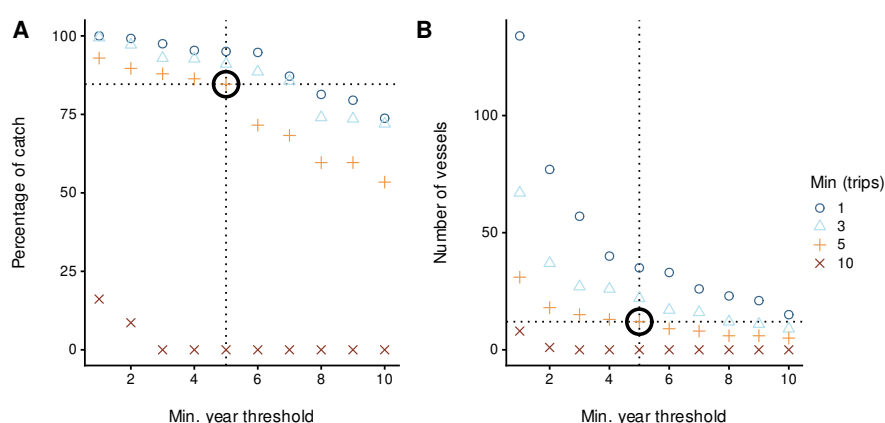


Figure D.119: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW pred JMD event no weights CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

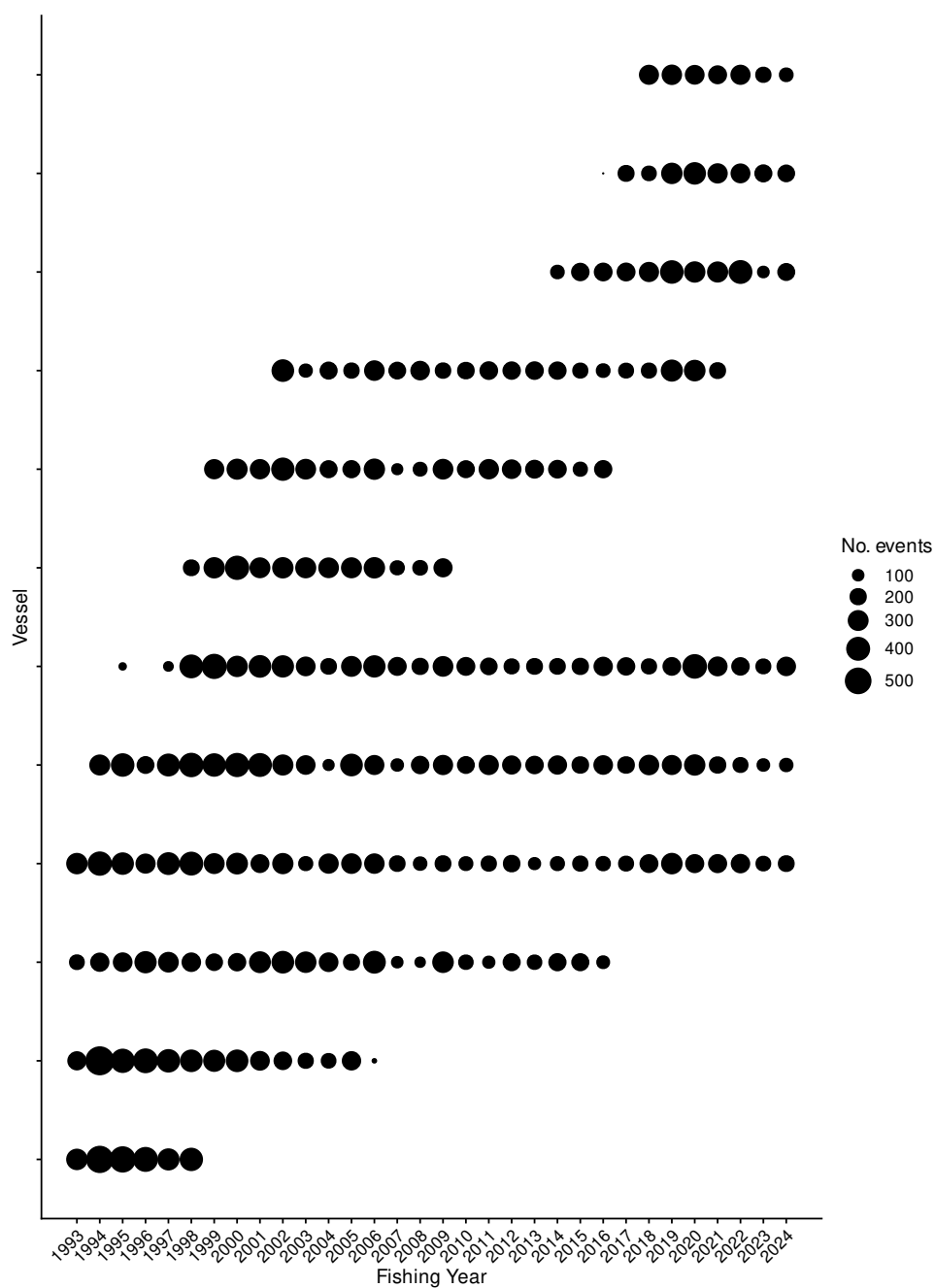


Figure D.120: Number of events by fishing year for core vessels in the JMA3 MW pred JMD event no weights series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table D.26: Summary of the JMA3 MW pred JMD event no weights dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	2303 (100%) n: 7113	834 (100%) n: 6413	1647 (100%) n: 7617	2692 (100%) n: 7993	1573 (100%) n: 5763	2340 (100%) n: 5648	3583 (100%) n: 5256	2528 (100%) n: 3758	459 (100%) n: 3011
Fishing speed not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2691 (100%) n: 7985	1571 (100%) n: 5757	2340 (100%) n: 5644	3583 (100%) n: 5252	2528 (100%) n: 3758	459 (100%) n: 3010
Fishing speed lt 10kts	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2682 (100%) n: 7953	1568 (100%) n: 5745	2340 (100%) n: 5639	3583 (100%) n: 5251	2528 (100%) n: 3758	459 (100%) n: 3010
Start date not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2682 (100%) n: 7953	1568 (100%) n: 5745	2340 (100%) n: 5639	3583 (100%) n: 5251	2528 (100%) n: 3758	459 (100%) n: 3010
End date not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2682 (100%) n: 7953	1568 (100%) n: 5745	2340 (100%) n: 5639	3583 (100%) n: 5251	2528 (100%) n: 3758	459 (100%) n: 3010
Start depth not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2682 (100%) n: 7946	1568 (100%) n: 5729	2272 (97%) n: 5626	3579 (100%) n: 5240	2527 (100%) n: 3755	459 (100%) n: 3000
Headline height not null	2303 (100%) n: 7113	834 (100%) n: 6413	1637 (99%) n: 7615	2681 (100%) n: 7797	1567 (100%) n: 5721	2272 (97%) n: 5615	3574 (100%) n: 5233	2524 (100%) n: 3751	459 (100%) n: 2999
Fishing speed >3.5kn	2163 (94%) n: 6832	829 (99%) n: 6125	1631 (99%) n: 7473	2669 (99%) n: 7506	1558 (99%) n: 5470	2266 (97%) n: 5391	3548 (99%) n: 5118	2505 (99%) n: 3698	455 (99%) n: 2985
Headline height >15m	2157 (94%) n: 6811	823 (99%) n: 6075	1622 (99%) n: 7430	2610 (97%) n: 7400	1547 (98%) n: 5384	2254 (96%) n: 5366	3533 (99%) n: 5022	2503 (99%) n: 3688	455 (99%) n: 2978
Headline height <90m	1883 (82%) n: 6659	815 (98%) n: 6073	1622 (99%) n: 7430	2608 (97%) n: 7389	1376 (87%) n: 5181	2079 (89%) n: 4978	3522 (98%) n: 5008	2501 (99%) n: 3678	455 (99%) n: 2977
Fishing duration >15mins	1833 (80%) n: 6627	812 (97%) n: 6056	1617 (98%) n: 7413	2579 (96%) n: 7360	1364 (87%) n: 5165	2077 (89%) n: 4964	3519 (98%) n: 4997	2501 (99%) n: 3675	455 (99%) n: 2970
Fishing duration <15h	1827 (79%) n: 6609	810 (97%) n: 6040	1607 (98%) n: 7404	2571 (96%) n: 7342	1344 (85%) n: 5134	2071 (89%) n: 4949	3508 (98%) n: 4988	2482 (98%) n: 3656	455 (99%) n: 2970
Seabed depth >50m	1827 (79%) n: 6609	810 (97%) n: 6040	1607 (98%) n: 7403	2571 (96%) n: 7342	1344 (85%) n: 5134	2068 (88%) n: 4946	3508 (98%) n: 4987	2482 (98%) n: 3655	455 (99%) n: 2970
Seabed depth <350m	1825 (79%) n: 6570	807 (97%) n: 6000	1605 (97%) n: 7227	2567 (95%) n: 7313	1339 (85%) n: 5121	2067 (88%) n: 4942	3502 (98%) n: 4964	2481 (98%) n: 3645	454 (99%) n: 2967
Start time >0	1766 (77%) n: 6508	791 (95%) n: 5958	1576 (96%) n: 7156	2467 (92%) n: 7221	1290 (82%) n: 5067	2025 (87%) n: 4901	3365 (94%) n: 4916	2456 (97%) n: 3623	446 (97%) n: 2956
SA subset	1766 (77%) n: 6508	791 (95%) n: 5958	1576 (96%) n: 7156	2467 (92%) n: 7221	1290 (82%) n: 5067	2025 (87%) n: 4901	3365 (94%) n: 4916	2456 (97%) n: 3623	446 (97%) n: 2956
No effort allocation	1765 (77%) n: 6462	781 (94%) n: 5829	1574 (96%) n: 7023	2467 (92%) n: 7221	1290 (82%) n: 5066	2025 (87%) n: 4901	3365 (94%) n: 4916	2456 (97%) n: 3619	446 (97%) n: 2956
Core fleet selection	1000 (43%) n: 1050	513 (62%) n: 2090	1053 (64%) n: 1937	1368 (51%) n: 1698	788 (50%) n: 1813	1420 (61%) n: 2393	2166 (60%) n: 2269	2007 (79%) n: 2351	396 (86%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
Fishing speed not null	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
Fishing speed lt 10kts	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
Start date not null	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
End date not null	1374 (100%) n: 3311	424 (100%) n: 3108	172 (100%) n: 3281	137 (100%) n: 3639	1491 (100%) n: 2834	502 (100%) n: 2416	488 (100%) n: 2250	388 (100%) n: 2187	697 (100%) n: 1313
Start depth not null	1373 (100%) n: 3306	424 (100%) n: 3106	172 (100%) n: 3278	137 (100%) n: 3635	1491 (100%) n: 2831	502 (100%) n: 2412	488 (100%) n: 2246	388 (100%) n: 2187	697 (100%) n: 1313
Headline height not null	1373 (100%) n: 3306	424 (100%) n: 3106	172 (100%) n: 3278	137 (100%) n: 3635	1491 (100%) n: 2831	502 (100%) n: 2412	488 (100%) n: 2246	388 (100%) n: 2187	697 (100%) n: 1313
Fishing speed >3.5kn	1372 (100%) n: 3266	422 (99%) n: 3061	171 (100%) n: 3167	137 (100%) n: 3520	1490 (100%) n: 2794	501 (100%) n: 2380	483 (99%) n: 2222	377 (97%) n: 2132	697 (100%) n: 1300
Headline height >15m	1363 (99%) n: 3243	422 (99%) n: 3043	170 (99%) n: 3150	137 (100%) n: 3512	1490 (100%) n: 2790	501 (100%) n: 2359	483 (99%) n: 2205	374 (97%) n: 2128	697 (100%) n: 1297
Headline height <90m	1363 (99%) n: 3243	422 (99%) n: 3043	169 (98%) n: 3149	137 (100%) n: 3512	1490 (100%) n: 2789	501 (100%) n: 2359	483 (99%) n: 2204	374 (97%) n: 2128	697 (100%) n: 1297
Fishing duration >15mins	1361 (99%) n: 3229	422 (99%) n: 3038	169 (98%) n: 3140	137 (100%) n: 3501	1489 (100%) n: 2782	501 (100%) n: 2354	482 (99%) n: 2198	374 (97%) n: 2126	697 (100%) n: 1295
Fishing duration <15h	1361 (99%) n: 3226	420 (99%) n: 3037	169 (98%) n: 3138	137 (100%) n: 3501	1489 (100%) n: 2780	501 (100%) n: 2353	482 (99%) n: 2195	374 (97%) n: 2122	697 (100%) n: 1294
Seabed depth >50m	1358 (99%) n: 3224	420 (99%) n: 3037	169 (98%) n: 3138	137 (100%) n: 3501	1489 (100%) n: 2780	501 (100%) n: 2353	482 (99%) n: 2195	374 (97%) n: 2122	697 (100%) n: 1294
Seabed depth <350m	1356 (99%) n: 3222	420 (99%) n: 3033	169 (98%) n: 3134	137 (100%) n: 3500	1489 (100%) n: 2779	501 (100%) n: 2351	482 (99%) n: 2193	371 (96%) n: 2120	697 (100%) n: 1293
Start time >0	1317 (96%) n: 3198	411 (97%) n: 3025	167 (97%) n: 3119	134 (98%) n: 3458	1456 (98%) n: 2766	484 (96%) n: 2334	477 (98%) n: 2182	358 (92%) n: 2108	688 (99%) n: 1280
SA subset	1317 (96%) n: 3198	411 (97%) n: 3025	167 (97%) n: 3119	134 (98%) n: 3458	1456 (98%) n: 2766	484 (96%) n: 2334	477 (98%) n: 2182	358 (92%) n: 2108	688 (99%) n: 1280
No effort allocation	1317 (96%) n: 3196	411 (97%) n: 2486	166 (97%) n: 2363	134 (98%) n: 2581	1456 (98%) n: 2593	484 (96%) n: 1705	475 (97%) n: 1587	357 (92%) n: 1990	687 (99%) n: 1260
Core fleet selection	1232 (90%) n: 2598	383 (90%) n: 1904	163 (95%) n: 1725	133 (97%) n: 2103	1444 (97%) n: 2204	443 (88%) n: 1109	446 (91%) n: 1223	252 (65%) n: 1809	664 (95%) n: 1191

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2232 (100%) n: 1678	1041 (100%) n: 2307
Fishing speed not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2232 (100%) n: 1678	1041 (100%) n: 2307
Fishing speed lt 10kts	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
Start date not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
End date not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
Start depth not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
Headline height not null	1144 (100%) n: 1434	1110 (100%) n: 1486	1627 (100%) n: 1247	1626 (100%) n: 1484	895 (100%) n: 1445	626 (100%) n: 1549	1639 (100%) n: 1368	2229 (100%) n: 1675	1041 (100%) n: 2303
Fishing speed >3.5kn	1143 (100%) n: 1412	1104 (99%) n: 1465	1626 (100%) n: 1229	1626 (100%) n: 1454	892 (100%) n: 1381	625 (100%) n: 1503	1638 (100%) n: 1357	2222 (100%) n: 1625	1039 (100%) n: 2269
Headline height >15m	1130 (99%) n: 1395	1104 (99%) n: 1464	1626 (100%) n: 1229	1626 (100%) n: 1454	892 (100%) n: 1379	625 (100%) n: 1503	1624 (99%) n: 1354	2222 (100%) n: 1625	1039 (100%) n: 2263
Headline height <90m	1130 (99%) n: 1395	1104 (99%) n: 1463	1626 (100%) n: 1229	1626 (100%) n: 1454	892 (100%) n: 1379	625 (100%) n: 1503	1624 (99%) n: 1354	2222 (100%) n: 1624	1039 (100%) n: 2263
Fishing duration >15mins	1130 (99%) n: 1394	1104 (99%) n: 1459	1624 (100%) n: 1224	1626 (100%) n: 1449	892 (100%) n: 1378	625 (100%) n: 1498	1624 (99%) n: 1352	2222 (100%) n: 1624	1039 (100%) n: 2260
Fishing duration <15h	1130 (99%) n: 1392	1103 (99%) n: 1457	1624 (100%) n: 1224	1626 (100%) n: 1448	892 (100%) n: 1378	625 (100%) n: 1497	1624 (99%) n: 1352	2222 (100%) n: 1624	1036 (100%) n: 2257
Seabed depth >50m	1130 (99%) n: 1392	1103 (99%) n: 1457	1624 (100%) n: 1224	1626 (100%) n: 1448	892 (100%) n: 1378	625 (100%) n: 1497	1624 (99%) n: 1352	2222 (100%) n: 1624	1036 (100%) n: 2257
Seabed depth <350m	1130 (99%) n: 1390	1103 (99%) n: 1457	1624 (100%) n: 1224	1626 (100%) n: 1448	892 (100%) n: 1378	625 (100%) n: 1491	1624 (99%) n: 1352	2222 (100%) n: 1623	1036 (100%) n: 2256
Start time >0	1120 (98%) n: 1382	1100 (99%) n: 1453	1611 (99%) n: 1217	1579 (97%) n: 1438	883 (99%) n: 1370	616 (98%) n: 1483	1622 (99%) n: 1349	2213 (99%) n: 1617	1036 (100%) n: 2252
SA subset	1120 (98%) n: 1382	1100 (99%) n: 1453	1611 (99%) n: 1217	1579 (97%) n: 1438	883 (99%) n: 1370	616 (98%) n: 1483	1622 (99%) n: 1349	2213 (99%) n: 1617	1036 (100%) n: 2252
No effort allocation	1120 (98%) n: 1382	1100 (99%) n: 1390	1611 (99%) n: 1216	1579 (97%) n: 1436	883 (99%) n: 1370	613 (98%) n: 1447	1622 (99%) n: 1336	2213 (99%) n: 1616	1036 (100%) n: 2252
Core fleet selection	1111 (97%) n: 1301	1061 (96%) n: 1344	1593 (98%) n: 1169	1576 (97%) n: 1420	881 (98%) n: 1362	602 (96%) n: 1409	1608 (98%) n: 1212	2207 (99%) n: 1599	976 (94%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1330 (100%) n: 1343
Fishing speed not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1330 (100%) n: 1343
Fishing speed lt 10kts	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1330 (100%) n: 1343
Start date not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1330 (100%) n: 1343
End date not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1327 (100%) n: 1342
Start depth not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1327 (100%) n: 1342
Headline height not null	923 (100%) n: 2542	2669 (100%) n: 1919	2154 (100%) n: 1800	2677 (100%) n: 1038	1327 (100%) n: 1342
Fishing speed >3.5kn	922 (100%) n: 2430	2669 (100%) n: 1919	2153 (100%) n: 1794	2676 (100%) n: 1037	1327 (100%) n: 1342
Headline height >15m	920 (100%) n: 2426	2669 (100%) n: 1917	2153 (100%) n: 1792	2676 (100%) n: 1035	1319 (99%) n: 1336
Headline height <90m	920 (100%) n: 2426	2669 (100%) n: 1917	2153 (100%) n: 1792	2676 (100%) n: 1035	1319 (99%) n: 1336
Fishing duration >15mins	920 (100%) n: 2421	2656 (100%) n: 1912	2153 (100%) n: 1785	2676 (100%) n: 1032	1319 (99%) n: 1331
Fishing duration <15h	920 (100%) n: 2421	2653 (99%) n: 1910	2153 (100%) n: 1785	2673 (100%) n: 1031	1319 (99%) n: 1330
Seabed depth >50m	920 (100%) n: 2421	2653 (99%) n: 1910	2153 (100%) n: 1784	2673 (100%) n: 1031	1319 (99%) n: 1330
Seabed depth <350m	920 (100%) n: 2419	2653 (99%) n: 1910	2153 (100%) n: 1783	2673 (100%) n: 1030	1319 (99%) n: 1329
Start time >0	920 (100%) n: 2415	2571 (96%) n: 1902	2139 (99%) n: 1781	2666 (100%) n: 1029	1319 (99%) n: 1326
SA subset	920 (100%) n: 2415	2571 (96%) n: 1902	2139 (99%) n: 1781	2666 (100%) n: 1029	1319 (99%) n: 1326
No effort allocation	920 (100%) n: 2414	2571 (96%) n: 1898	2139 (99%) n: 1775	2666 (100%) n: 1029	1319 (99%) n: 1306
Core fleet selection	787 (85%) n: 2235	2467 (92%) n: 1744	1866 (87%) n: 1603	2622 (98%) n: 953	1202 (90%) n: 1157

Table D.27: Summary of the JMA3 MW pred JMD event no weights dataset after core fleet selection. 'Records' indicates the number of rows (events) in the dataset, and 'Records caught' indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	996.13	50.00
1994	5	40	2 090	5 313.80	512.98	34.55
1995	6	38	1 937	5 281.88	1 053.16	37.43
1996	5	31	1 698	4 946.23	1 368.23	59.60
1997	6	23	1 813	5 486.45	788.35	52.84
1998	7	36	2 393	6 500.45	1 420.22	49.44
1999	7	29	2 269	6 680.20	2 166.15	58.35
2000	7	34	2 351	7 026.89	2 007.22	60.57
2001	7	29	2 174	7 230.32	395.61	29.62
2002	8	32	2 598	8 281.02	1 231.81	40.57
2003	8	33	1 904	6 719.12	383.48	21.48
2004	8	23	1 725	6 488.50	163.05	10.09
2005	8	28	2 103	7 303.95	133.39	9.94
2006	8	33	2 204	8 642.28	1 443.61	34.48
2007	7	27	1 109	4 762.03	443.37	24.89
2008	7	27	1 223	5 763.20	446.30	18.23
2009	7	37	1 809	8 957.70	251.73	13.27
2010	6	25	1 191	5 181.56	664.44	38.04
2011	6	21	1 301	5 811.68	1 111.23	32.97
2012	6	27	1 344	5 844.70	1 061.15	31.70
2013	6	25	1 169	4 960.32	1 593.29	42.86
2014	7	36	1 420	6 220.82	1 575.73	46.76
2015	7	37	1 362	6 240.75	880.87	41.56
2016	8	48	1 409	6 312.63	602.02	25.83
2017	6	29	1 212	6 426.48	1 607.59	47.77
2018	7	33	1 599	7 557.02	2 206.59	52.47
2019	7	36	2 156	9 997.48	976.42	36.83
2020	7	44	2 235	10 344.52	787.14	34.54
2021	7	32	1 744	7 955.15	2 466.83	63.65
2022	6	35	1 603	7 543.75	1 866.15	63.32
2023	6	25	953	4 692.92	2 621.64	88.98
2024	6	34	1 157	5 419.63	1 201.65	85.13

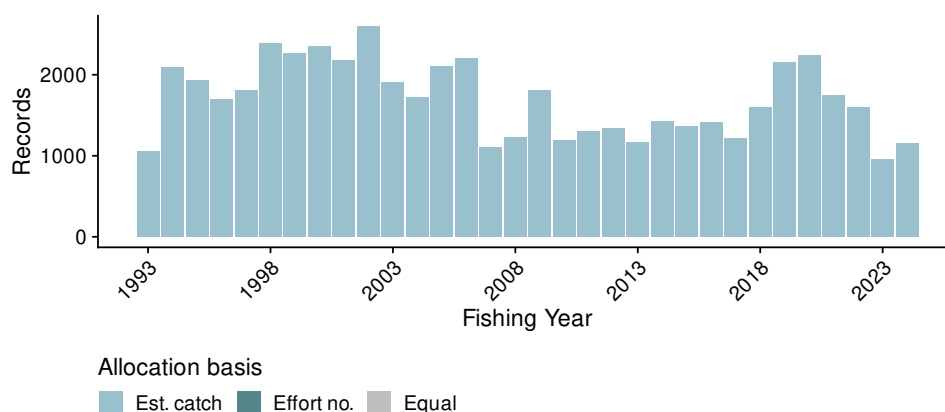


Figure D.121: The allocation approach used for attributing catches to records in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.28: Summary table for occurrence of positive catch in the JMA3 MW pred JMD event no weights series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	73 473.09	0.00	0.00	*
fyear	31	65 974.91	10.29	10.29	*
target_species	2	47 227.36	35.81	25.52	*
vessel_key	11	46 898.85	36.29	0.48	*
month	11	46 162.50	37.32	1.03	*
start_obs_fma	3	43 317.72	41.20	3.88	*
ns(log(fishing_duration), 3)	3	43 271.59	41.27	0.07	*
ns(log(start_time), 3)	3	43 170.73	41.42	0.15	*
ns(log(bottom_depth), 3)	3	43 003.74	41.65	0.24	*
ns(log(effort_height), 3)	3	42 967.98	41.71	0.06	*
ns(effort_speed, 3)	3	42 519.35	42.33	0.62	*

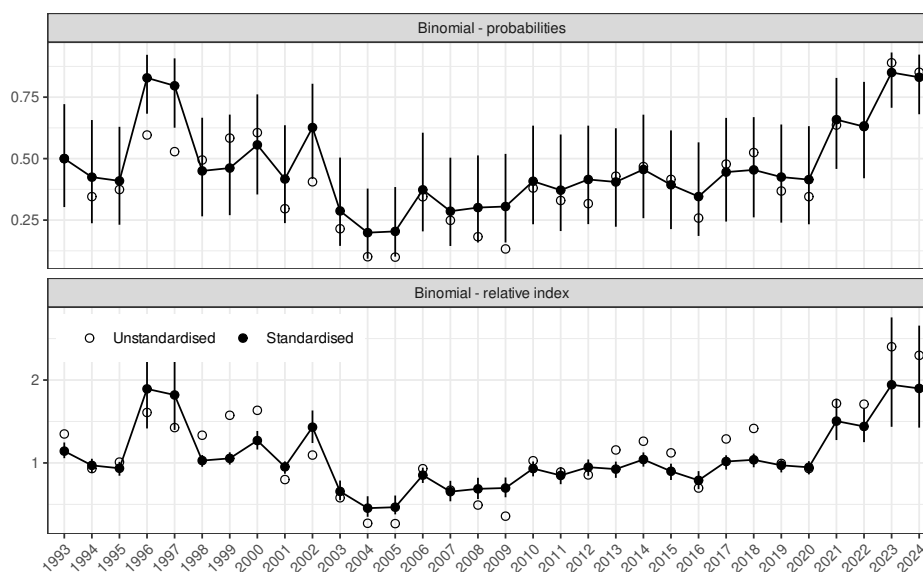


Figure D.122: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW pred JMD event no weights dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

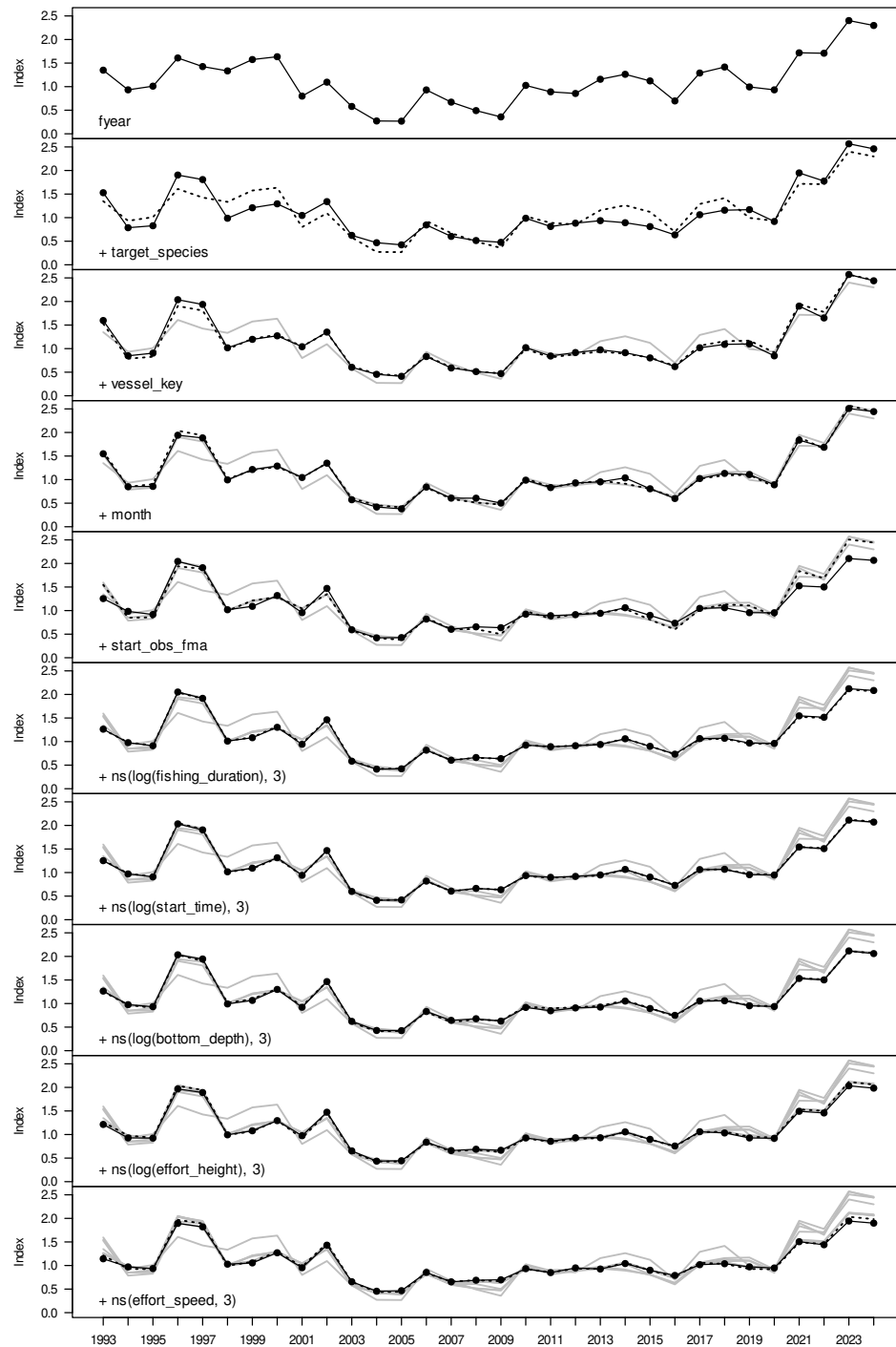


Figure D.123: Step plot for occurrence of catch in the JMA3 MW pred JMD event no weights dataset.

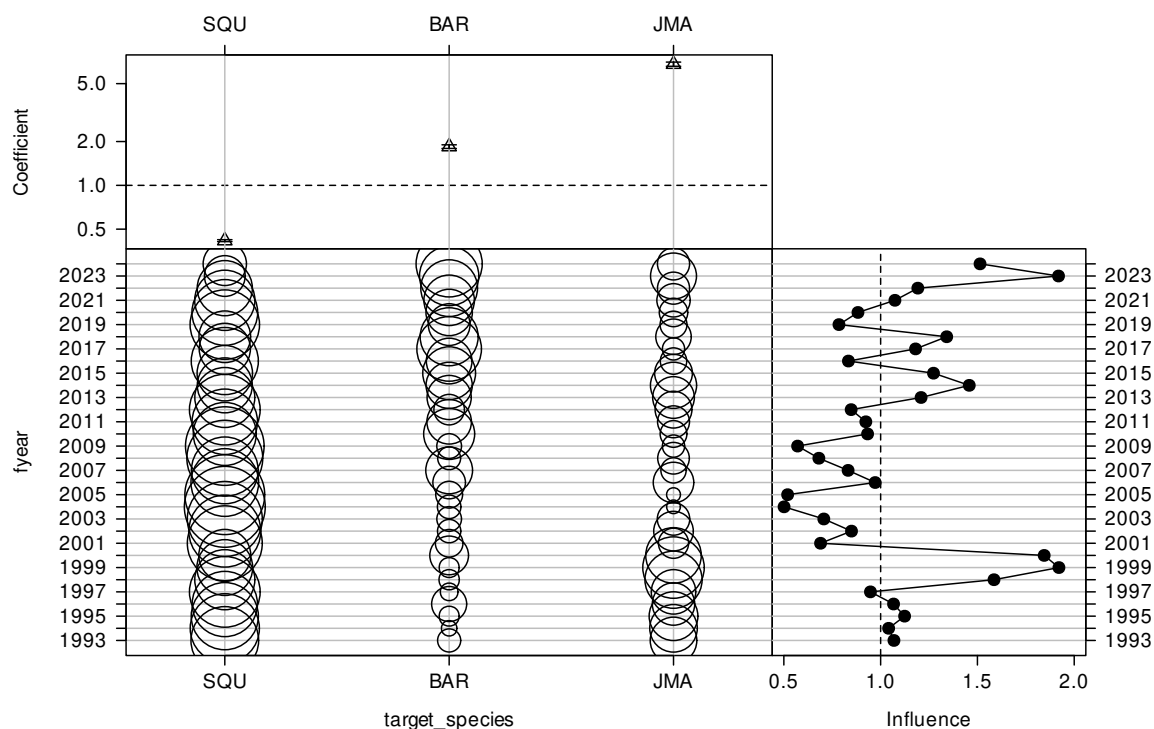


Figure D.124: CDI plot for target species for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

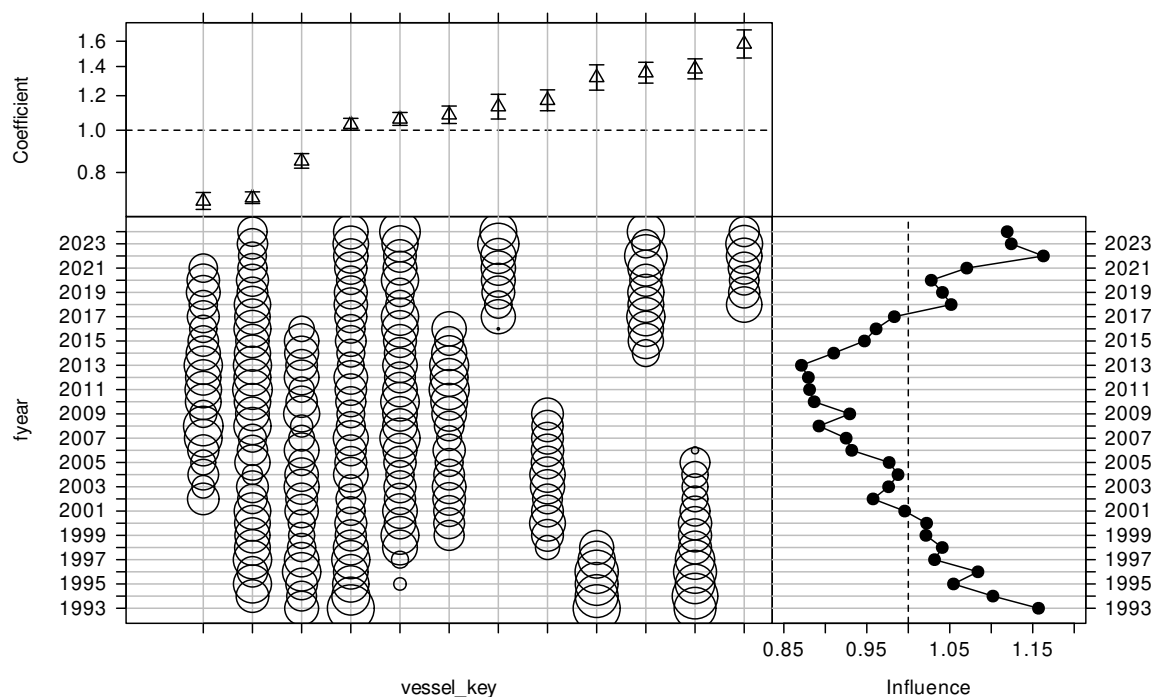


Figure D.125: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

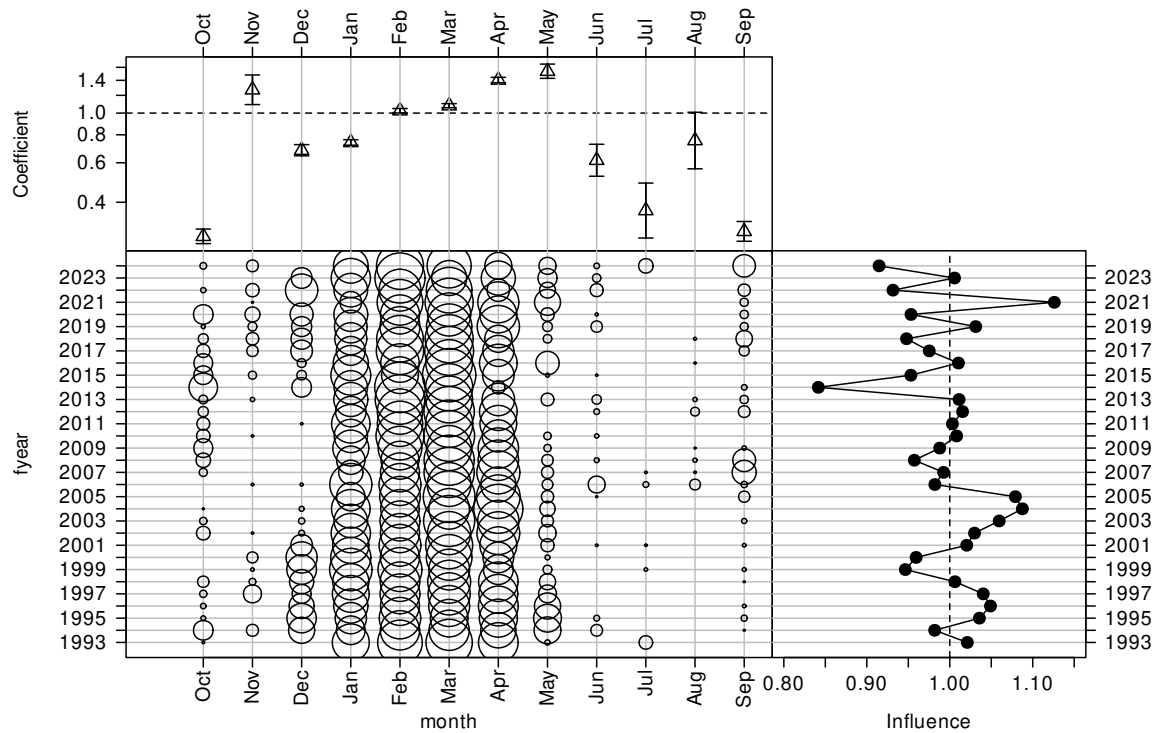


Figure D.126: CDI plot for month for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

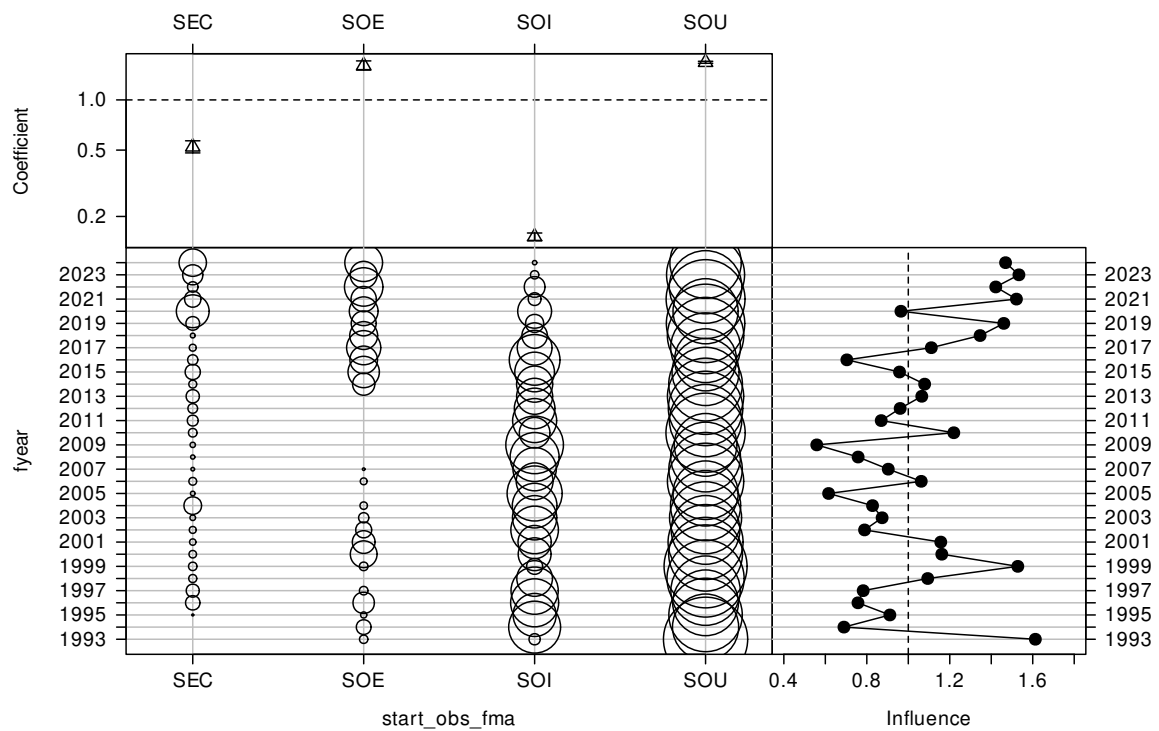


Figure D.127: CDI plot for start obs fma for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

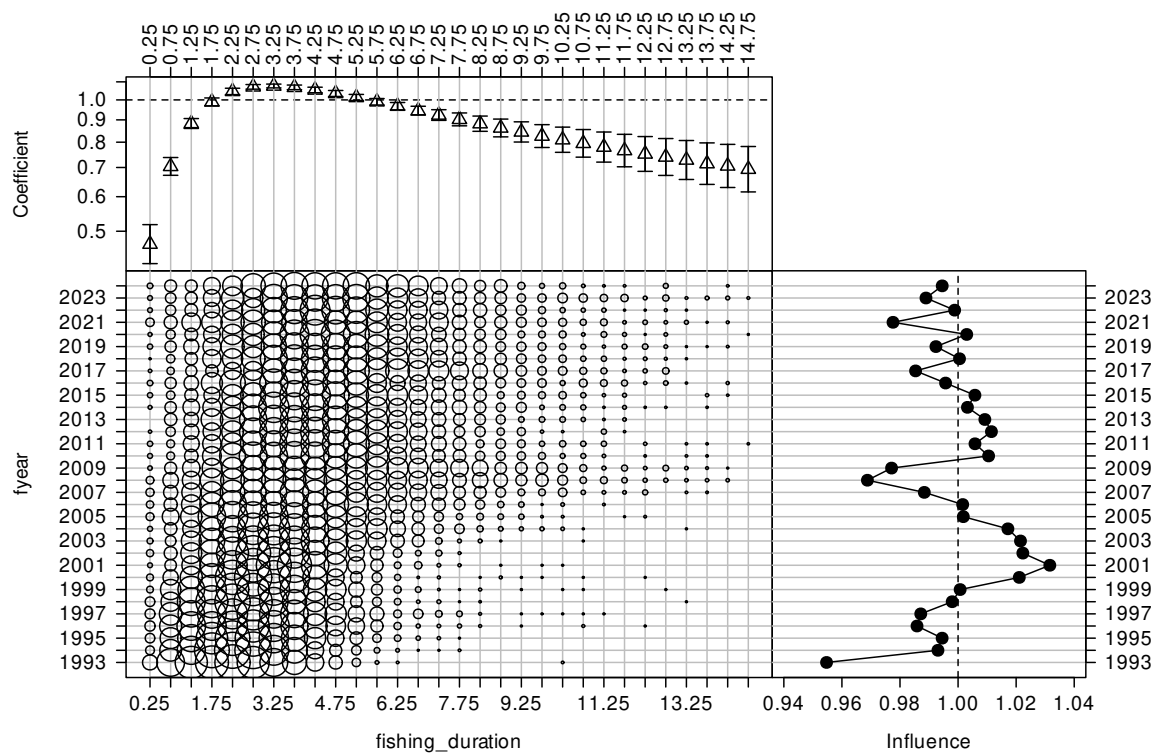


Figure D.128: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

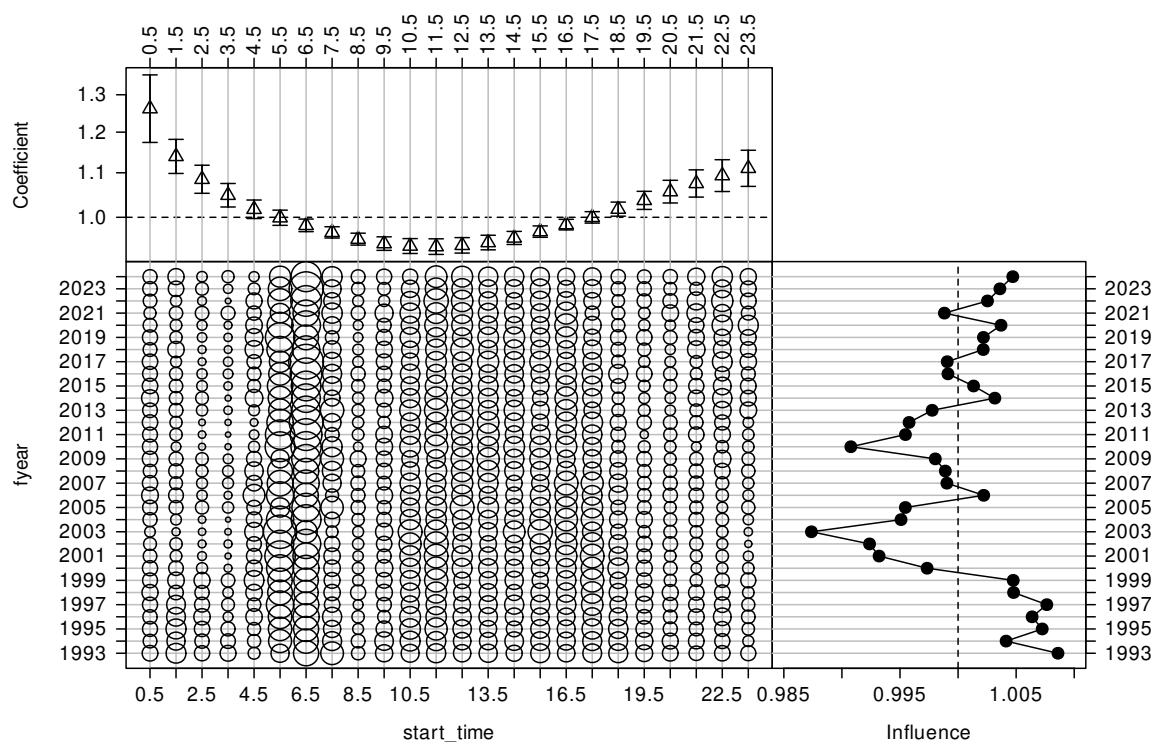


Figure D.129: CDI plot for start time for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

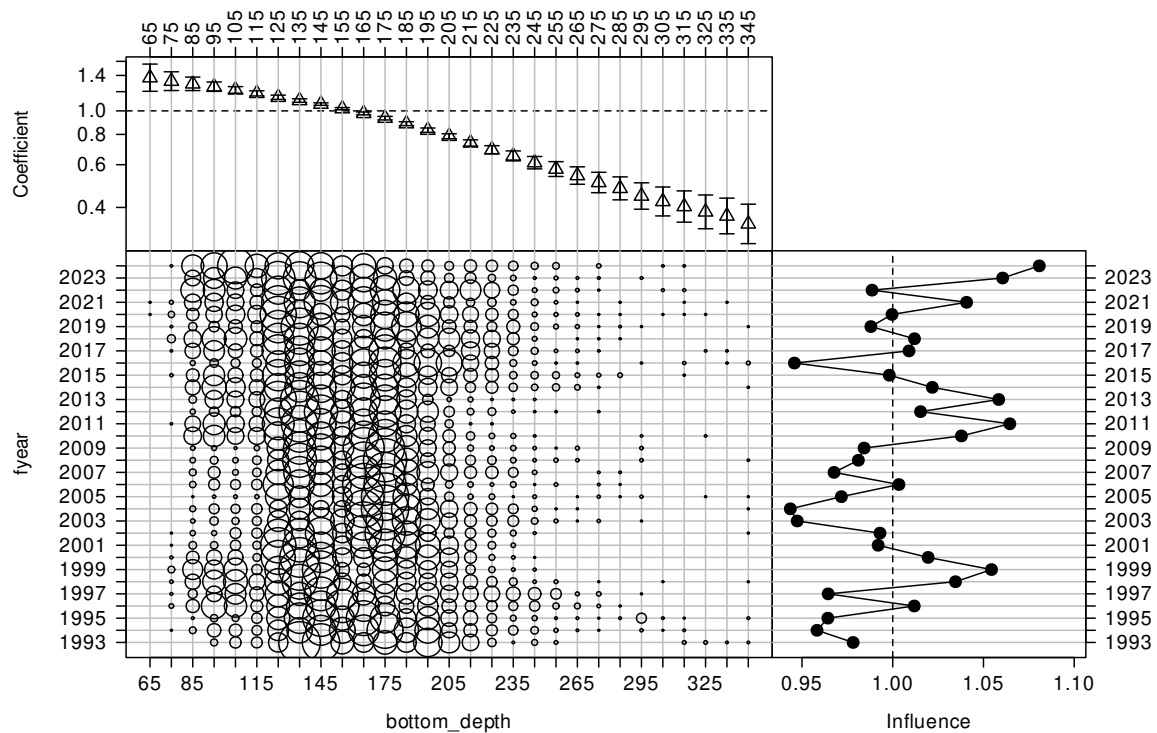


Figure D.130: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

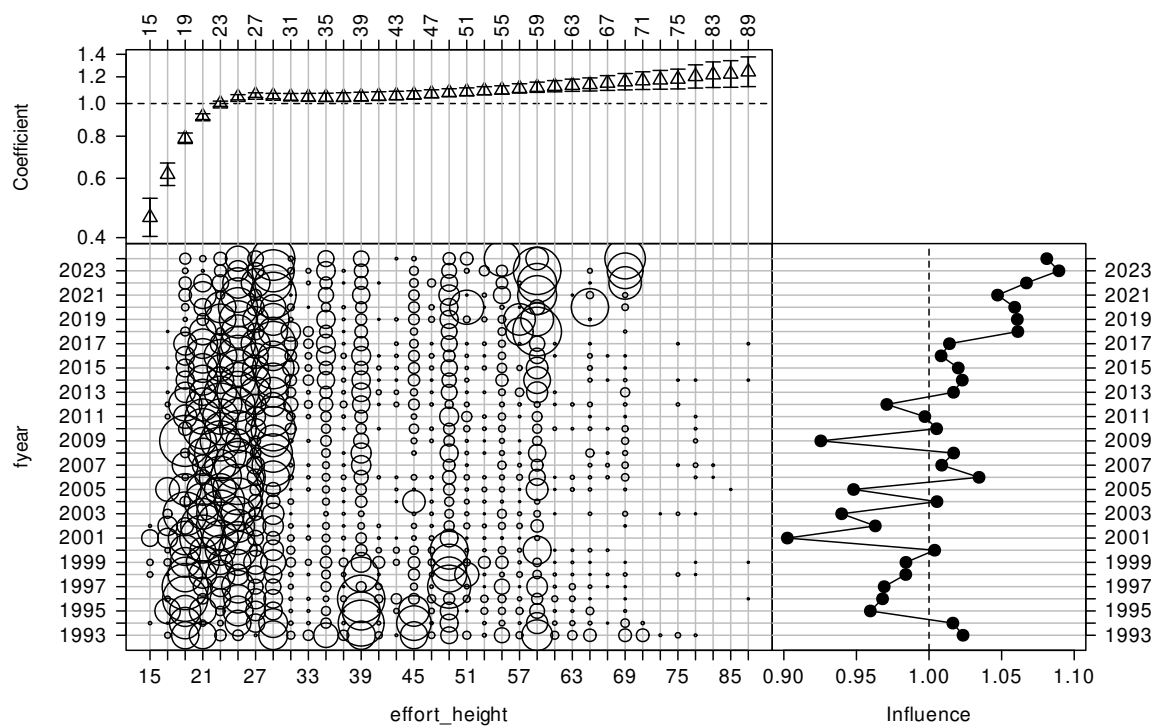


Figure D.131: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

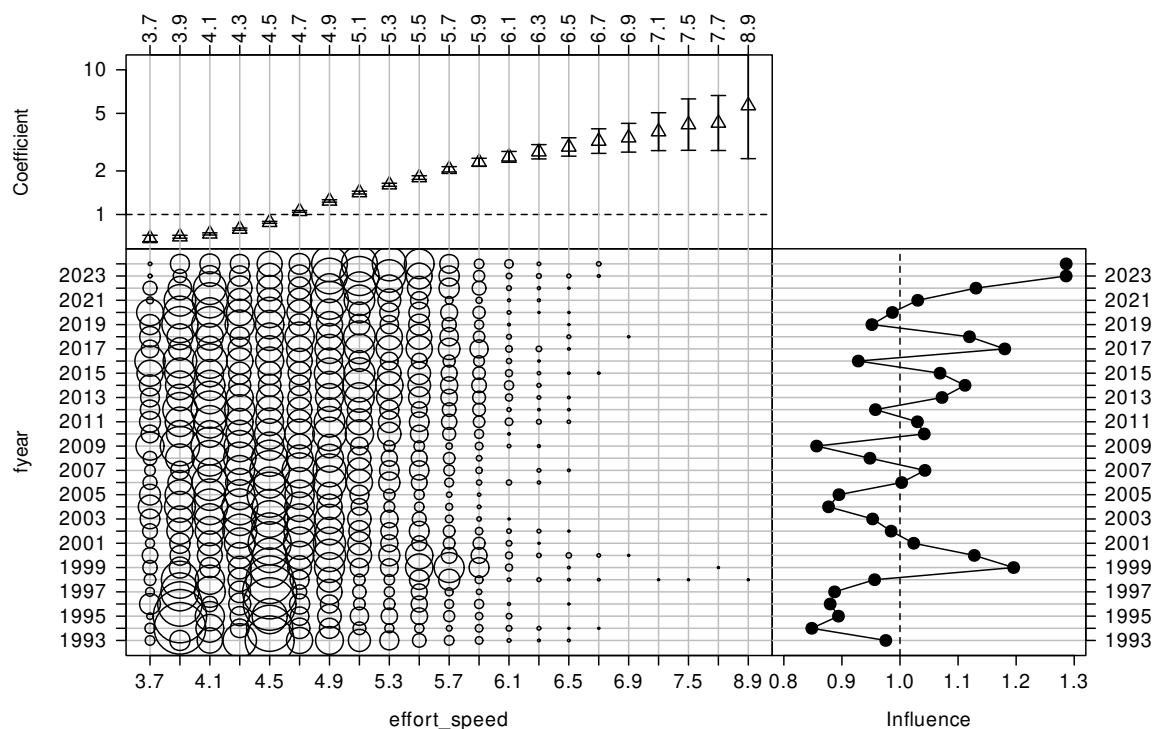


Figure D.132: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

Table D.29: Summary table for the Weibull model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	362 616.0	0.00	0.00	*
fyear	31	361 186.3	6.92	6.92	*
target_species	2	357 817.2	22.56	15.64	*
vessel_key	11	357 292.6	25.10	2.53	*
month	11	356 757.6	27.68	2.58	*
start_obs_fma	3	356 582.5	28.52	0.84	*
ns(log(fishing_duration), 3)	3	356 497.1	28.94	0.42	*
ns(log(start_time), 3)	3	356 317.2	29.80	0.86	*
ns(log(bottom_depth), 3)	3	356 272.4	30.04	0.24	*
ns(log(effort_height), 3)	3	356 187.3	30.46	0.42	*
ns(effort_speed, 3)	3	356 084.5	30.97	0.50	*

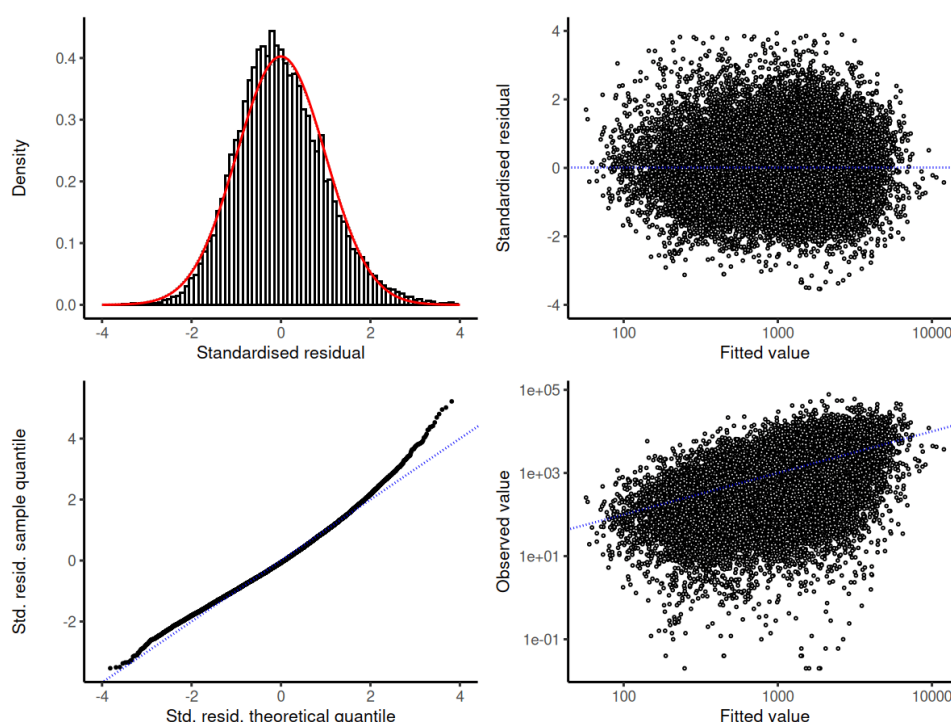


Figure D.133: Diagnostic plots for the selected Weibull model for positive catches in the JMA3 MW pred JMD event no weights dataset.

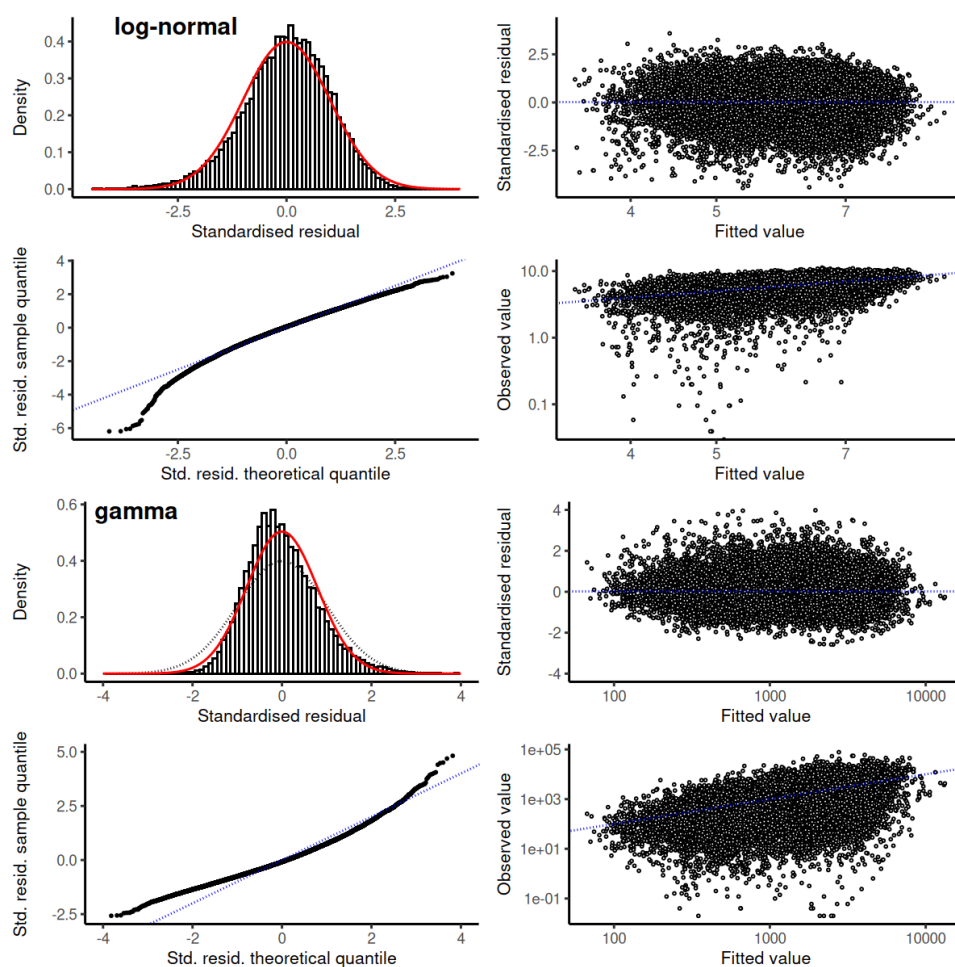


Figure D.134: Diagnostic plots for the alternative log-normal and gamma models considered for positive catches in the JMA3 MW pred JMD event no weights dataset.

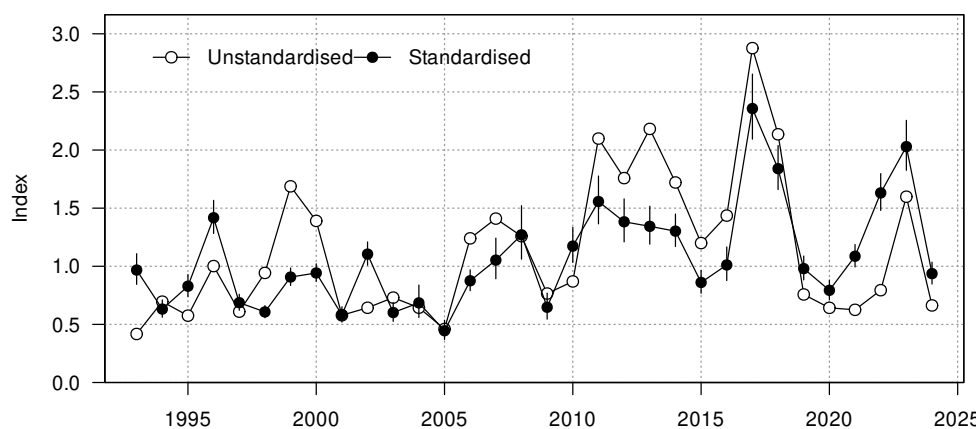


Figure D.135: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the Weibull model for the JMA3 MW pred JMD event no weights dataset.

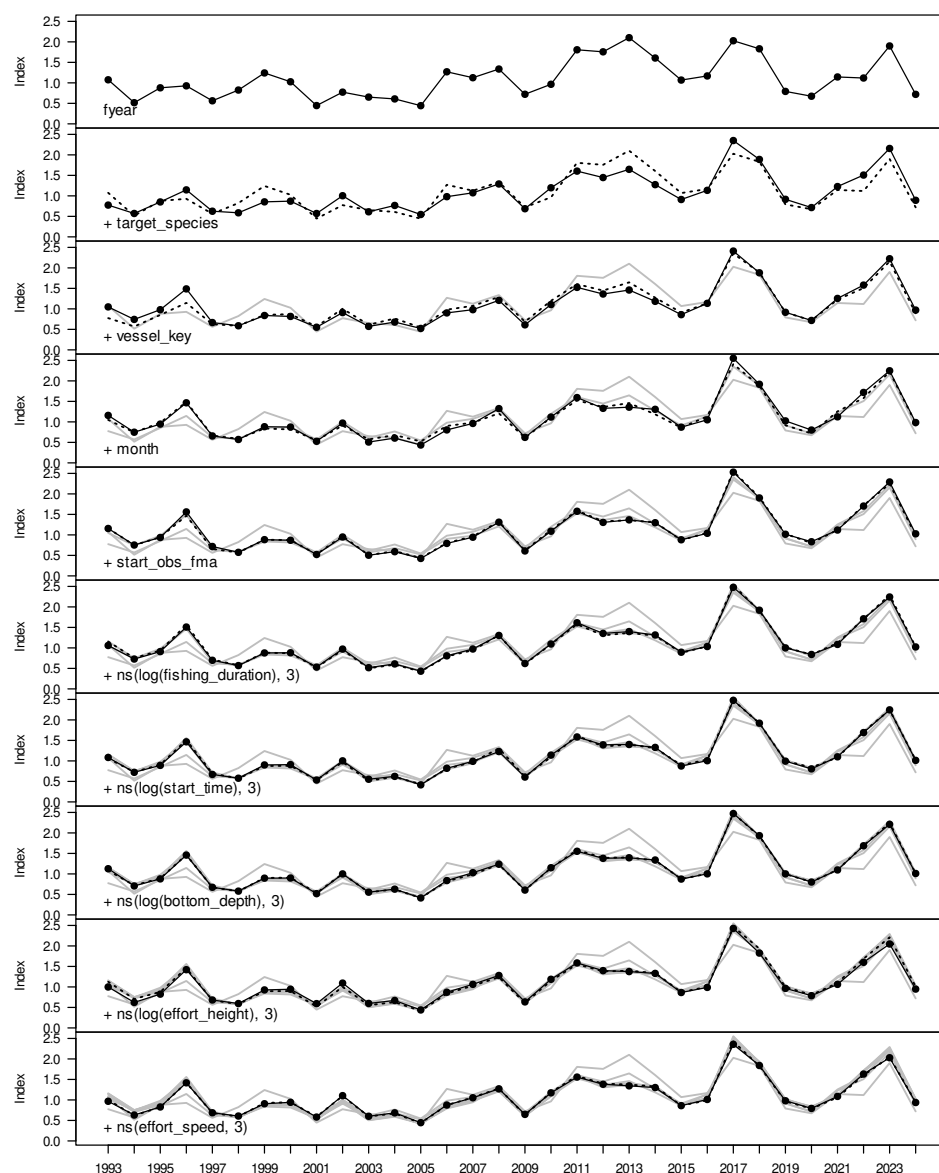


Figure D.136: Changes to the JMA3 MW pred JMD event no weights positive catch index as terms are successively entered into the Weibull model.

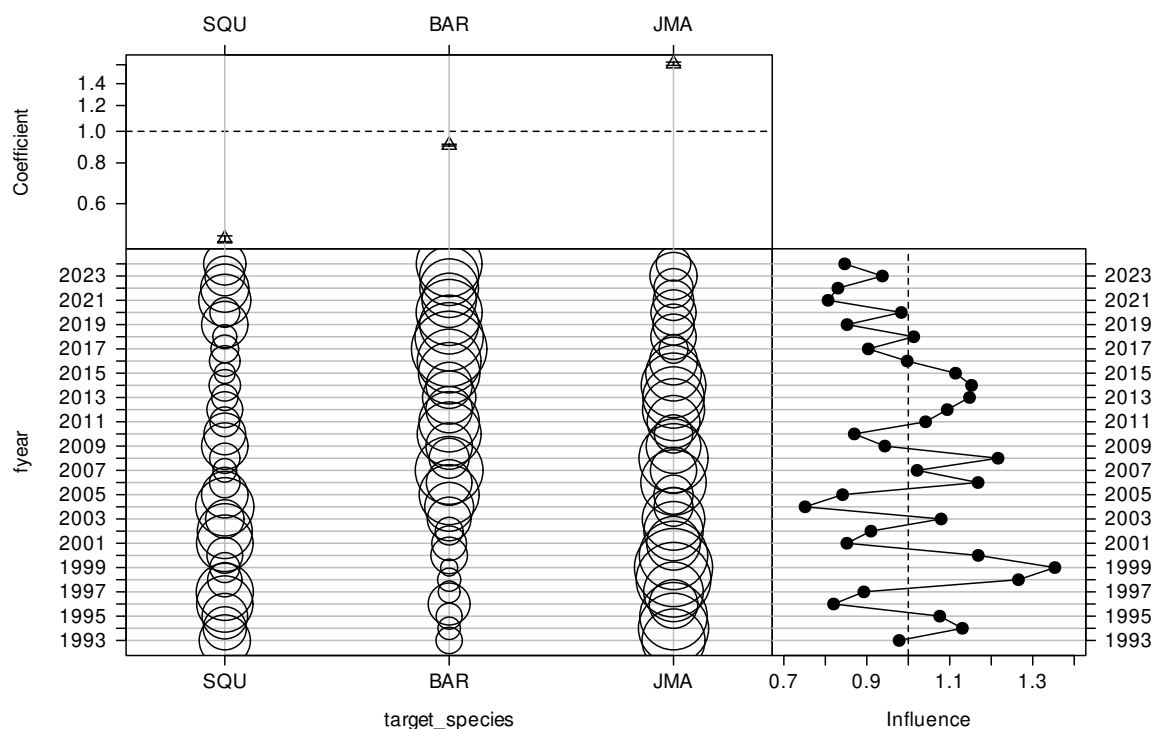


Figure D.137: CDI plot for target species for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

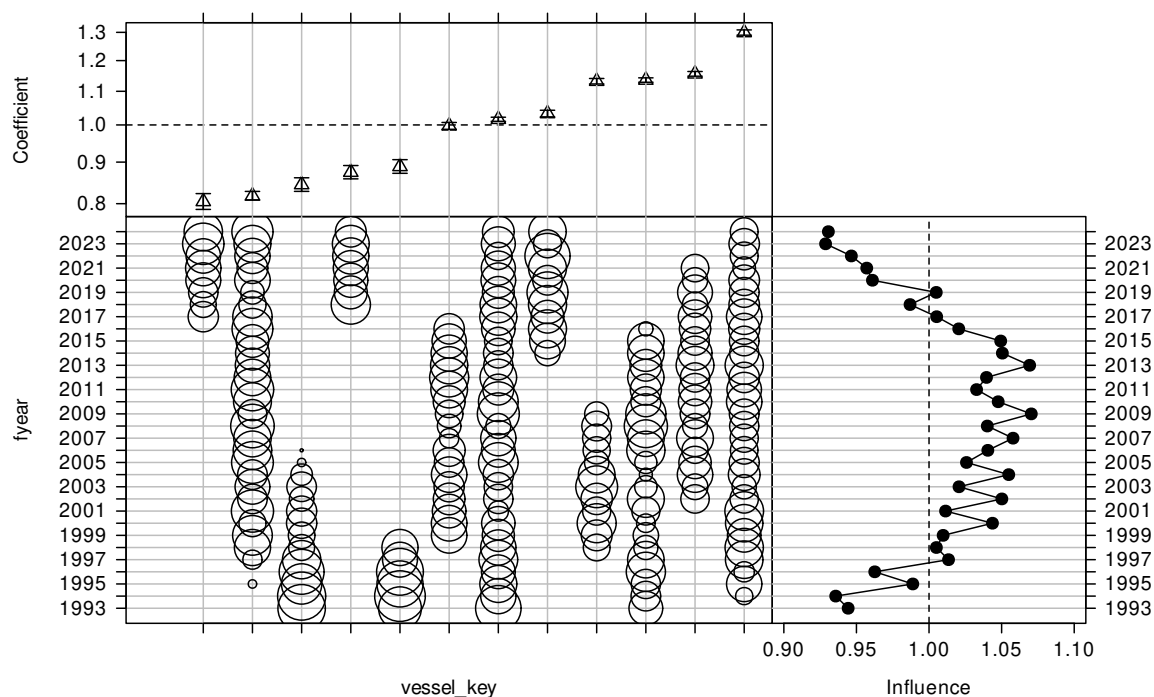


Figure D.138: CDI plot for vessel key for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

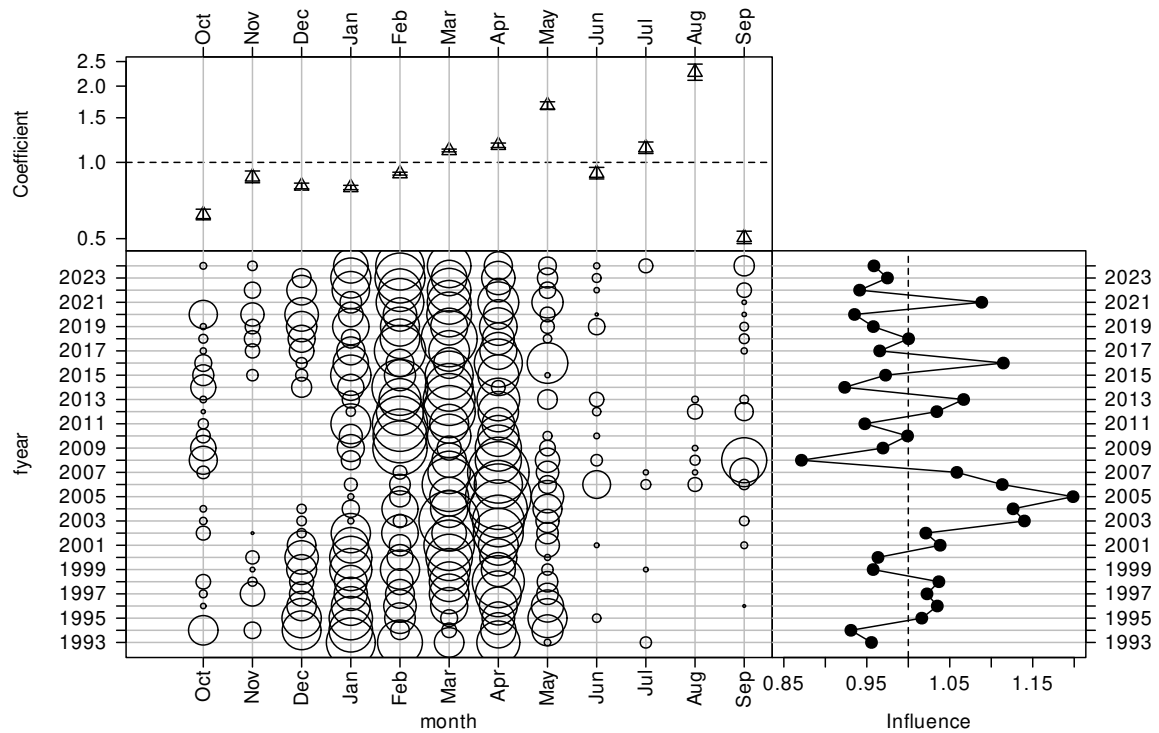


Figure D.139: CDI plot for month for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

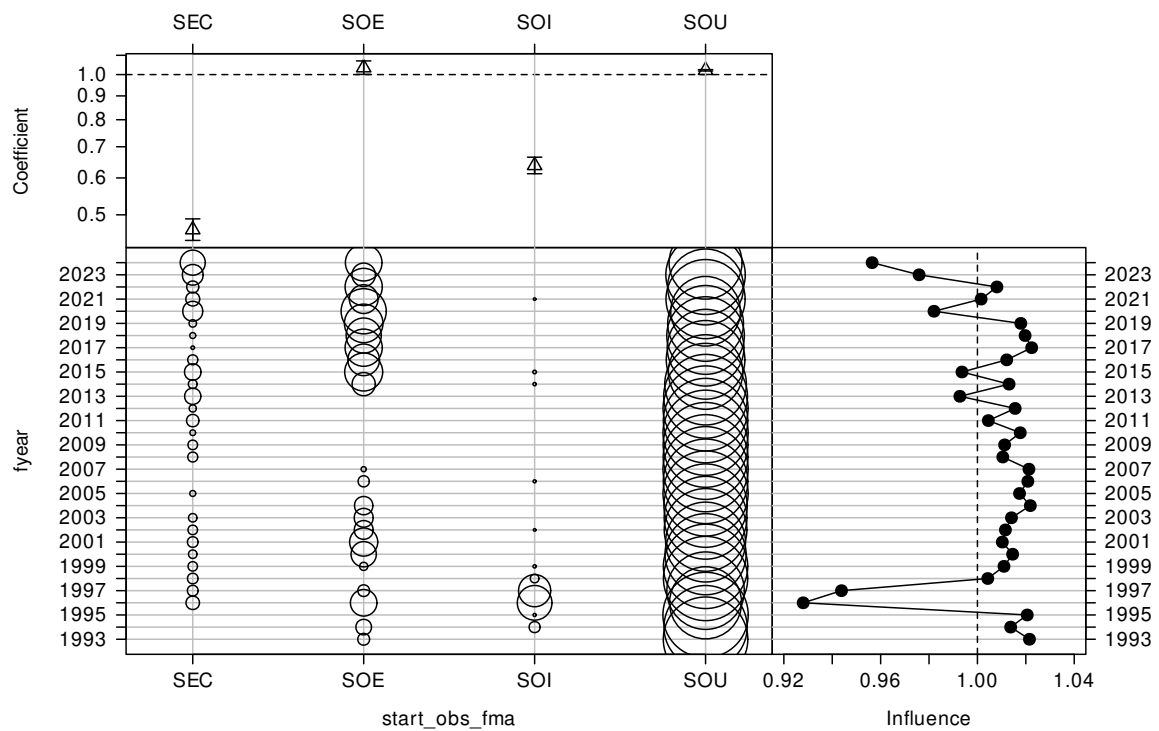


Figure D.140: CDI plot for start obs fma for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

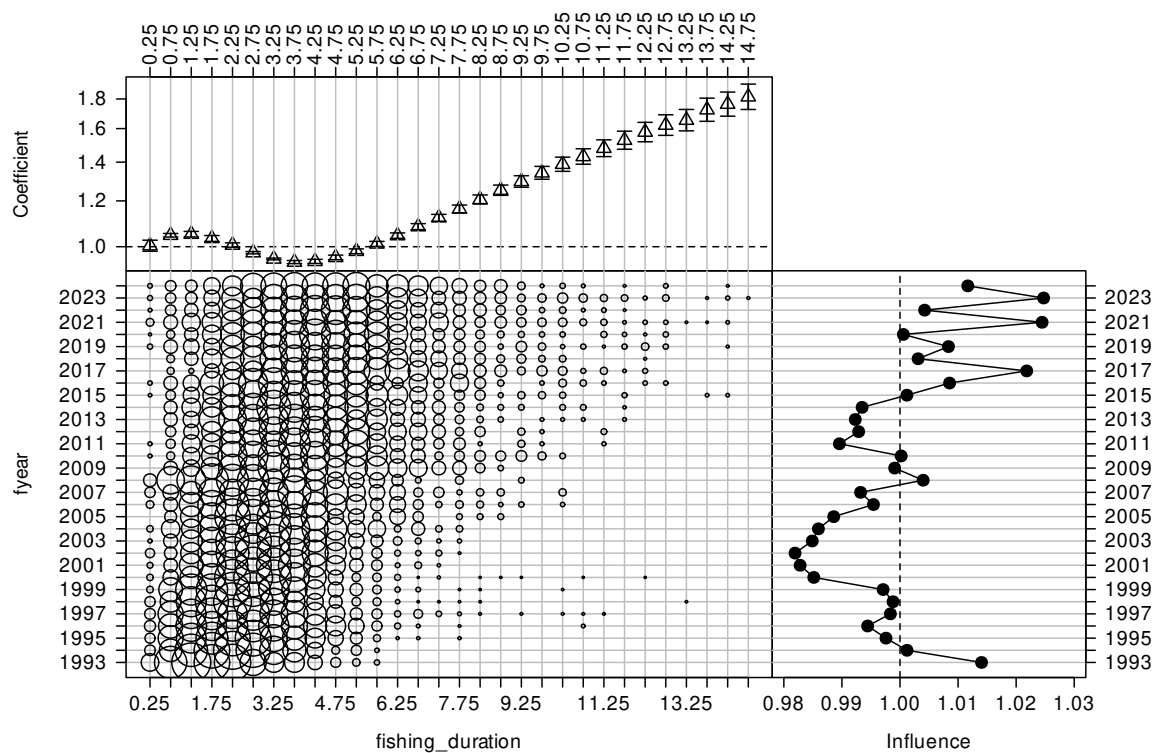


Figure D.141: CDI plot for fishing duration (h) for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

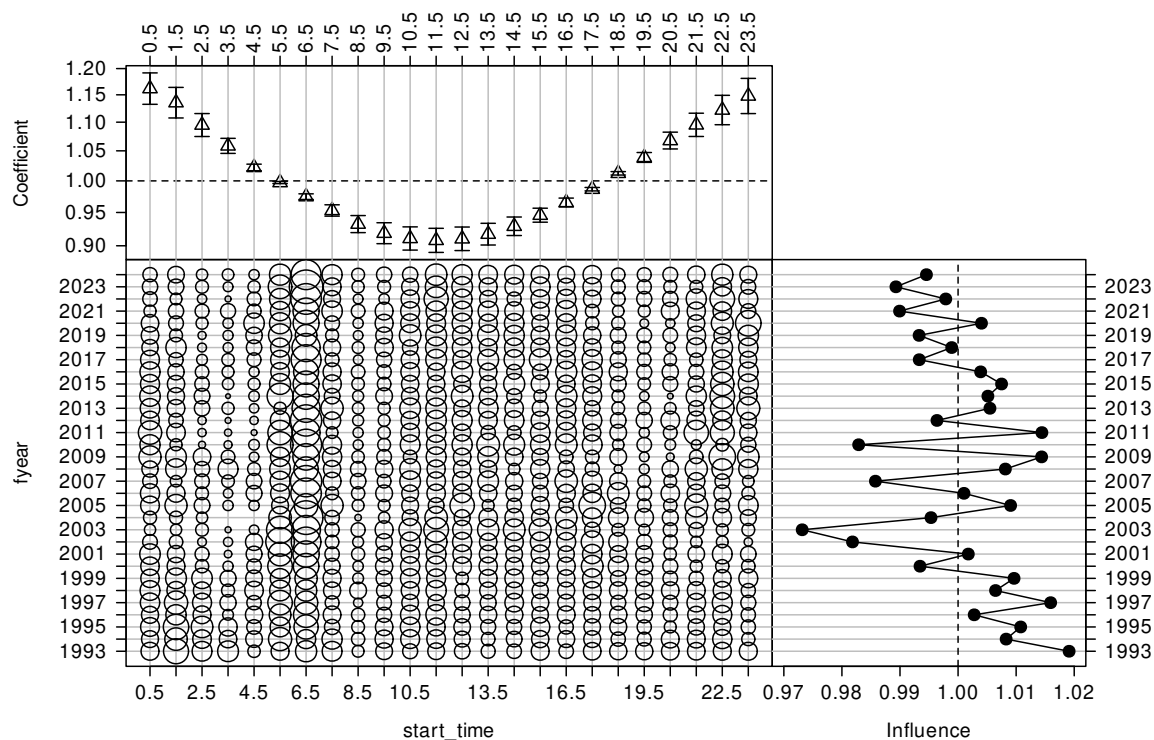


Figure D.142: CDI plot for start time for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

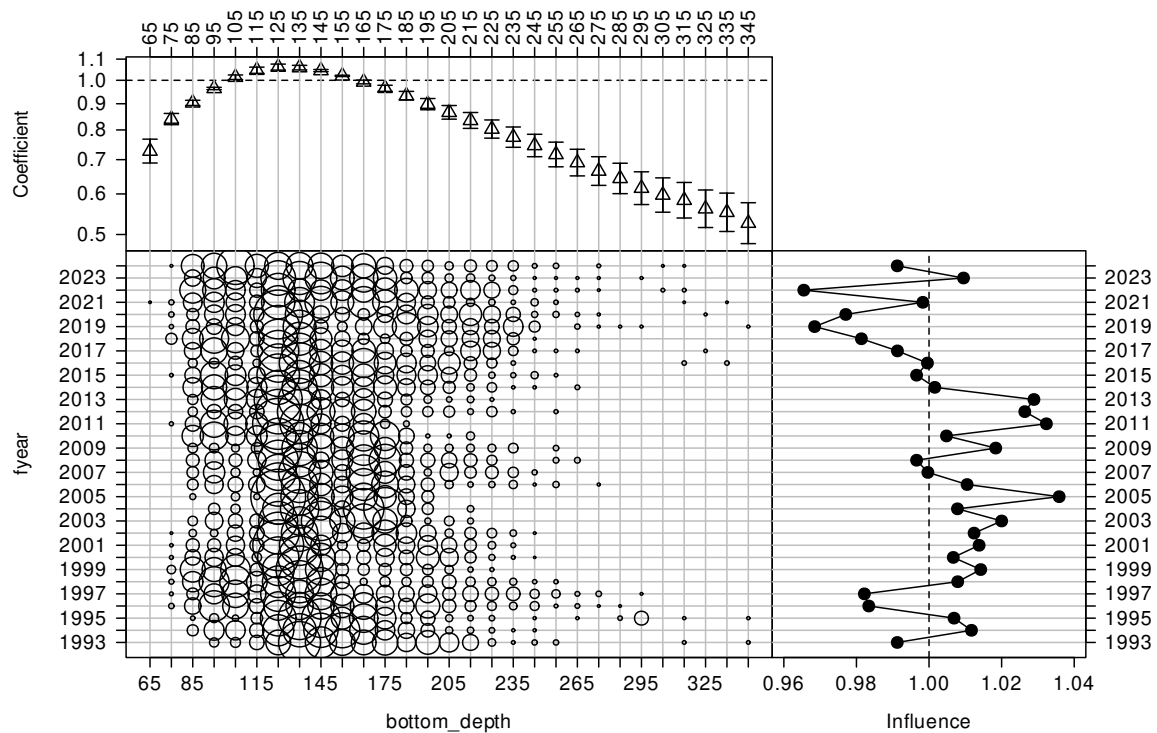


Figure D.143: CDI plot for bottom depth (m) for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

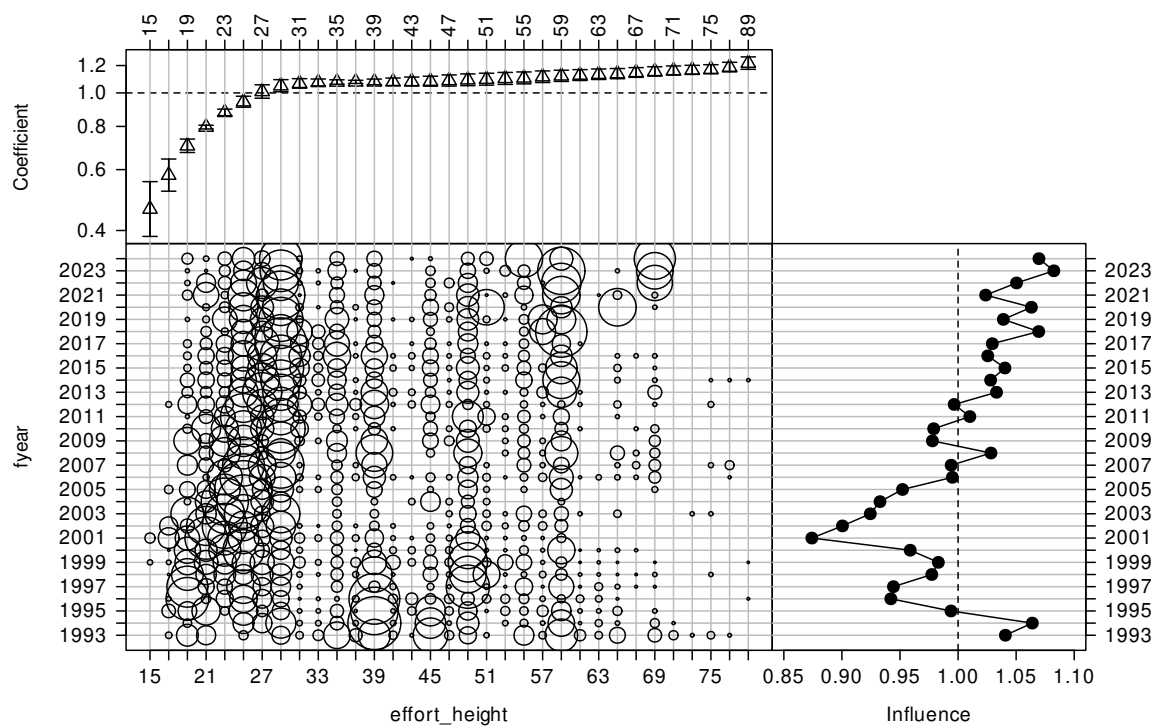


Figure D.144: CDI plot for effort height (m) for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

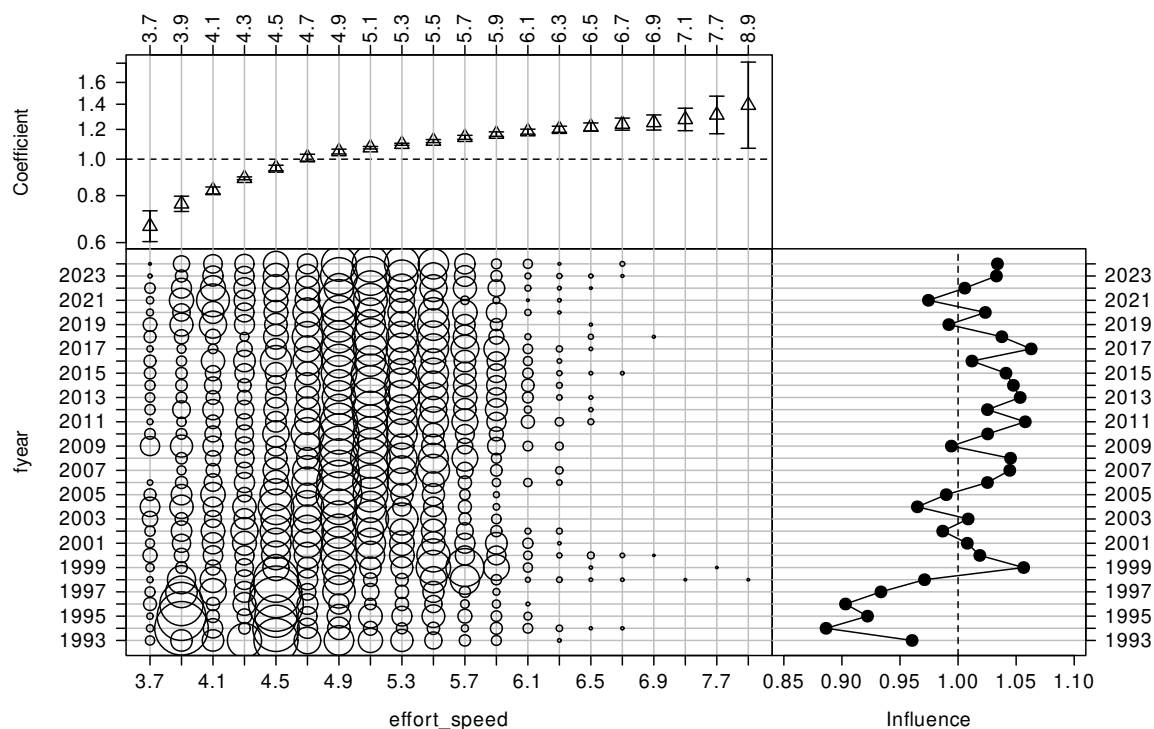


Figure D.145: CDI plot for effort speed for the Weibull model of positive catches in the JMA3 MW pred JMD event no weights catch-per-unit-effort dataset.

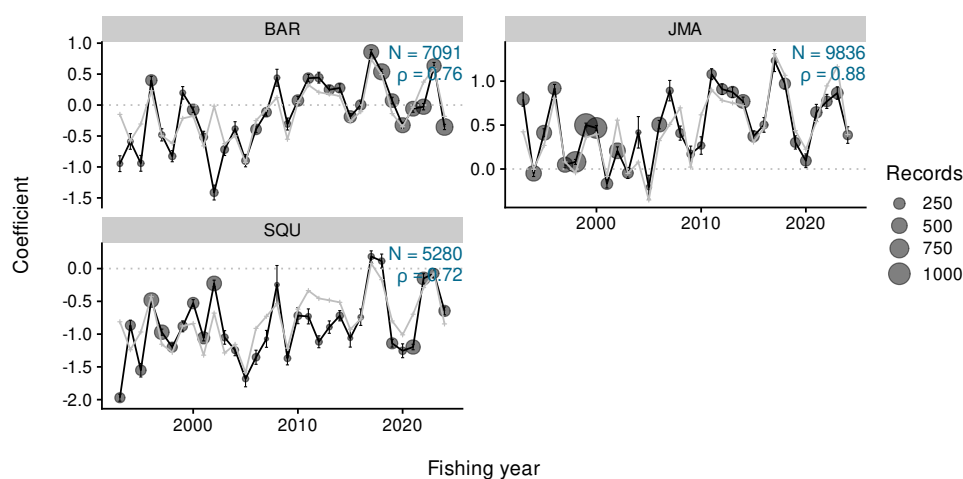


Figure D.146: Residual implied coefficients for target-year in the Weibull positive catch model for the JMA3 MW pred JMD event no weights dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

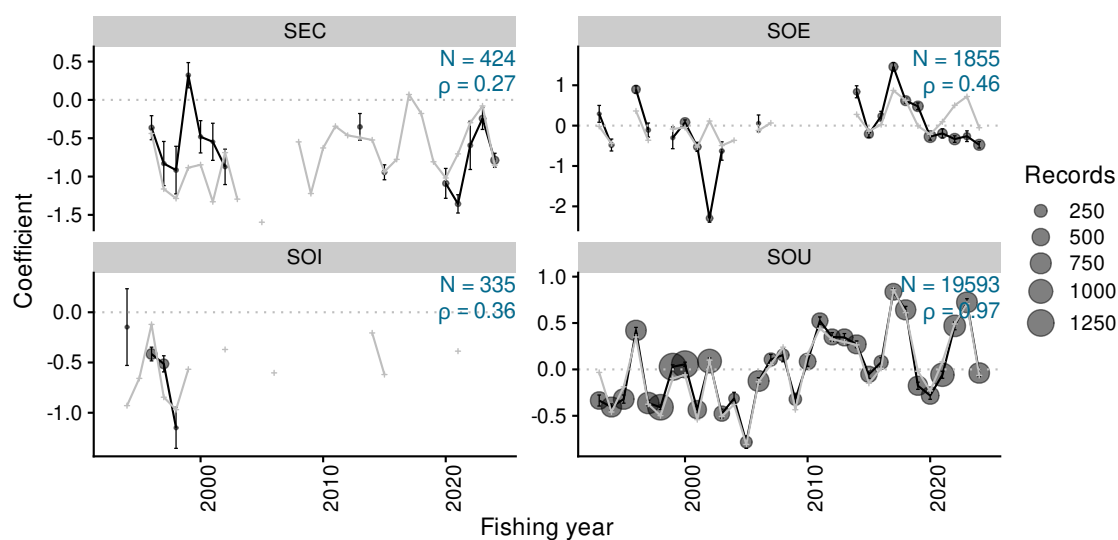


Figure D.147: Residual implied coefficients for area-year in the Weibull positive catch model for the JMA3 MW pred JMD event no weights dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

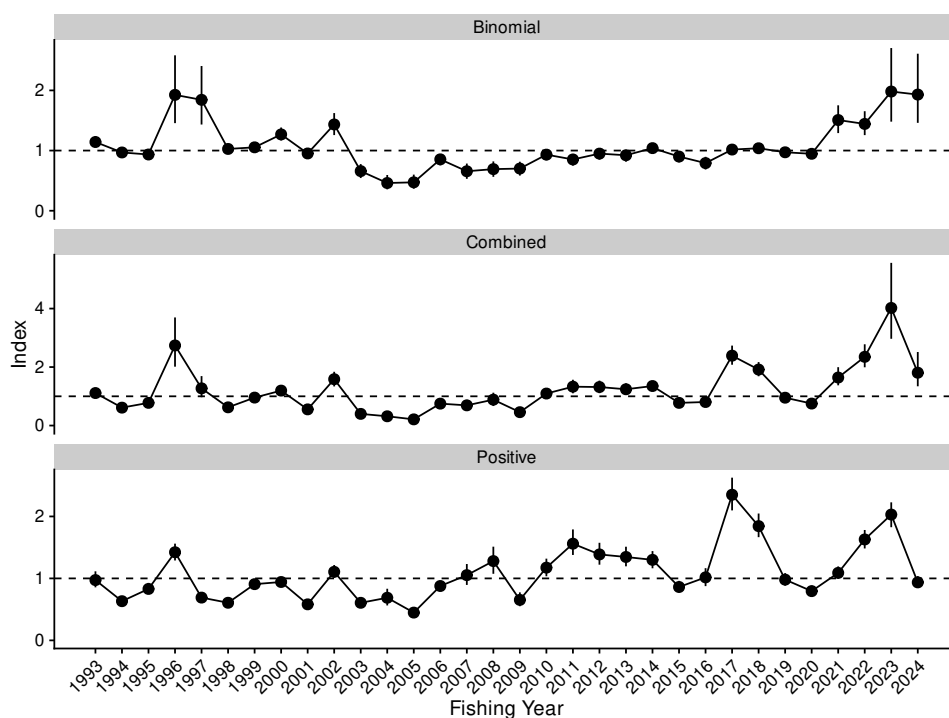


Figure D.148: Standardised indices and 95% confidence intervals for the JMA3 MW pred JMD event no weights dataset.

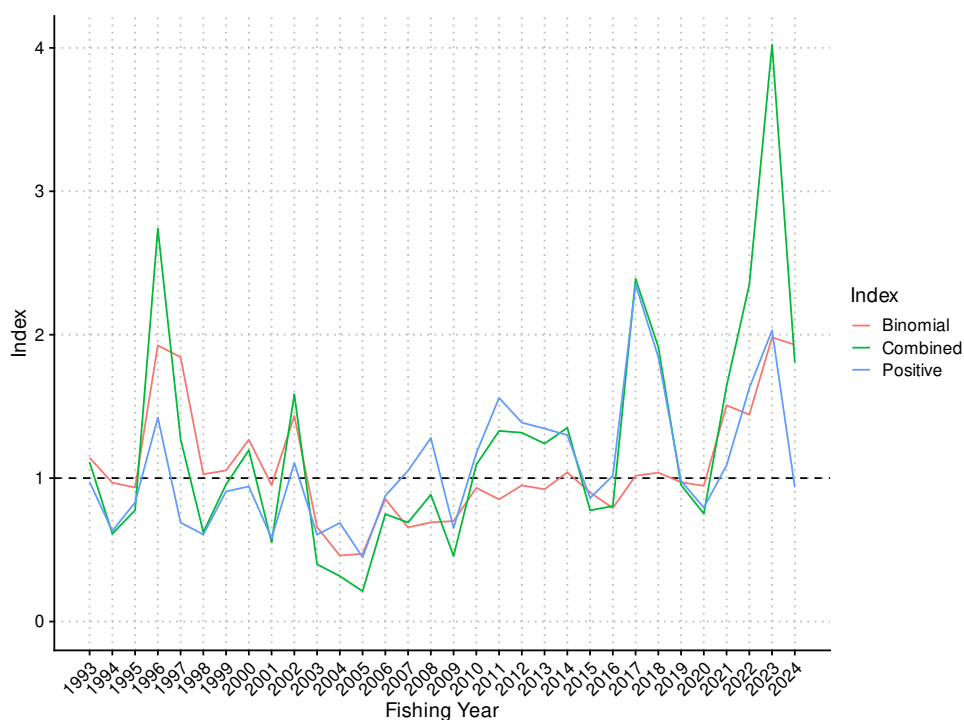


Figure D.149: Standardised indices for the JMA3 MW pred JMD event no weights dataset.

Table D.30: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW pred JMD event no weights series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.142	0.048	1.053	1.242	1.111	0.089	0.949	1.299	0.973	0.066	0.856	1.114
1994	0.968	0.042	0.884	1.049	0.612	0.045	0.524	0.700	0.632	0.036	0.567	0.709
1995	0.935	0.044	0.842	1.013	0.776	0.057	0.670	0.892	0.830	0.046	0.747	0.928
1996	1.926	0.287	1.456	2.583	2.739	0.429	2.013	3.696	1.422	0.069	1.289	1.561
1997	1.843	0.248	1.433	2.405	1.272	0.184	0.968	1.691	0.690	0.036	0.621	0.761
1998	1.027	0.037	0.946	1.092	0.623	0.034	0.560	0.693	0.607	0.026	0.558	0.660
1999	1.054	0.038	0.979	1.127	0.956	0.050	0.859	1.056	0.907	0.036	0.839	0.982
2000	1.268	0.055	1.168	1.383	1.195	0.072	1.063	1.344	0.942	0.039	0.868	1.020
2001	0.952	0.037	0.875	1.019	0.554	0.038	0.480	0.627	0.581	0.035	0.514	0.649
2002	1.434	0.093	1.257	1.623	1.585	0.128	1.338	1.838	1.106	0.053	1.009	1.216
2003	0.658	0.059	0.543	0.775	0.399	0.046	0.314	0.494	0.606	0.040	0.532	0.687
2004	0.461	0.061	0.356	0.594	0.317	0.051	0.228	0.430	0.688	0.069	0.564	0.833
2005	0.472	0.060	0.366	0.600	0.212	0.033	0.153	0.281	0.448	0.040	0.374	0.532
2006	0.854	0.047	0.754	0.937	0.749	0.055	0.645	0.862	0.877	0.044	0.791	0.963
2007	0.656	0.065	0.530	0.784	0.691	0.090	0.529	0.880	1.052	0.086	0.895	1.232
2008	0.692	0.065	0.564	0.820	0.885	0.116	0.668	1.123	1.280	0.112	1.074	1.512
2009	0.701	0.059	0.584	0.814	0.458	0.057	0.356	0.578	0.653	0.057	0.551	0.775
2010	0.932	0.046	0.837	1.018	1.094	0.087	0.928	1.270	1.174	0.073	1.034	1.319
2011	0.852	0.050	0.749	0.944	1.329	0.118	1.103	1.566	1.560	0.105	1.378	1.790
2012	0.949	0.048	0.848	1.037	1.317	0.110	1.107	1.537	1.387	0.090	1.221	1.575
2013	0.922	0.051	0.815	1.014	1.241	0.100	1.055	1.445	1.346	0.081	1.195	1.511
2014	1.040	0.042	0.960	1.123	1.351	0.090	1.175	1.527	1.299	0.071	1.163	1.441
2015	0.900	0.047	0.804	0.987	0.775	0.059	0.669	0.899	0.861	0.048	0.772	0.960
2016	0.792	0.054	0.685	0.896	0.805	0.080	0.656	0.968	1.017	0.074	0.875	1.165
2017	1.017	0.044	0.932	1.104	2.389	0.167	2.080	2.734	2.350	0.135	2.098	2.626
2018	1.038	0.039	0.960	1.111	1.914	0.124	1.685	2.171	1.844	0.097	1.666	2.047
2019	0.971	0.034	0.902	1.037	0.952	0.062	0.836	1.080	0.980	0.052	0.882	1.085
2020	0.946	0.036	0.872	1.013	0.752	0.050	0.656	0.853	0.794	0.043	0.716	0.885
2021	1.507	0.118	1.290	1.752	1.642	0.158	1.376	1.995	1.089	0.051	0.994	1.193
2022	1.443	0.101	1.257	1.654	2.350	0.201	1.992	2.779	1.629	0.076	1.483	1.781
2023	1.981	0.312	1.481	2.704	4.021	0.662	2.967	5.563	2.030	0.102	1.826	2.228
2024	1.930	0.293	1.461	2.609	1.807	0.299	1.343	2.514	0.936	0.049	0.845	1.037

D.6 JMA3 MW pred JMM event no weights

Table D.31: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW pred JMM event no weights CPUE series.

Series	JMA3 MW pred JMM event no weights
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	$\text{pred_catch_JMM} \sim \text{fyear} + \text{vessel_key} + \text{target_species} + \text{month} + \text{start_obs_fma} + \text{ns}(\log(\text{fishing_duration}), 3) + \text{ns}(\log(\text{start_time}), 3) + \text{ns}(\log(\text{bottom_depth}), 3) + \text{ns}(\log(\text{effort_height}), 3) + \text{ns}(\text{effort_speed}, 3)$
Stepwise selection	No
Positive catch distribution	Weibull

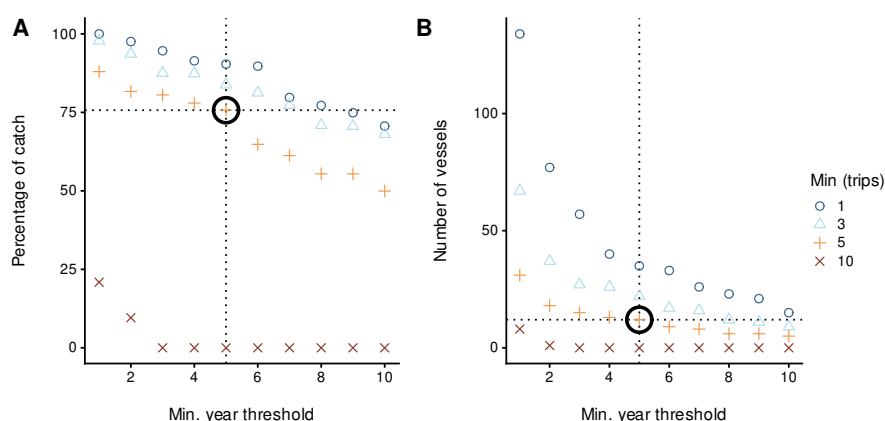


Figure D.150: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW pred JMM event no weights CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

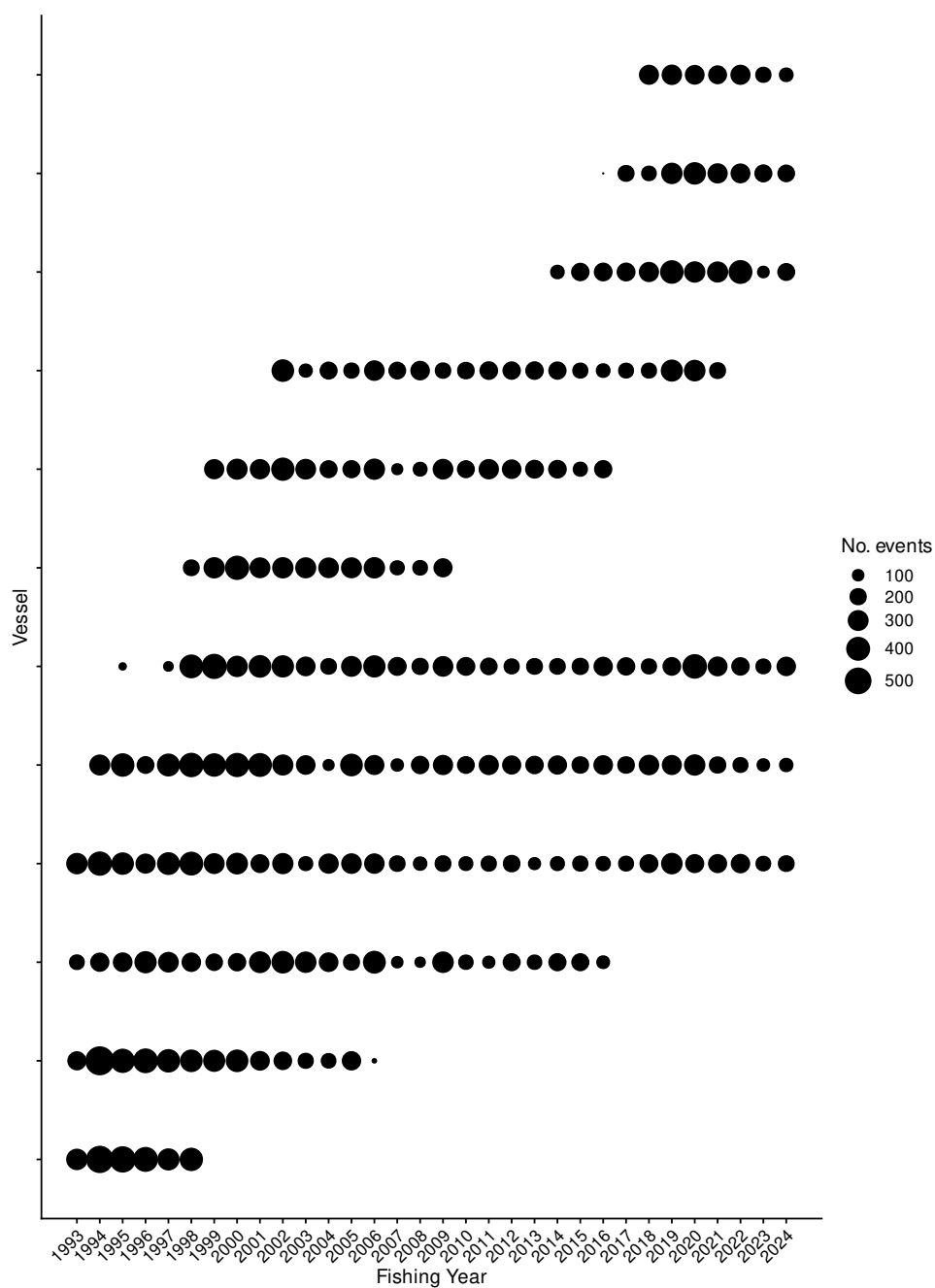


Figure D.151: Number of events by fishing year for core vessels in the JMA3 MW pred JMM event no weights series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table D.32: Summary of the JMA3 MW pred JMM event no weights dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	7278 (100%) n: 7113	4154 (100%) n: 6413	5515 (100%) n: 7617	11101 (100%) n: 7993	10598 (100%) n: 5763	9731 (100%) n: 5648	10988 (100%) n: 5256	5715 (100%) n: 3758	1541 (100%) n: 3011
Fishing speed not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11096 (100%) n: 7985	10577 (100%) n: 5757	9731 (100%) n: 5644	10986 (100%) n: 5252	5715 (100%) n: 3758	1541 (100%) n: 3010
Fishing speed lt 10kts	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11052 (100%) n: 7953	10555 (100%) n: 5745	9731 (100%) n: 5639	10986 (100%) n: 5251	5715 (100%) n: 3758	1541 (100%) n: 3010
Start date not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11052 (100%) n: 7953	10555 (100%) n: 5745	9731 (100%) n: 5639	10986 (100%) n: 5251	5715 (100%) n: 3758	1541 (100%) n: 3010
End date not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11052 (100%) n: 7953	10555 (100%) n: 5745	9731 (100%) n: 5639	10986 (100%) n: 5251	5715 (100%) n: 3758	1541 (100%) n: 3010
Start depth not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11052 (100%) n: 7946	10552 (100%) n: 5729	9652 (99%) n: 5626	10967 (100%) n: 5240	5715 (100%) n: 3755	1539 (100%) n: 3000
Headline height not null	7278 (100%) n: 7113	4154 (100%) n: 6413	5489 (100%) n: 7615	11042 (99%) n: 7797	10551 (100%) n: 5721	9650 (99%) n: 5615	10955 (100%) n: 5233	5708 (100%) n: 3751	1539 (100%) n: 2999
Fishing speed >3.5kn	7039 (97%) n: 6832	4131 (99%) n: 6125	5478 (99%) n: 7473	10968 (99%) n: 7506	10479 (99%) n: 5470	9612 (99%) n: 5391	10869 (99%) n: 5118	5667 (99%) n: 3698	1533 (99%) n: 2985
Headline height >15m	7022 (96%) n: 6811	4099 (99%) n: 6075	5437 (99%) n: 7430	10755 (97%) n: 7400	10411 (98%) n: 5384	9585 (99%) n: 5366	10829 (99%) n: 5022	5663 (99%) n: 3688	1532 (99%) n: 2978
Headline height <90m	6651 (91%) n: 6659	4074 (98%) n: 6073	5437 (99%) n: 7430	10745 (97%) n: 7389	9306 (88%) n: 5181	8744 (90%) n: 4978	10789 (98%) n: 5008	5654 (99%) n: 3678	1532 (99%) n: 2977
Fishing duration >15mins	6564 (90%) n: 6627	4059 (98%) n: 6056	5409 (98%) n: 7413	10663 (96%) n: 7360	9243 (87%) n: 5165	8730 (90%) n: 4964	10782 (98%) n: 4997	5654 (99%) n: 3675	1532 (99%) n: 2970
Fishing duration <15h	6553 (90%) n: 6609	4051 (98%) n: 6040	5394 (98%) n: 7404	10630 (96%) n: 7342	9089 (86%) n: 5134	8692 (89%) n: 4949	10754 (98%) n: 4988	5613 (98%) n: 3656	1532 (99%) n: 2970
Seabed depth >50m	6553 (90%) n: 6609	4051 (98%) n: 6040	5394 (98%) n: 7403	10630 (96%) n: 7342	9089 (86%) n: 5134	8673 (89%) n: 4946	10754 (98%) n: 4987	5613 (98%) n: 3655	1532 (99%) n: 2970
Seabed depth <350m	6519 (90%) n: 6570	4041 (97%) n: 6000	5385 (98%) n: 7227	10607 (96%) n: 7313	9057 (85%) n: 5121	8663 (89%) n: 4942	10728 (98%) n: 4964	5611 (98%) n: 3645	1528 (99%) n: 2967
Start time >0	6238 (86%) n: 6508	3954 (95%) n: 5958	5211 (94%) n: 7156	10262 (92%) n: 7221	8758 (83%) n: 5067	8490 (87%) n: 4901	10370 (94%) n: 4916	5548 (97%) n: 3623	1512 (98%) n: 2956
SA subset	6238 (86%) n: 6508	3954 (95%) n: 5958	5211 (94%) n: 7156	10262 (92%) n: 7221	8758 (83%) n: 5067	8490 (87%) n: 4901	10370 (94%) n: 4916	5548 (97%) n: 3623	1512 (98%) n: 2956
No effort allocation	6225 (86%) n: 6462	3905 (94%) n: 5829	5191 (94%) n: 7023	10262 (92%) n: 7221	8758 (83%) n: 5066	8490 (87%) n: 4901	10370 (94%) n: 4916	5548 (97%) n: 3619	1512 (98%) n: 2956
Core fleet selection	2057 (28%) n: 1050	2574 (62%) n: 2090	3005 (54%) n: 1937	5111 (46%) n: 1698	5094 (48%) n: 1813	5887 (60%) n: 2393	6915 (63%) n: 2269	4502 (79%) n: 2351	1332 (86%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
Fishing speed not null	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
Fishing speed lt 10kts	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
Start date not null	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
End date not null	2289 (100%) n: 3311	1224 (100%) n: 3108	357 (100%) n: 3281	433 (100%) n: 3639	3116 (100%) n: 2834	944 (100%) n: 2416	1688 (100%) n: 2250	1405 (100%) n: 2187	1524 (100%) n: 1313
Start depth not null	2288 (100%) n: 3306	1224 (100%) n: 3106	357 (100%) n: 3278	433 (100%) n: 3635	3116 (100%) n: 2831	943 (100%) n: 2412	1688 (100%) n: 2246	1405 (100%) n: 2187	1524 (100%) n: 1313
Headline height not null	2288 (100%) n: 3306	1224 (100%) n: 3106	357 (100%) n: 3278	433 (100%) n: 3635	3116 (100%) n: 2831	943 (100%) n: 2412	1688 (100%) n: 2246	1405 (100%) n: 2187	1524 (100%) n: 1313
Fishing speed >3.5kn	2288 (100%) n: 3266	1216 (99%) n: 3061	355 (100%) n: 3167	433 (100%) n: 3520	3111 (100%) n: 2794	942 (100%) n: 2380	1664 (99%) n: 2222	1367 (97%) n: 2132	1524 (100%) n: 1300
Headline height >15m	2251 (98%) n: 3243	1214 (99%) n: 3043	349 (98%) n: 3150	433 (100%) n: 3512	3111 (100%) n: 2790	942 (100%) n: 2359	1664 (99%) n: 2205	1359 (97%) n: 2128	1523 (100%) n: 1297
Headline height <90m	2251 (98%) n: 3243	1214 (99%) n: 3043	347 (97%) n: 3149	433 (100%) n: 3512	3111 (100%) n: 2789	942 (100%) n: 2359	1664 (99%) n: 2204	1359 (97%) n: 2128	1523 (100%) n: 1297
Fishing duration >15mins	2213 (97%) n: 3229	1214 (99%) n: 3038	347 (97%) n: 3140	433 (100%) n: 3501	3109 (100%) n: 2782	941 (100%) n: 2354	1663 (99%) n: 2198	1359 (97%) n: 2126	1523 (100%) n: 1295
Fishing duration <15h	2213 (97%) n: 3226	1211 (99%) n: 3037	347 (97%) n: 3138	433 (100%) n: 3501	3109 (100%) n: 2780	941 (100%) n: 2353	1651 (98%) n: 2195	1359 (97%) n: 2122	1523 (100%) n: 1294
Seabed depth >50m	2211 (97%) n: 3224	1211 (99%) n: 3037	347 (97%) n: 3138	433 (100%) n: 3501	3109 (100%) n: 2780	941 (100%) n: 2353	1651 (98%) n: 2195	1359 (97%) n: 2122	1523 (100%) n: 1294
Seabed depth <350m	2209 (97%) n: 3222	1211 (99%) n: 3033	347 (97%) n: 3134	433 (100%) n: 3500	3109 (100%) n: 2779	941 (100%) n: 2351	1651 (98%) n: 2193	1343 (96%) n: 2120	1523 (100%) n: 1293
Start time >0	2183 (95%) n: 3198	1195 (98%) n: 3025	343 (96%) n: 3119	422 (97%) n: 3458	3052 (98%) n: 2766	918 (97%) n: 2334	1631 (97%) n: 2182	1294 (92%) n: 2108	1489 (98%) n: 1280
SA subset	2183 (95%) n: 3198	1195 (98%) n: 3025	343 (96%) n: 3119	422 (97%) n: 3458	3052 (98%) n: 2766	918 (97%) n: 2334	1631 (97%) n: 2182	1294 (92%) n: 2108	1489 (98%) n: 1280
No effort allocation	2183 (95%) n: 3196	1194 (98%) n: 2486	341 (96%) n: 2363	421 (97%) n: 2581	3052 (98%) n: 2593	916 (97%) n: 1705	1628 (96%) n: 1587	1289 (92%) n: 1990	1489 (98%) n: 1260
Core fleet selection	2090 (91%) n: 2598	1072 (88%) n: 1904	332 (93%) n: 1725	418 (97%) n: 2103	3002 (96%) n: 2204	802 (85%) n: 1109	1246 (74%) n: 1223	1000 (71%) n: 1809	1408 (92%) n: 1191

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2792 (100%) n: 1678	3260 (100%) n: 2307
Fishing speed not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2792 (100%) n: 1678	3260 (100%) n: 2307
Fishing speed lt 10kts	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
Start date not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
End date not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
Start depth not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
Headline height not null	2232 (100%) n: 1434	1572 (100%) n: 1486	1861 (100%) n: 1247	2690 (100%) n: 1484	2729 (100%) n: 1445	1832 (100%) n: 1549	2440 (100%) n: 1368	2780 (100%) n: 1675	3260 (100%) n: 2303
Fishing speed >3.5kn	2224 (100%) n: 1412	1564 (100%) n: 1465	1860 (100%) n: 1229	2688 (100%) n: 1454	2720 (100%) n: 1381	1826 (100%) n: 1503	2439 (100%) n: 1357	2772 (99%) n: 1625	3254 (100%) n: 2269
Headline height >15m	2188 (98%) n: 1395	1564 (100%) n: 1464	1860 (100%) n: 1229	2688 (100%) n: 1454	2719 (100%) n: 1379	1826 (100%) n: 1503	2414 (99%) n: 1354	2772 (99%) n: 1625	3254 (100%) n: 2263
Headline height <90m	2188 (98%) n: 1395	1564 (100%) n: 1463	1860 (100%) n: 1229	2688 (100%) n: 1454	2719 (100%) n: 1379	1826 (100%) n: 1503	2414 (99%) n: 1354	2772 (99%) n: 1624	3254 (100%) n: 2263
Fishing duration >15mins	2186 (98%) n: 1394	1564 (100%) n: 1459	1858 (100%) n: 1224	2688 (100%) n: 1449	2719 (100%) n: 1378	1826 (100%) n: 1498	2414 (99%) n: 1352	2772 (99%) n: 1624	3254 (100%) n: 2260
Fishing duration <15h	2186 (98%) n: 1392	1564 (100%) n: 1457	1858 (100%) n: 1224	2688 (100%) n: 1448	2719 (100%) n: 1378	1826 (100%) n: 1497	2414 (99%) n: 1352	2772 (99%) n: 1624	3242 (99%) n: 2257
Seabed depth >50m	2186 (98%) n: 1392	1564 (100%) n: 1457	1858 (100%) n: 1224	2688 (100%) n: 1448	2719 (100%) n: 1378	1826 (100%) n: 1497	2414 (99%) n: 1352	2772 (99%) n: 1624	3242 (99%) n: 2257
Seabed depth <350m	2186 (98%) n: 1390	1564 (100%) n: 1457	1858 (100%) n: 1224	2688 (100%) n: 1448	2719 (100%) n: 1378	1826 (100%) n: 1491	2414 (99%) n: 1352	2772 (99%) n: 1623	3242 (99%) n: 2256
Start time >0	2154 (97%) n: 1382	1558 (99%) n: 1453	1827 (98%) n: 1217	2570 (96%) n: 1438	2664 (98%) n: 1370	1782 (97%) n: 1483	2412 (99%) n: 1349	2766 (99%) n: 1617	3242 (99%) n: 2252
SA subset	2154 (97%) n: 1382	1558 (99%) n: 1453	1827 (98%) n: 1217	2570 (96%) n: 1438	2664 (98%) n: 1370	1782 (97%) n: 1483	2412 (99%) n: 1349	2766 (99%) n: 1617	3242 (99%) n: 2252
No effort allocation	2154 (97%) n: 1382	1558 (99%) n: 1390	1827 (98%) n: 1216	2570 (96%) n: 1436	2664 (98%) n: 1370	1762 (96%) n: 1447	2412 (99%) n: 1336	2766 (99%) n: 1616	3242 (99%) n: 2252
Core fleet selection	2139 (96%) n: 1301	1512 (96%) n: 1344	1782 (96%) n: 1169	2563 (95%) n: 1420	2655 (97%) n: 1362	1727 (94%) n: 1409	2388 (98%) n: 1212	2759 (99%) n: 1599	3150 (97%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1711 (100%) n: 1343
Fishing speed not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1711 (100%) n: 1343
Fishing speed lt 10kts	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1711 (100%) n: 1343
Start date not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1711 (100%) n: 1343
End date not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1698 (99%) n: 1342
Start depth not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1698 (99%) n: 1342
Headline height not null	3539 (100%) n: 2542	2573 (100%) n: 1919	2471 (100%) n: 1800	2085 (100%) n: 1038	1698 (99%) n: 1342
Fishing speed >3.5kn	3536 (100%) n: 2430	2573 (100%) n: 1919	2471 (100%) n: 1794	2084 (100%) n: 1037	1698 (99%) n: 1342
Headline height >15m	3530 (100%) n: 2426	2573 (100%) n: 1917	2471 (100%) n: 1792	2084 (100%) n: 1035	1695 (99%) n: 1336
Headline height <90m	3530 (100%) n: 2426	2573 (100%) n: 1917	2471 (100%) n: 1792	2084 (100%) n: 1035	1695 (99%) n: 1336
Fishing duration >15mins	3530 (100%) n: 2421	2539 (99%) n: 1912	2471 (100%) n: 1785	2083 (100%) n: 1032	1695 (99%) n: 1331
Fishing duration <15h	3530 (100%) n: 2421	2537 (99%) n: 1910	2471 (100%) n: 1785	2083 (100%) n: 1031	1695 (99%) n: 1330
Seabed depth >50m	3530 (100%) n: 2421	2537 (99%) n: 1910	2471 (100%) n: 1784	2083 (100%) n: 1031	1695 (99%) n: 1330
Seabed depth <350m	3530 (100%) n: 2419	2537 (99%) n: 1910	2471 (100%) n: 1783	2083 (100%) n: 1030	1695 (99%) n: 1329
Start time >0	3529 (100%) n: 2415	2454 (95%) n: 1902	2469 (100%) n: 1781	2080 (100%) n: 1029	1695 (99%) n: 1326
SA subset	3529 (100%) n: 2415	2454 (95%) n: 1902	2469 (100%) n: 1781	2080 (100%) n: 1029	1695 (99%) n: 1326
No effort allocation	3529 (100%) n: 2414	2454 (95%) n: 1898	2469 (100%) n: 1775	2080 (100%) n: 1029	1695 (99%) n: 1306
Core fleet selection	3206 (91%) n: 2235	2386 (93%) n: 1744	2391 (97%) n: 1603	2042 (98%) n: 953	1660 (97%) n: 1157

Table D.33: Summary of the JMA3 MW pred JMM event no weights dataset after core fleet selection. 'Records' indicates the number of rows (events) in the dataset, and 'Records caught' indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	2 057.14	50.10
1994	5	40	2 090	5 313.80	2 574.44	34.55
1995	6	38	1 937	5 281.88	3 004.77	37.43
1996	5	31	1 698	4 946.23	5 110.53	59.60
1997	6	23	1 813	5 486.45	5 094.05	52.84
1998	7	36	2 393	6 500.45	5 887.49	49.44
1999	7	29	2 269	6 680.20	6 914.54	58.35
2000	7	34	2 351	7 026.89	4 501.51	60.57
2001	7	29	2 174	7 230.32	1 332.08	29.62
2002	8	32	2 598	8 281.02	2 090.39	41.15
2003	8	33	1 904	6 719.12	1 071.63	21.48
2004	8	23	1 725	6 488.50	332.33	10.09
2005	8	28	2 103	7 303.95	418.02	9.94
2006	8	33	2 204	8 642.28	3 001.90	34.48
2007	7	27	1 109	4 762.03	801.83	24.89
2008	7	27	1 223	5 763.20	1 245.58	18.23
2009	7	37	1 809	8 957.70	996.80	13.27
2010	6	25	1 191	5 181.56	1 407.78	38.04
2011	6	21	1 301	5 811.68	2 138.62	32.97
2012	6	27	1 344	5 844.70	1 511.71	31.70
2013	6	25	1 169	4 960.32	1 781.64	42.86
2014	7	36	1 420	6 220.82	2 562.94	46.76
2015	7	37	1 362	6 240.75	2 655.39	41.56
2016	8	48	1 409	6 312.63	1 727.37	25.83
2017	6	29	1 212	6 426.48	2 388.20	47.77
2018	7	33	1 599	7 557.02	2 758.84	52.47
2019	7	36	2 156	9 997.48	3 149.66	36.83
2020	7	44	2 235	10 344.52	3 206.40	34.54
2021	7	32	1 744	7 955.15	2 385.58	63.65
2022	6	35	1 603	7 543.75	2 391.20	63.32
2023	6	25	953	4 692.92	2 042.41	88.98
2024	6	34	1 157	5 419.63	1 660.36	85.13

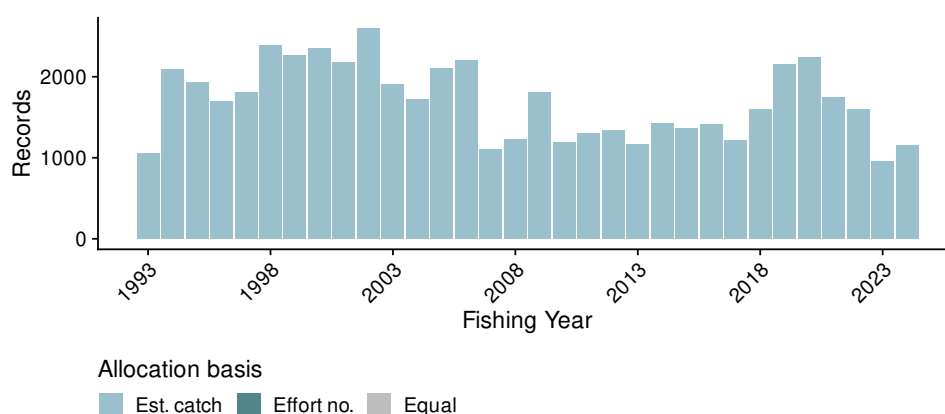


Figure D.152: The allocation approach used for attributing catches to records in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.34: Summary table for occurrence of positive catch in the JMA3 MW pred JMM event no weights series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	73 484.86	0.00	0.00	*
fyear	31	65 986.01	10.29	10.29	*
vessel_key	11	65 719.77	10.68	0.39	*
target_species	2	46 856.28	36.36	25.68	*
month	11	46 099.87	37.42	1.06	*
start_obs_fma	3	43 258.93	41.29	3.87	*
ns(log(fishing_duration), 3)	3	43 211.96	41.36	0.07	*
ns(log(start_time), 3)	3	43 109.52	41.51	0.15	*
ns(log(bottom_depth), 3)	3	42 939.85	41.75	0.24	*
ns(log(effort_height), 3)	3	42 903.60	41.81	0.06	*
ns(effort_speed, 3)	3	42 452.72	42.43	0.62	*

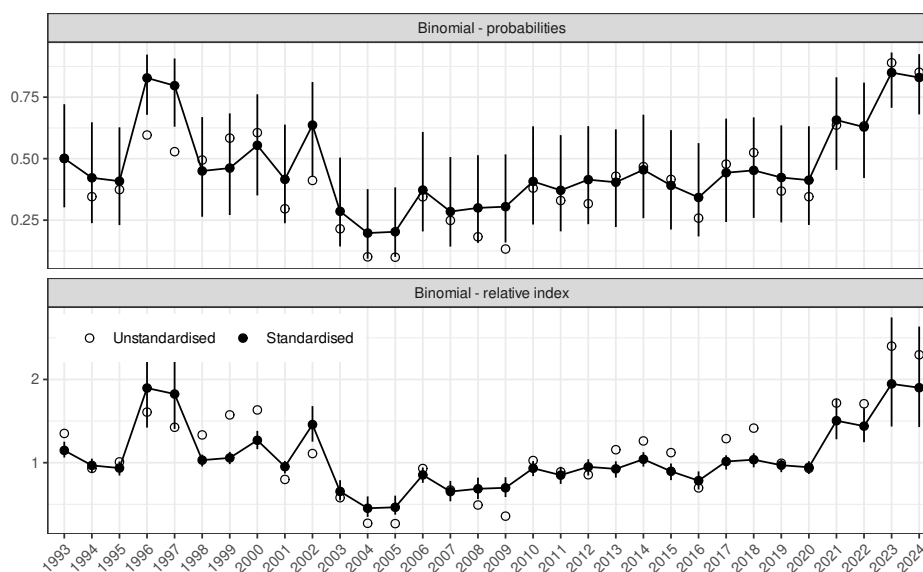


Figure D.153: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW pred JMM event no weights dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

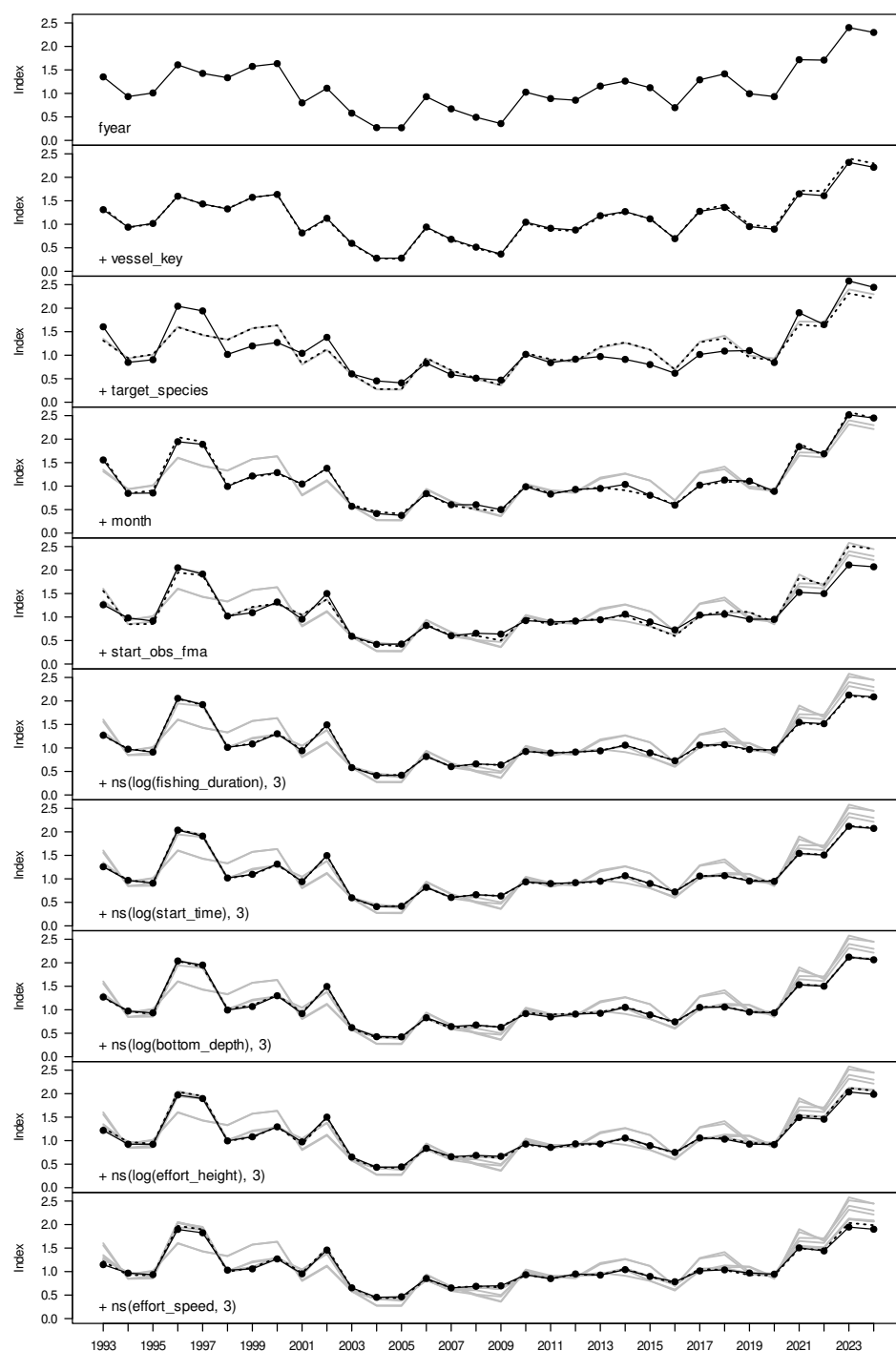


Figure D.154: Step plot for occurrence of catch in the JMA3 MW pred JMM event no weights dataset.

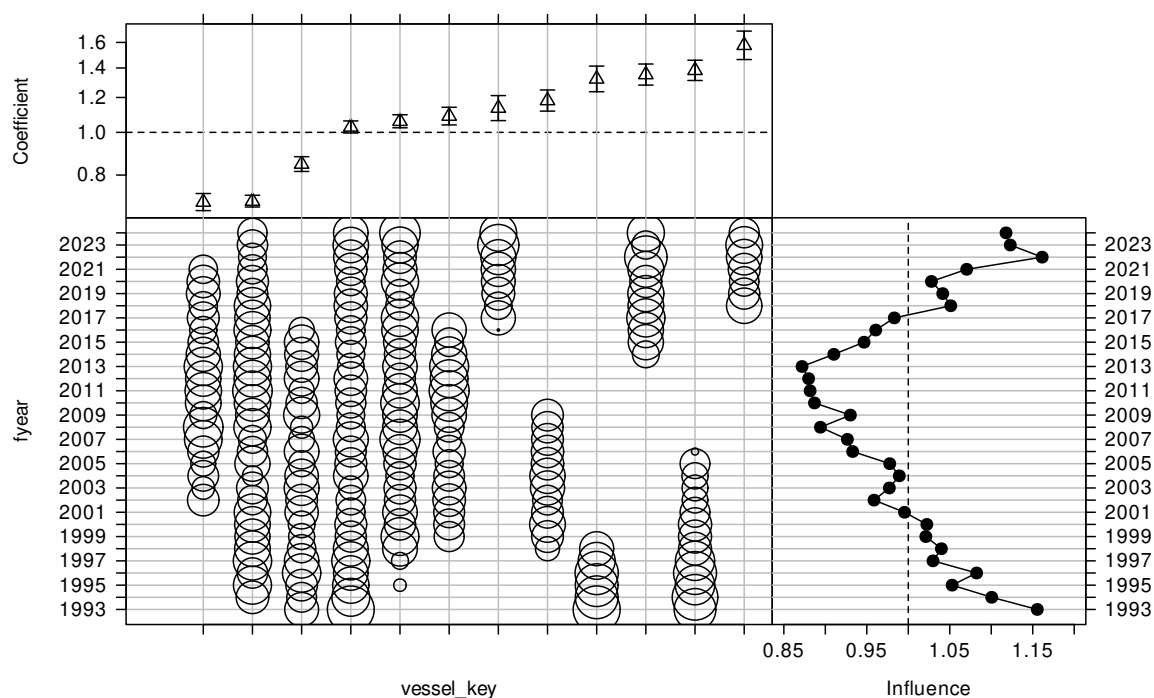


Figure D.155: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

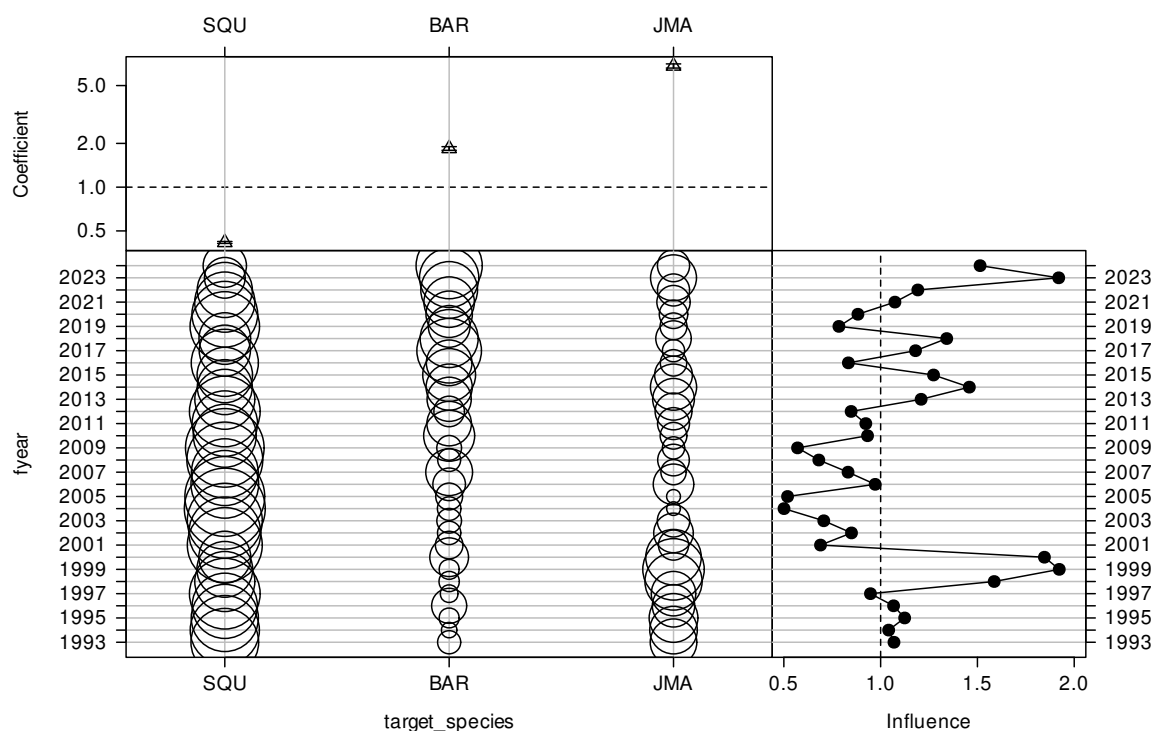


Figure D.156: CDI plot for target species for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

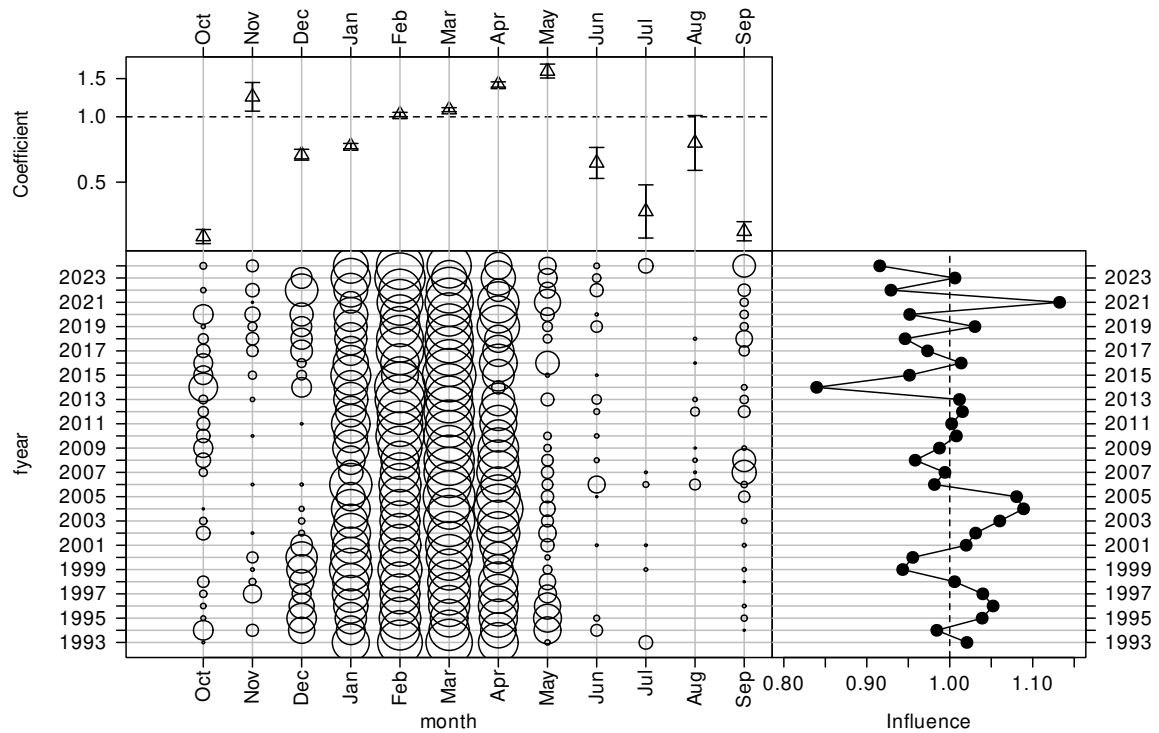


Figure D.157: CDI plot for month for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

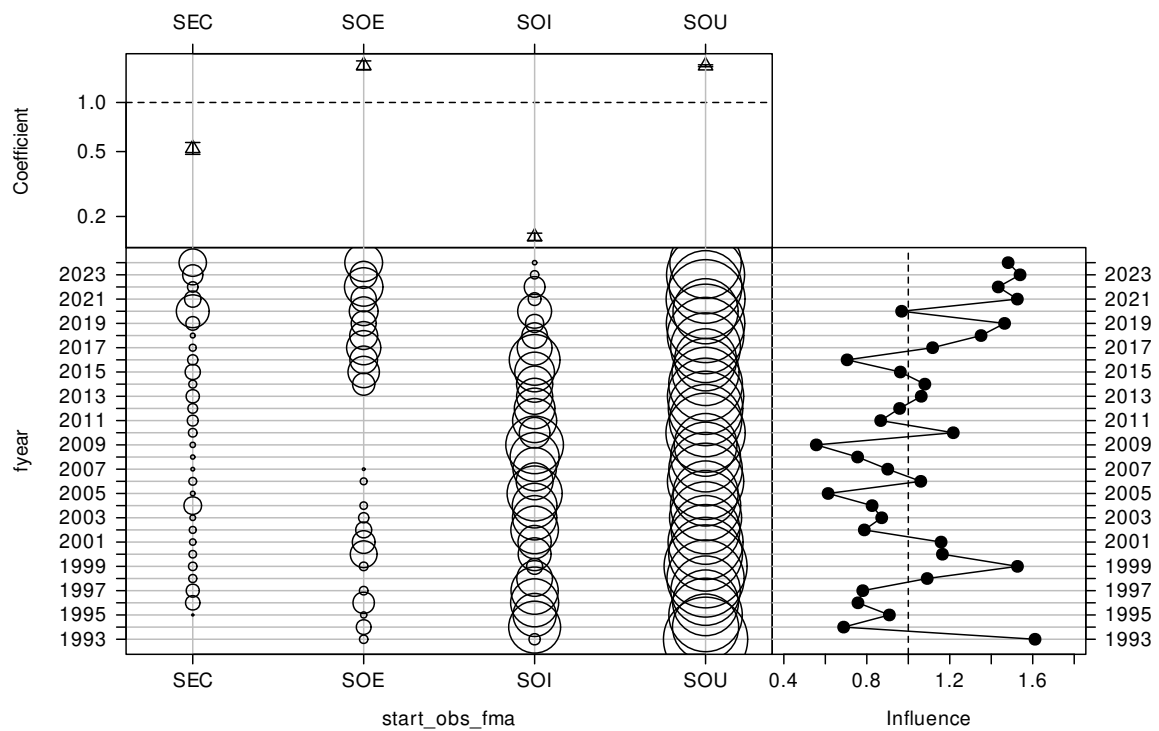


Figure D.158: CDI plot for start obs fma for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

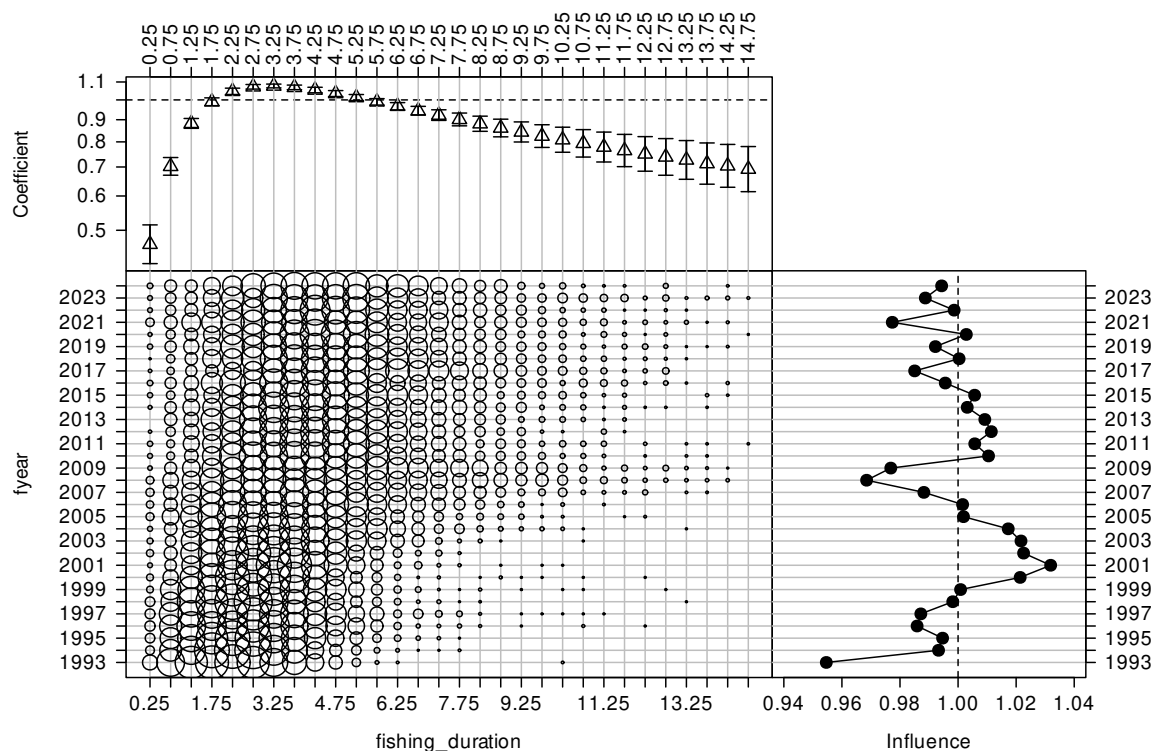


Figure D.159: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

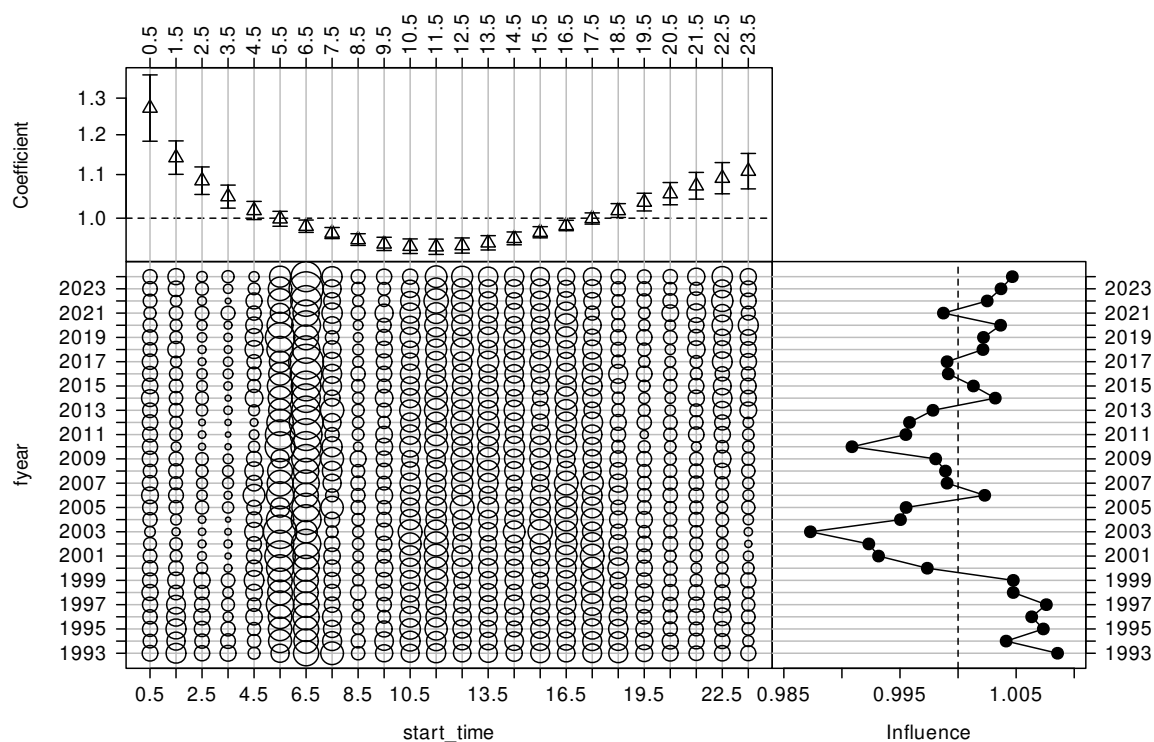


Figure D.160: CDI plot for start time for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

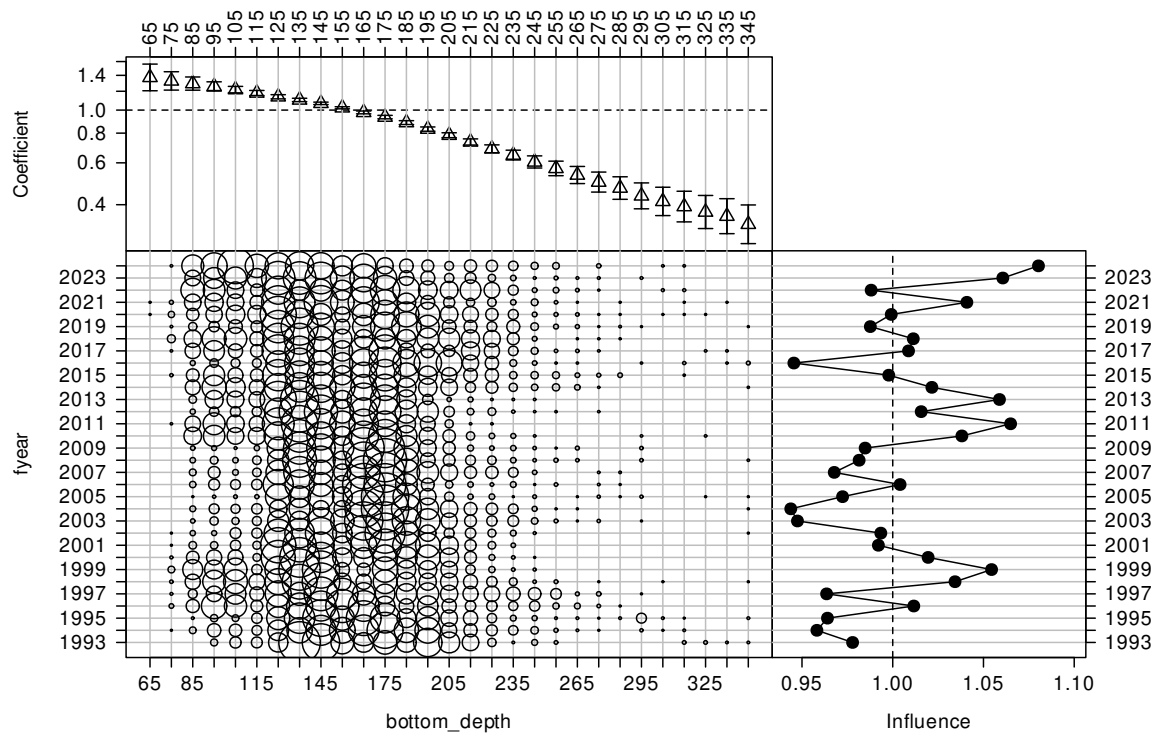


Figure D.161: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

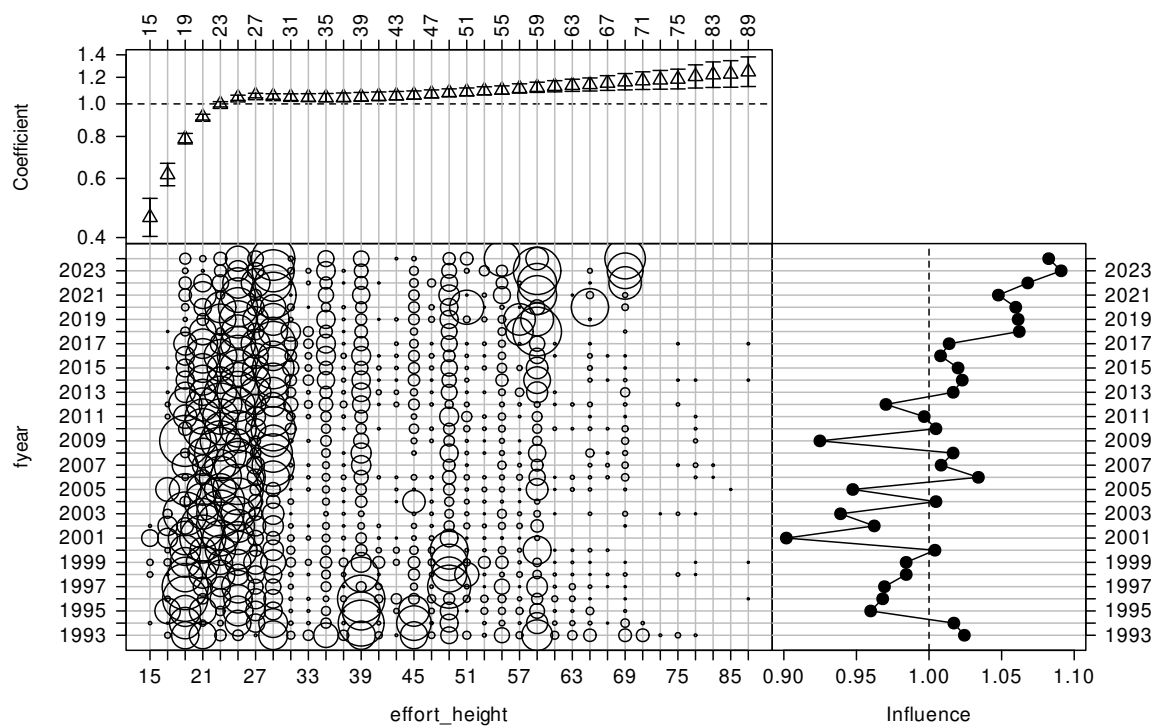


Figure D.162: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

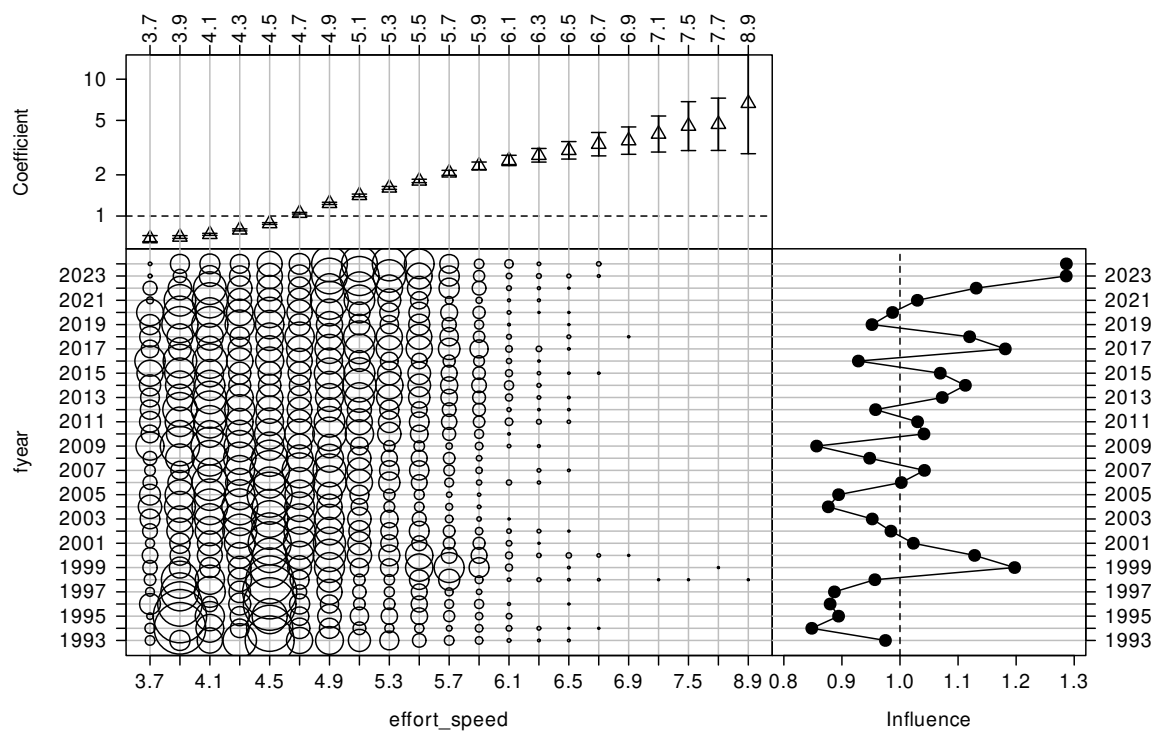


Figure D.163: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

Table D.35: Summary table for the Weibull model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	400 185.8	0.00	0.00	*
fyear	31	398 370.8	8.04	8.04	*
vessel_key	11	397 590.5	11.48	3.44	*
target_species	2	394 811.3	23.39	11.92	*
month	11	394 521.0	24.73	1.34	*
start_obs_fma	3	393 500.5	29.13	4.40	*
ns(log(fishing_duration), 3)	3	393 381.3	29.67	0.54	*
ns(log(start_time), 3)	3	393 127.7	30.78	1.11	*
ns(log(bottom_depth), 3)	3	392 996.9	31.36	0.59	*
ns(log(effort_height), 3)	3	392 973.7	31.49	0.12	*
ns(effort_speed, 3)	3	392 806.9	32.23	0.74	*

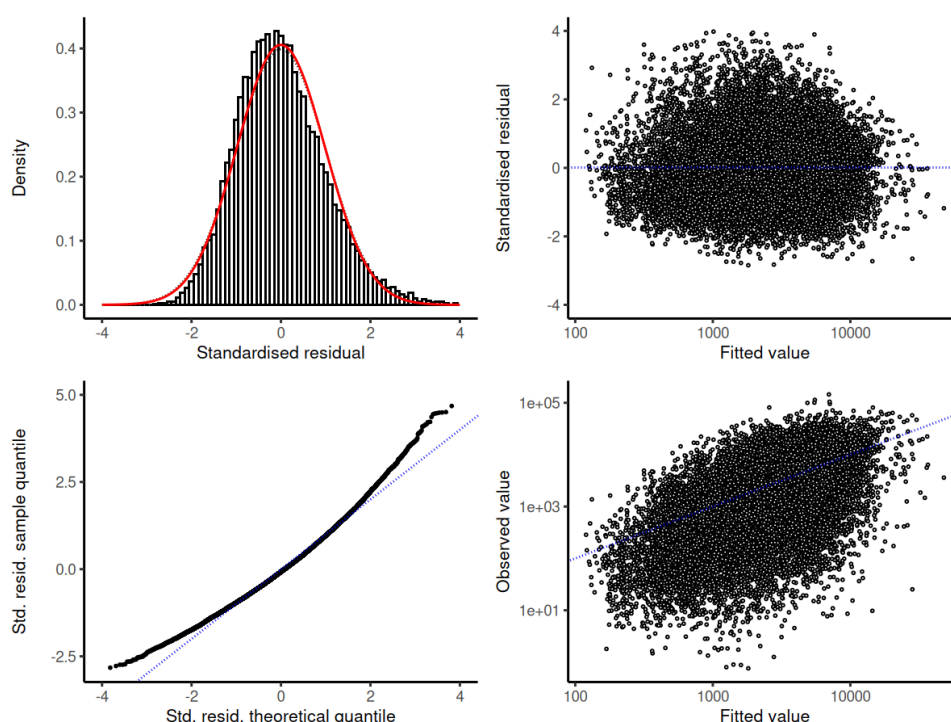


Figure D.164: Diagnostic plots for the selected Weibull model for positive catches in the JMA3 MW pred JMM event no weights dataset.

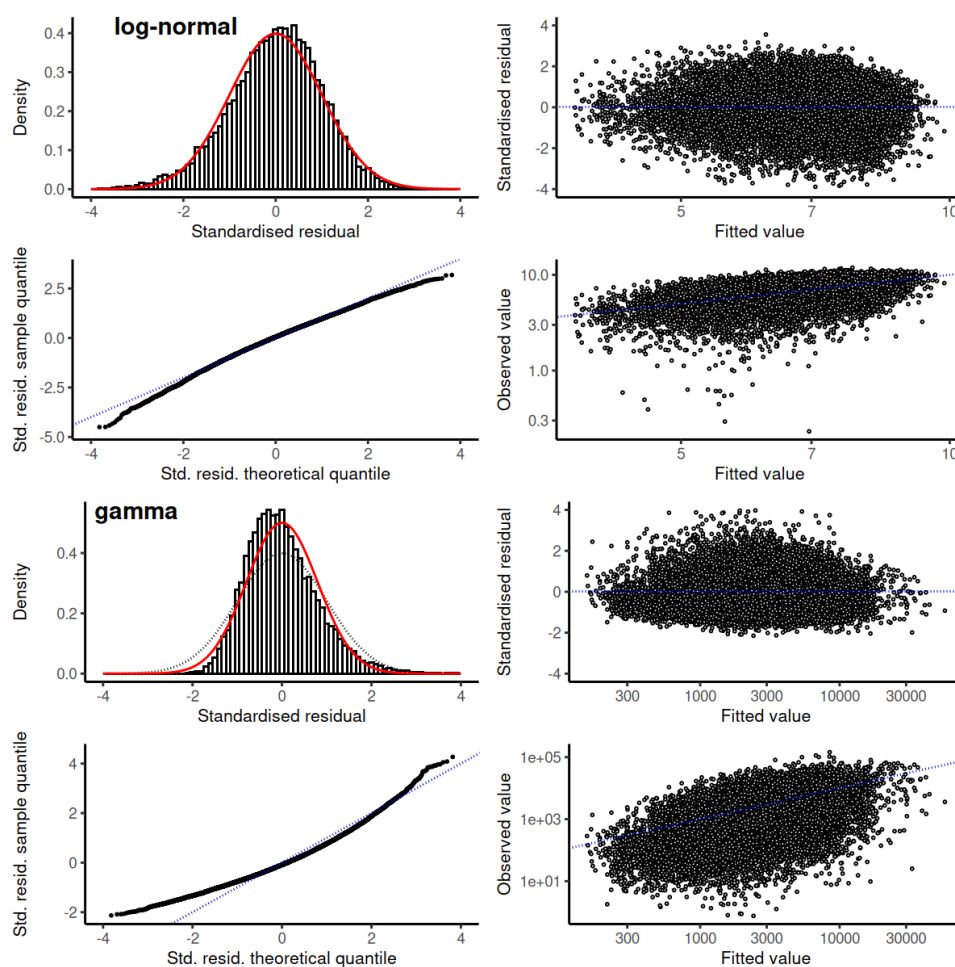


Figure D.165: Diagnostic plots for the alternative log-normal and gamma models considered for positive catches in the JMA3 MW pred JMM event no weights dataset.

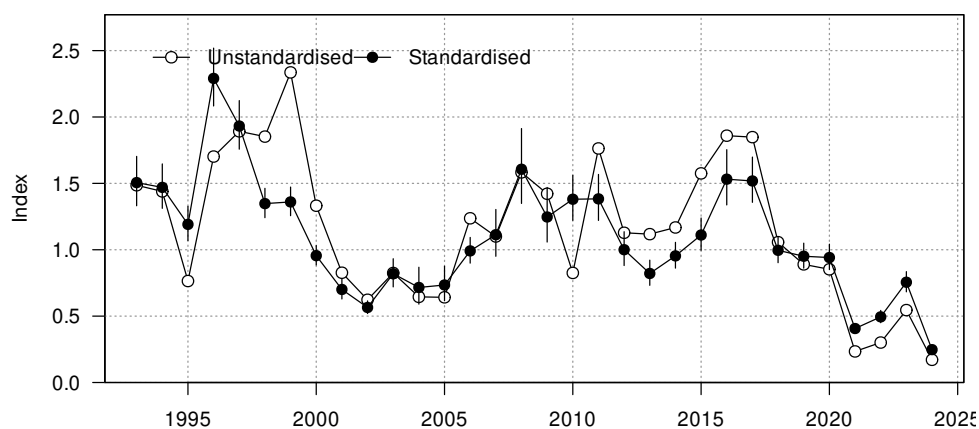


Figure D.166: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the Weibull model for the JMA3 MW pred JMM event no weights dataset.

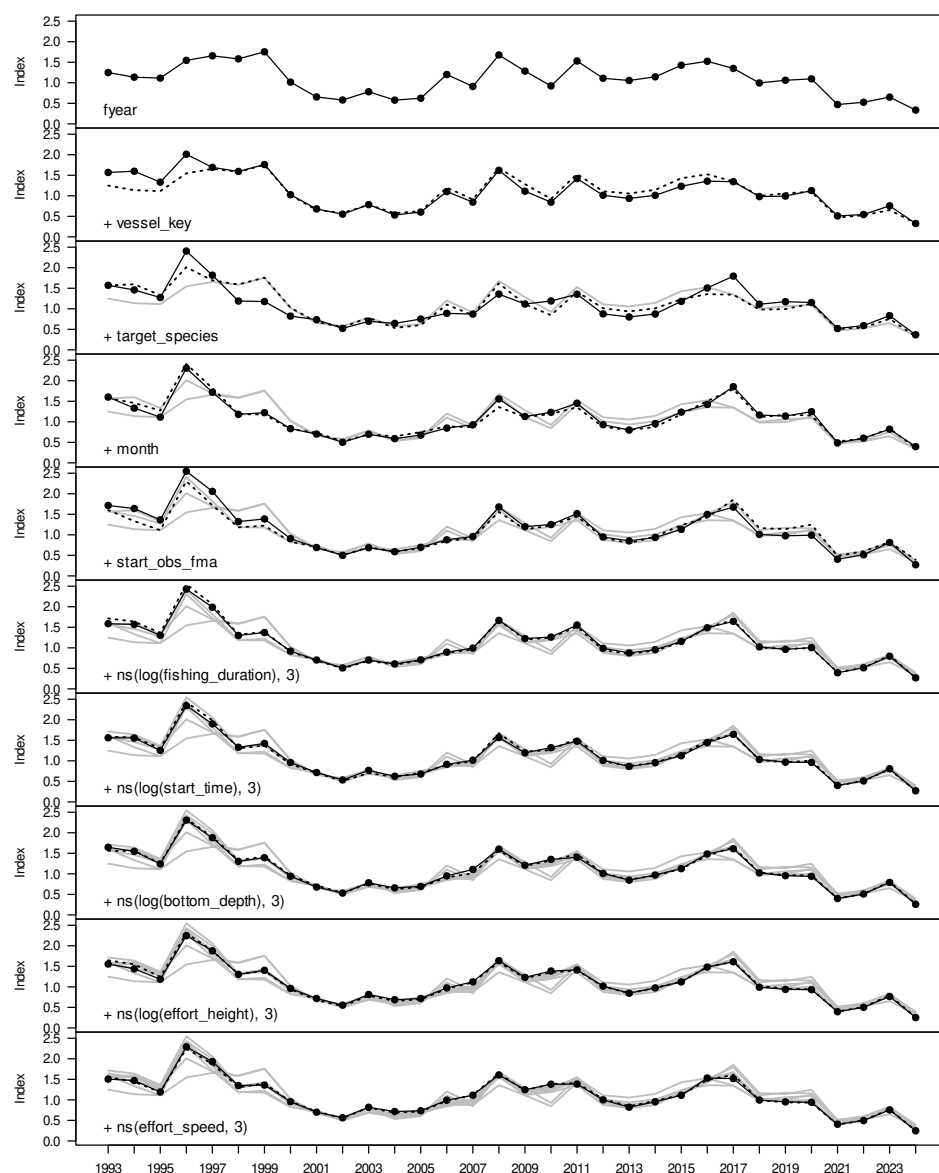


Figure D.167: Changes to the JMA3 MW pred JMM event no weights positive catch index as terms are successively entered into the Weibull model.

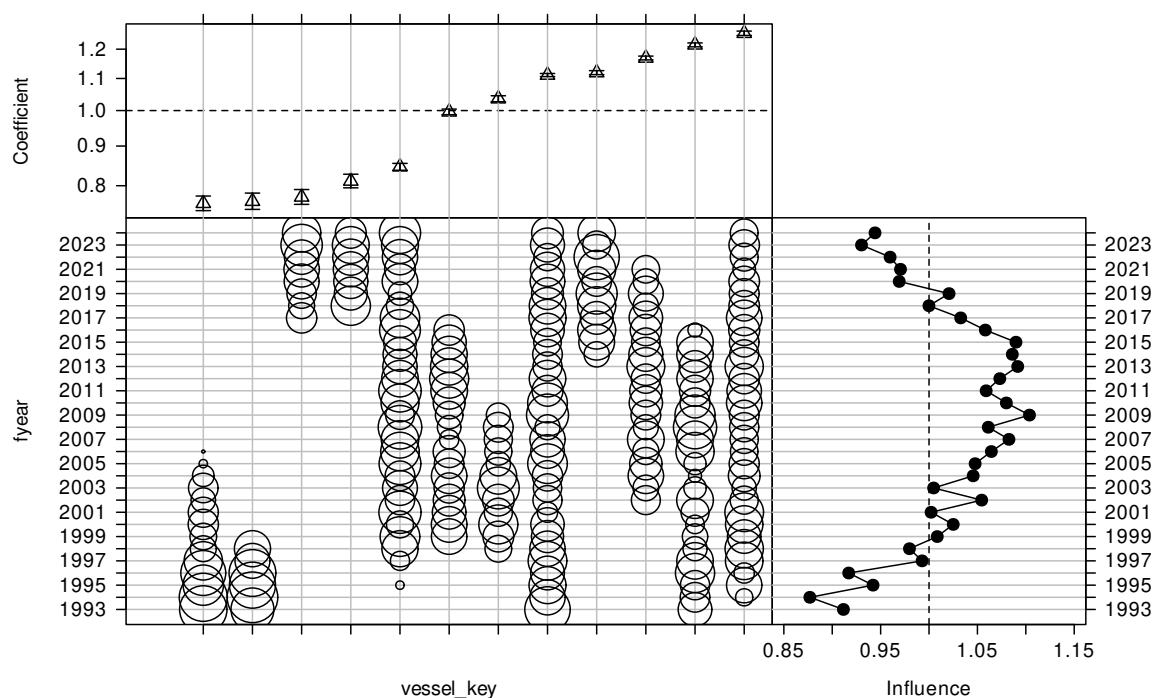


Figure D.168: CDI plot for vessel key for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

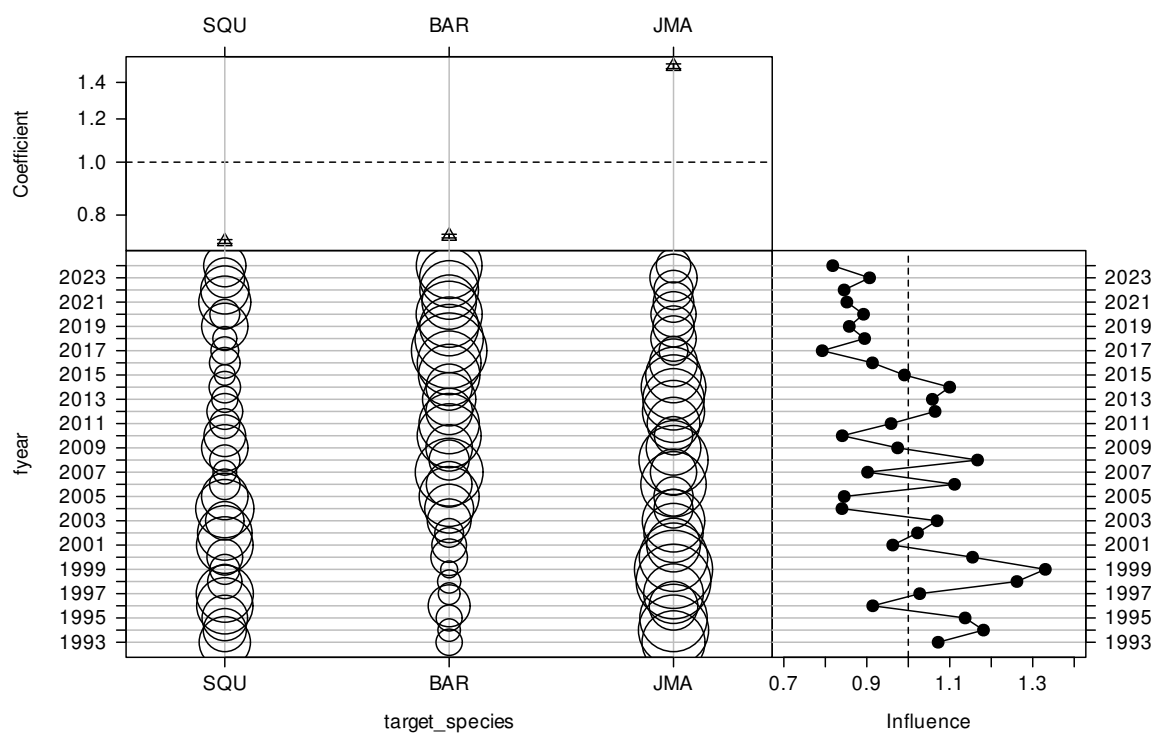


Figure D.169: CDI plot for target species for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

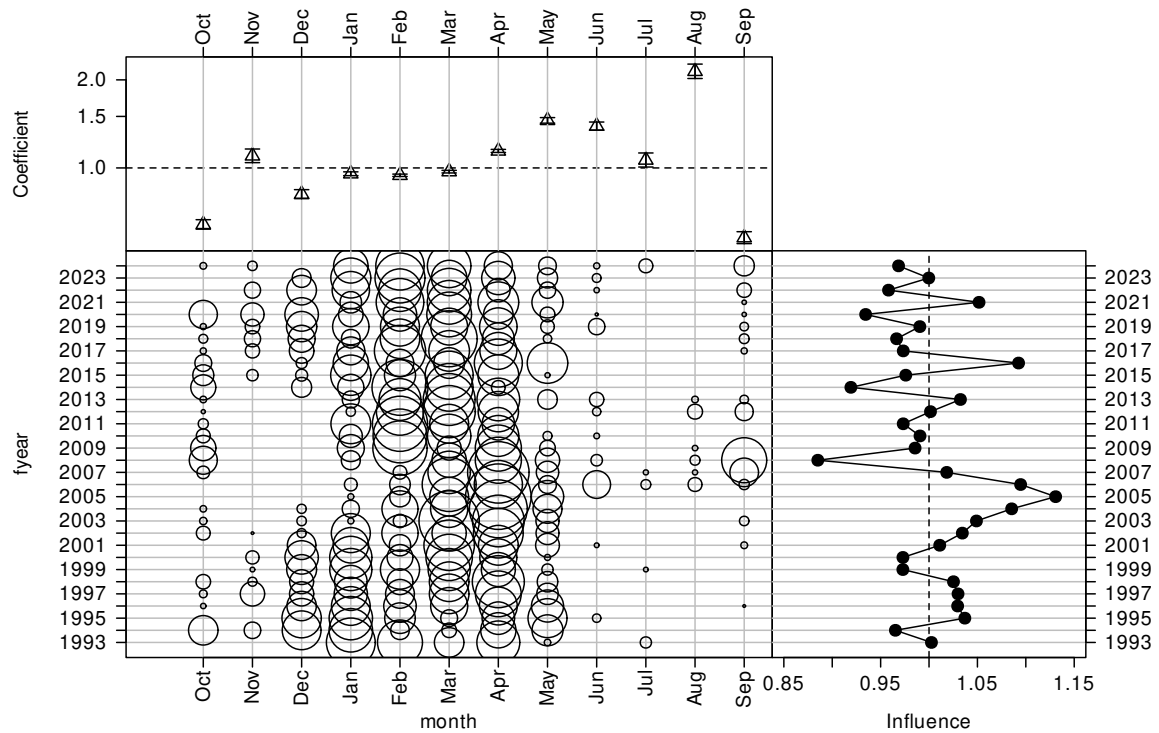


Figure D.170: CDI plot for month for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

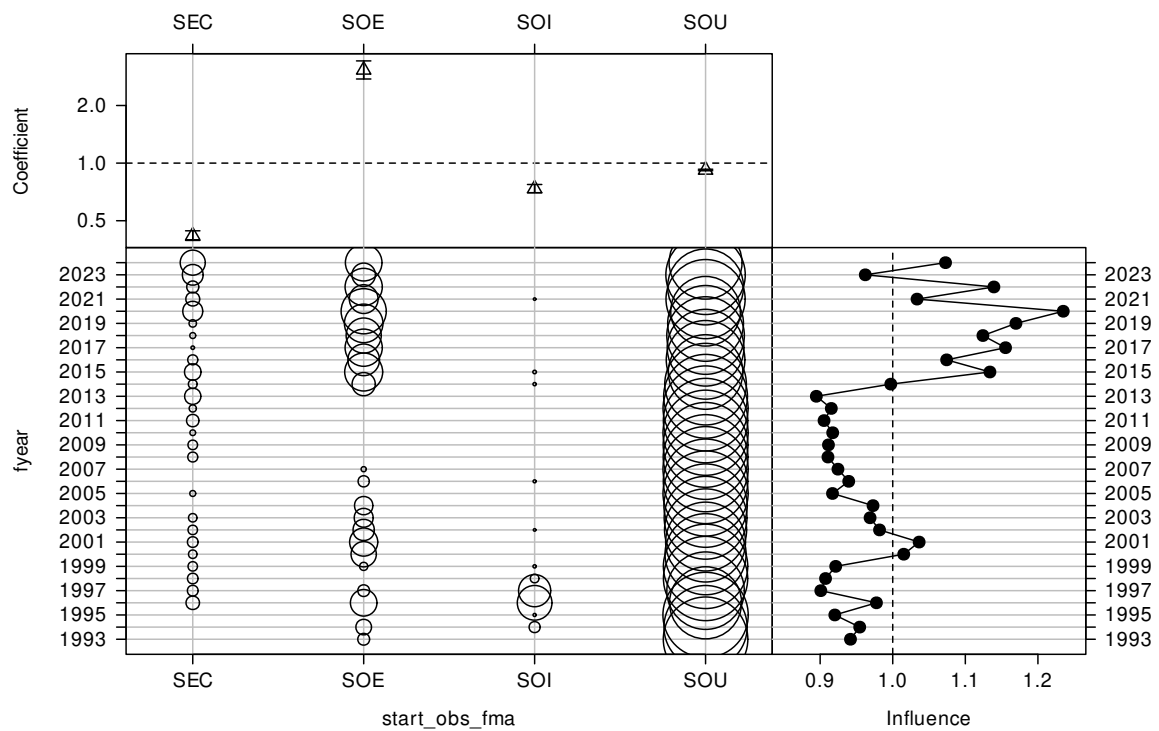


Figure D.171: CDI plot for start obs fma for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

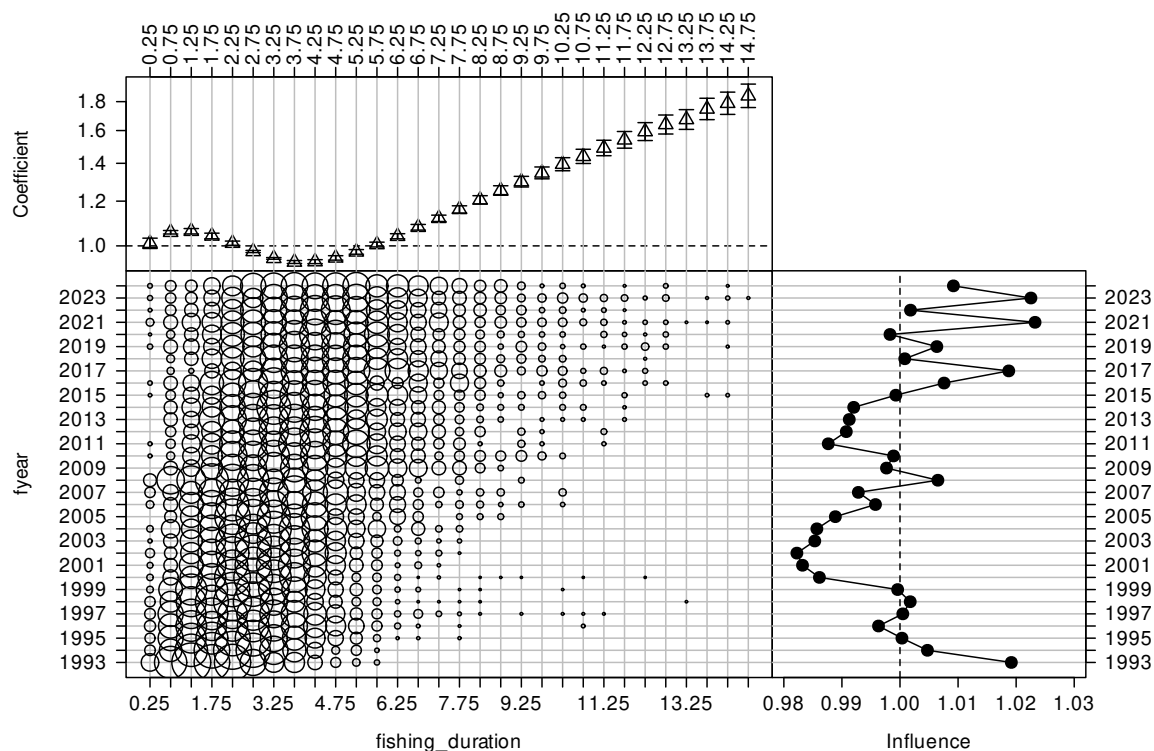


Figure D.172: CDI plot for fishing duration (h) for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

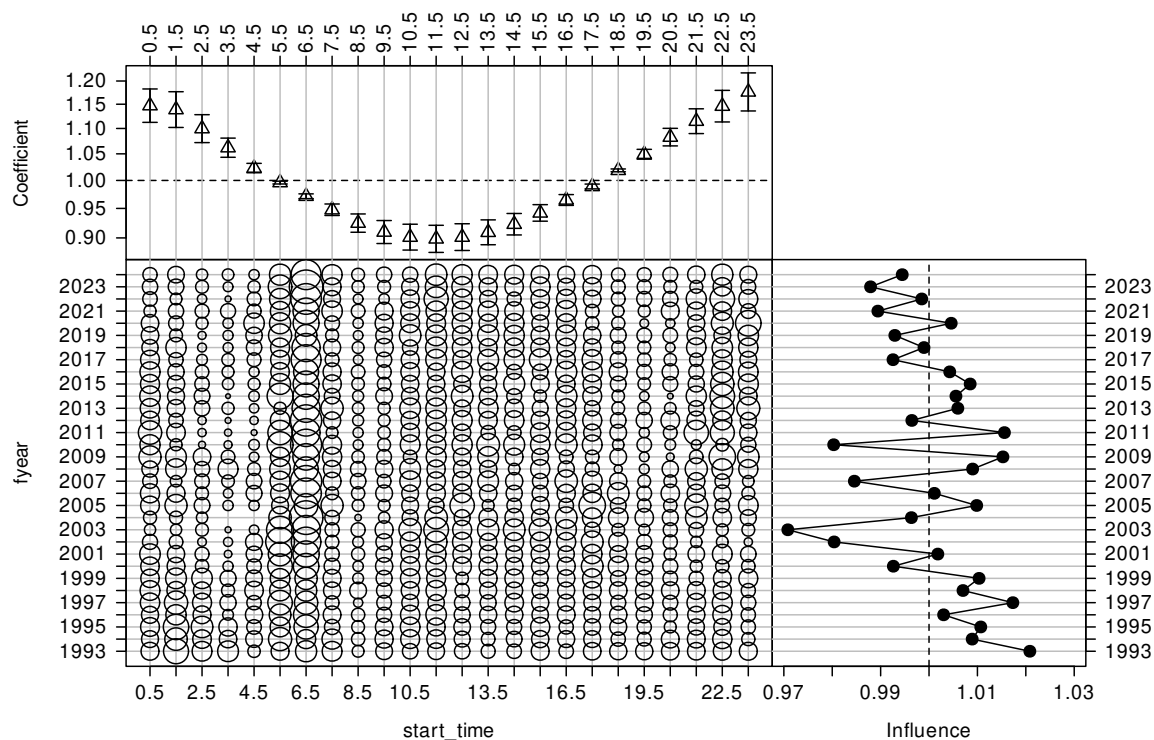


Figure D.173: CDI plot for start time for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

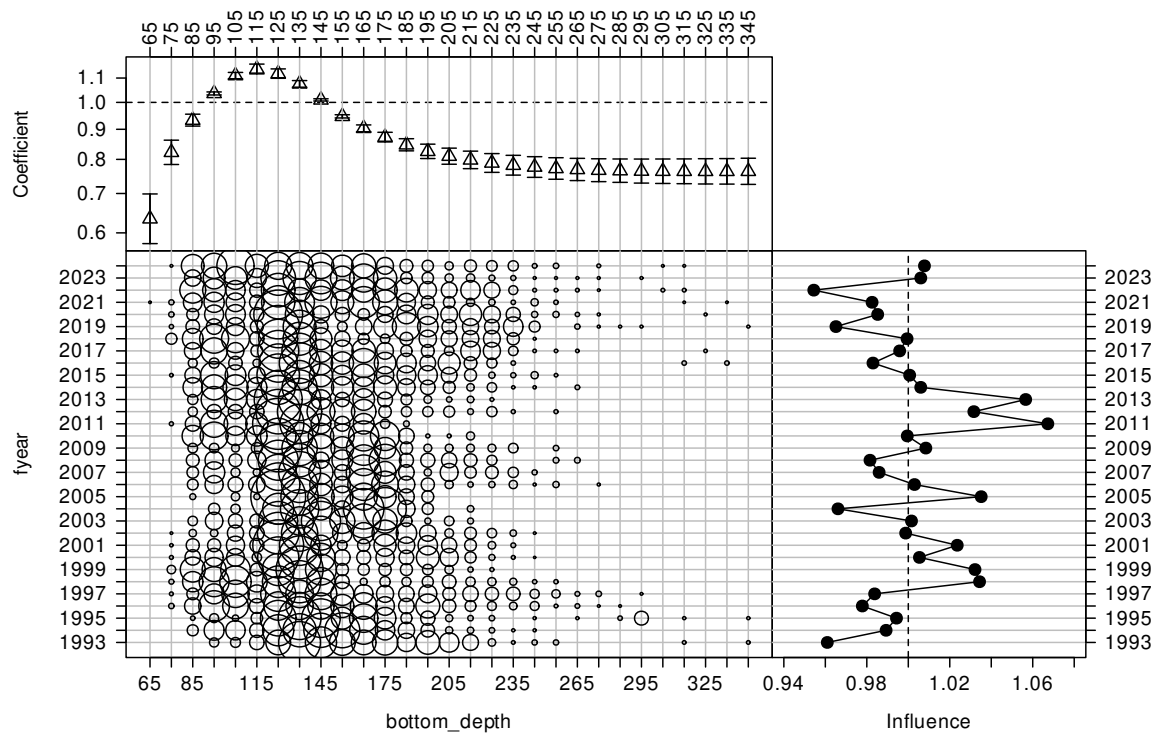


Figure D.174: CDI plot for bottom depth (m) for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

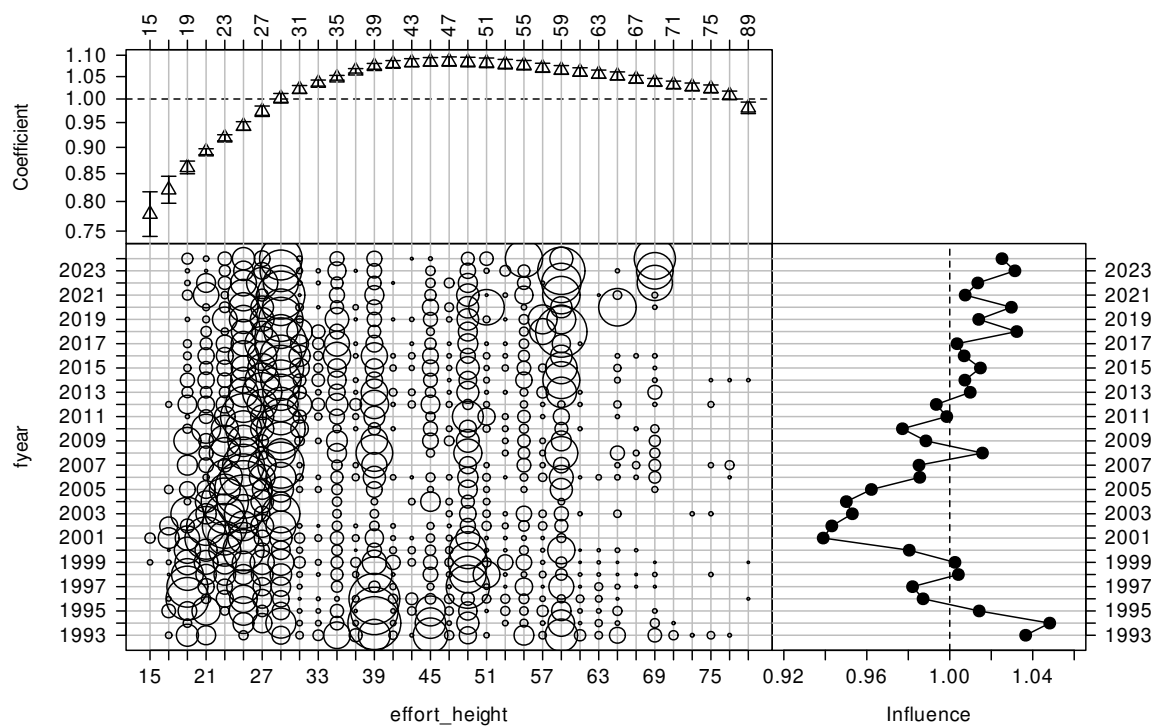


Figure D.175: CDI plot for effort height (m) for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

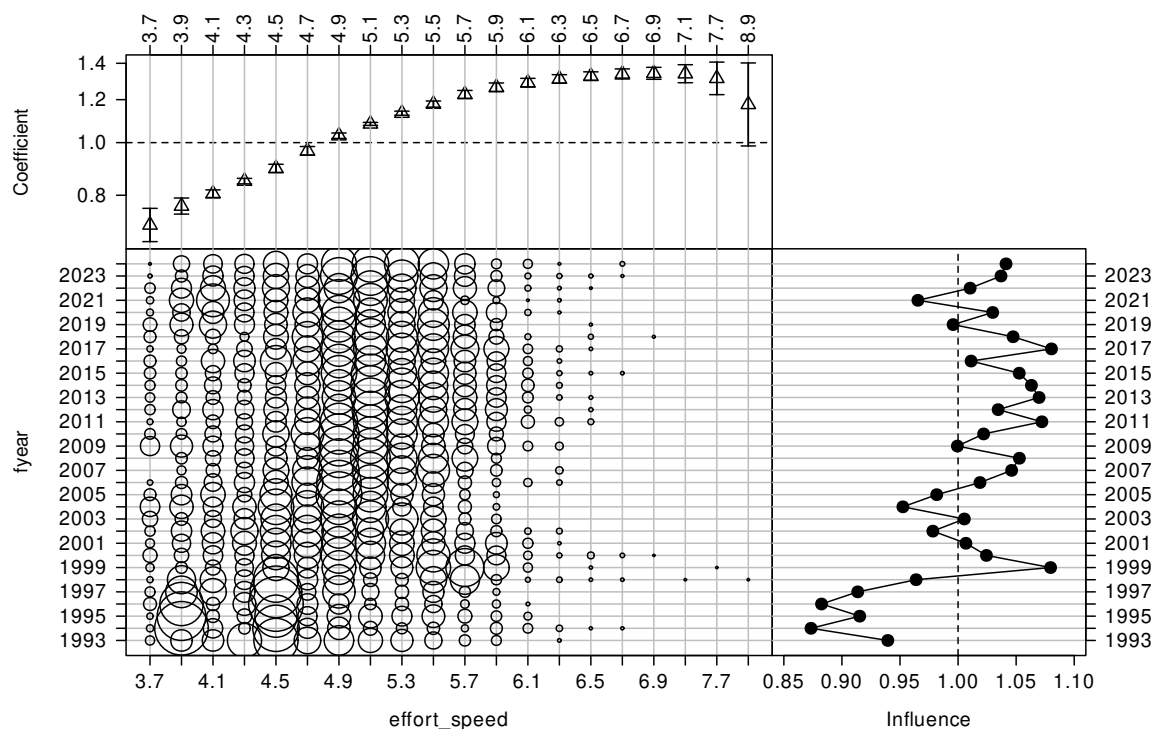


Figure D.176: CDI plot for effort speed for the Weibull model of positive catches in the JMA3 MW pred JMM event no weights catch-per-unit-effort dataset.

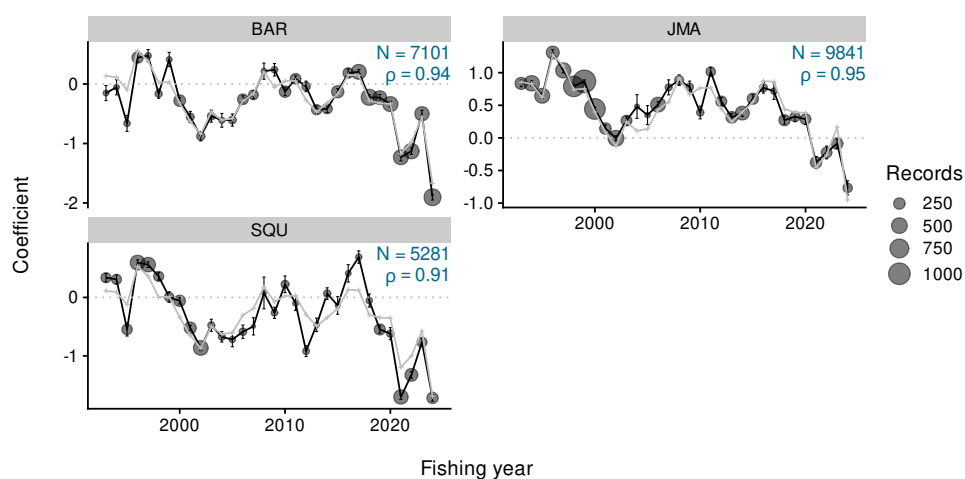


Figure D.177: Residual implied coefficients for target-year in the Weibull positive catch model for the JMA3 MW pred JMM event no weights dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

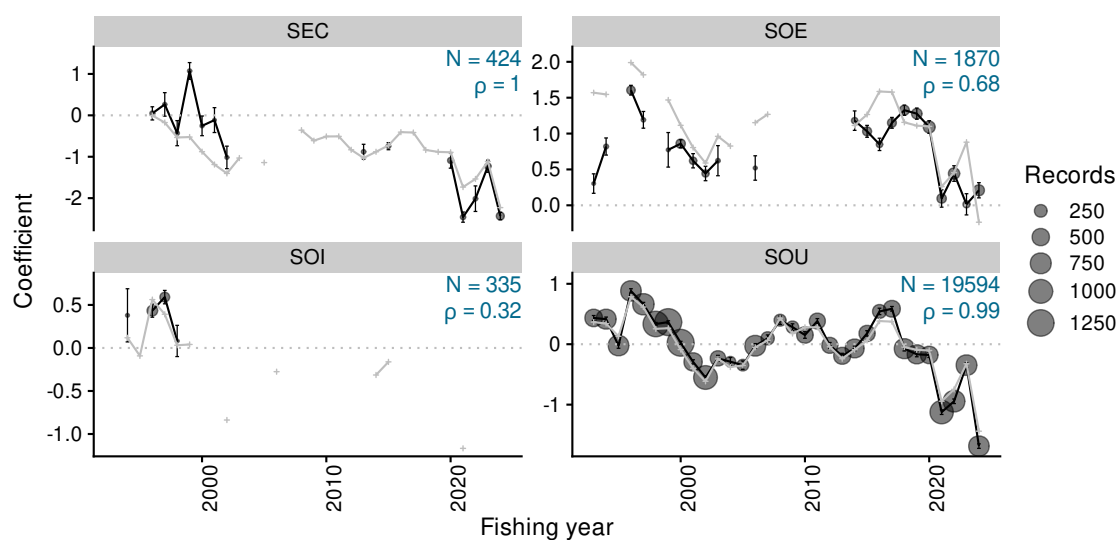


Figure D.178: Residual implied coefficients for area-year in the Weibull positive catch model for the JMA3 MW pred JMM event no weights dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

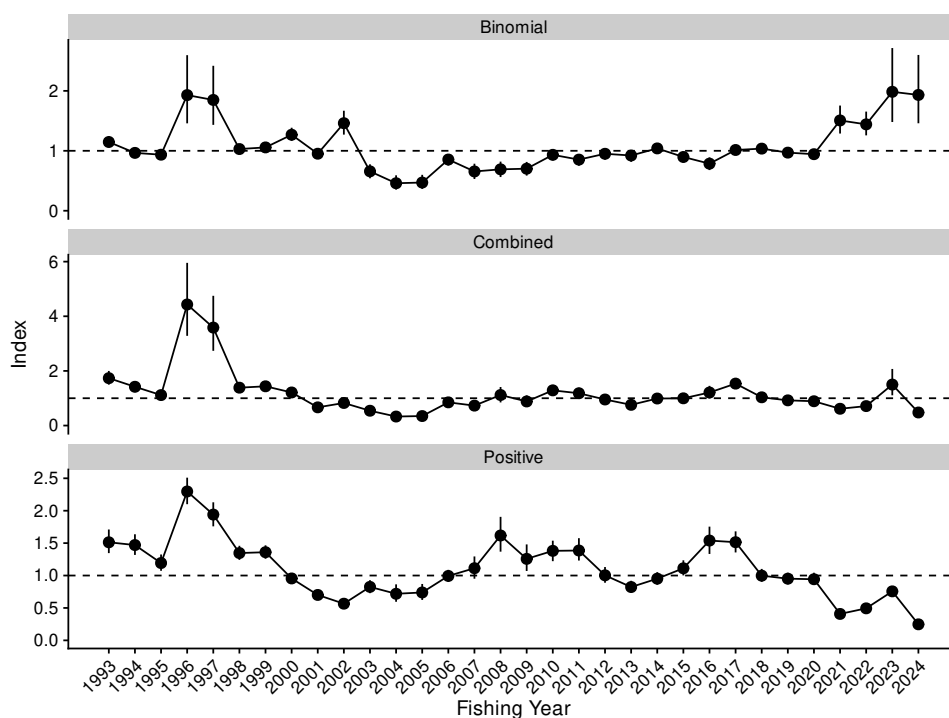


Figure D.179: Standardised indices and 95% confidence intervals for the JMA3 MW pred JMM event no weights dataset.

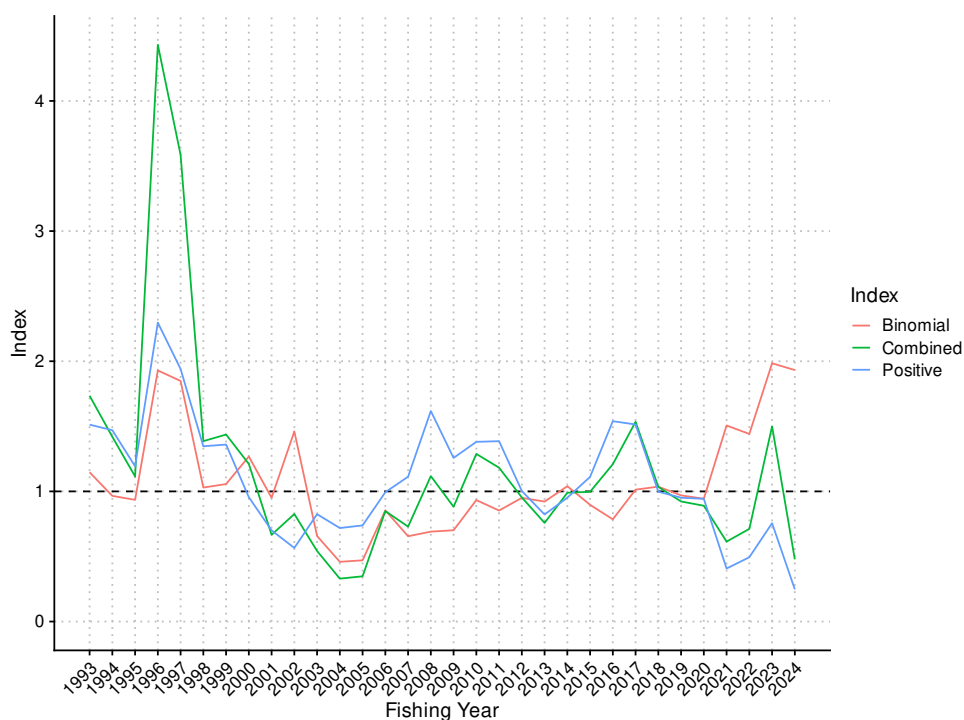


Figure D.180: Standardised indices for the JMA3 MW pred JMM event no weights dataset.

Table D.36: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW pred JMM event no weights series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.147	0.049	1.056	1.247	1.735	0.128	1.497	1.999	1.513	0.093	1.346	1.710
1994	0.965	0.043	0.877	1.046	1.419	0.103	1.219	1.625	1.470	0.081	1.318	1.636
1995	0.935	0.043	0.847	1.014	1.115	0.078	0.968	1.272	1.193	0.064	1.073	1.325
1996	1.929	0.290	1.458	2.596	4.431	0.681	3.284	5.955	2.296	0.104	2.101	2.510
1997	1.849	0.251	1.433	2.418	3.586	0.514	2.735	4.749	1.940	0.095	1.759	2.130
1998	1.029	0.039	0.946	1.097	1.386	0.071	1.251	1.528	1.347	0.055	1.241	1.459
1999	1.057	0.037	0.985	1.128	1.437	0.072	1.297	1.581	1.360	0.053	1.259	1.466
2000	1.268	0.056	1.165	1.385	1.211	0.070	1.075	1.350	0.955	0.037	0.884	1.029
2001	0.951	0.036	0.874	1.017	0.667	0.044	0.580	0.753	0.701	0.039	0.624	0.778
2002	1.461	0.102	1.270	1.669	0.826	0.067	0.699	0.962	0.566	0.025	0.520	0.616
2003	0.657	0.059	0.542	0.775	0.542	0.060	0.431	0.665	0.825	0.051	0.728	0.928
2004	0.459	0.061	0.353	0.591	0.330	0.053	0.237	0.444	0.718	0.069	0.595	0.864
2005	0.470	0.060	0.364	0.599	0.348	0.053	0.253	0.462	0.739	0.063	0.624	0.870
2006	0.854	0.047	0.753	0.939	0.849	0.060	0.732	0.967	0.994	0.048	0.901	1.088
2007	0.655	0.065	0.529	0.785	0.729	0.094	0.559	0.928	1.113	0.088	0.951	1.294
2008	0.691	0.066	0.562	0.819	1.117	0.144	0.846	1.411	1.618	0.137	1.368	1.905
2009	0.701	0.058	0.586	0.814	0.882	0.106	0.688	1.105	1.257	0.105	1.070	1.480
2010	0.933	0.046	0.838	1.019	1.288	0.100	1.097	1.489	1.381	0.081	1.222	1.538
2011	0.853	0.050	0.751	0.945	1.182	0.101	0.989	1.386	1.386	0.088	1.231	1.576
2012	0.950	0.048	0.851	1.039	0.954	0.077	0.804	1.106	1.003	0.062	0.889	1.131
2013	0.922	0.050	0.816	1.014	0.758	0.059	0.647	0.880	0.822	0.047	0.735	0.919
2014	1.040	0.041	0.960	1.122	0.989	0.063	0.865	1.113	0.952	0.050	0.858	1.052
2015	0.897	0.047	0.802	0.984	0.997	0.073	0.863	1.149	1.112	0.059	1.002	1.235
2016	0.786	0.054	0.679	0.891	1.209	0.118	0.989	1.453	1.539	0.107	1.333	1.754
2017	1.014	0.044	0.927	1.099	1.535	0.102	1.343	1.744	1.514	0.083	1.356	1.681
2018	1.036	0.040	0.957	1.114	1.034	0.065	0.910	1.164	0.998	0.051	0.903	1.102
2019	0.970	0.035	0.898	1.035	0.923	0.057	0.816	1.040	0.951	0.046	0.863	1.043
2020	0.944	0.036	0.869	1.011	0.890	0.059	0.778	1.010	0.943	0.048	0.855	1.043
2021	1.507	0.119	1.288	1.755	0.614	0.058	0.515	0.743	0.408	0.018	0.374	0.445
2022	1.441	0.101	1.258	1.654	0.712	0.061	0.604	0.843	0.494	0.022	0.451	0.539
2023	1.984	0.315	1.480	2.715	1.500	0.246	1.107	2.072	0.756	0.038	0.680	0.829
2024	1.932	0.291	1.459	2.599	0.478	0.078	0.357	0.663	0.247	0.012	0.224	0.273

D.7 JMA3 MW pred JMD event threshold

Table D.37: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW pred JMD event threshold CPUE series.

Series	JMA3 MW pred JMD event threshold
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	$\text{pred_catch_JMD_TH} \sim \text{fyear} + \text{target_species} + \text{vessel_key} + \text{month} + \text{start_obs_fma} + \text{ns}(\log(\text{fishing_duration}), 3) + \text{ns}(\log(\text{start_time}), 3) + \text{ns}(\log(\text{bottom_depth}), 3) + \text{ns}(\log(\text{effort_height}), 3) + \text{ns}(\text{effort_speed}, 3)$
Stepwise selection	No
Positive catch distribution	Weibull

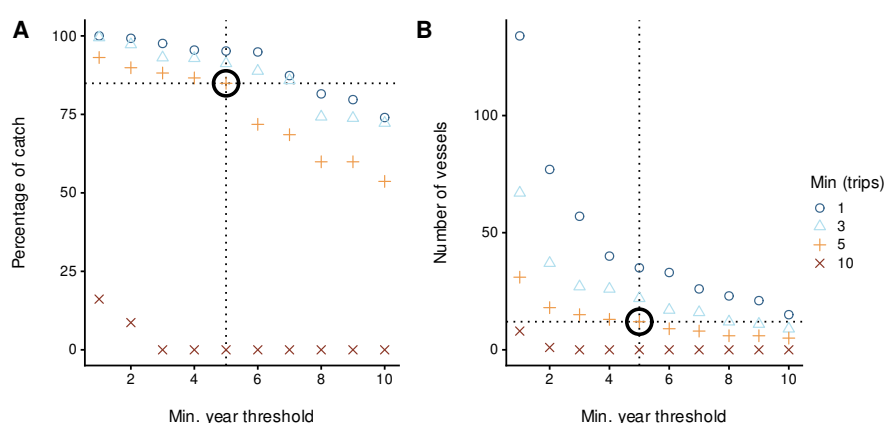


Figure D.181: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW pred JMD event threshold CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

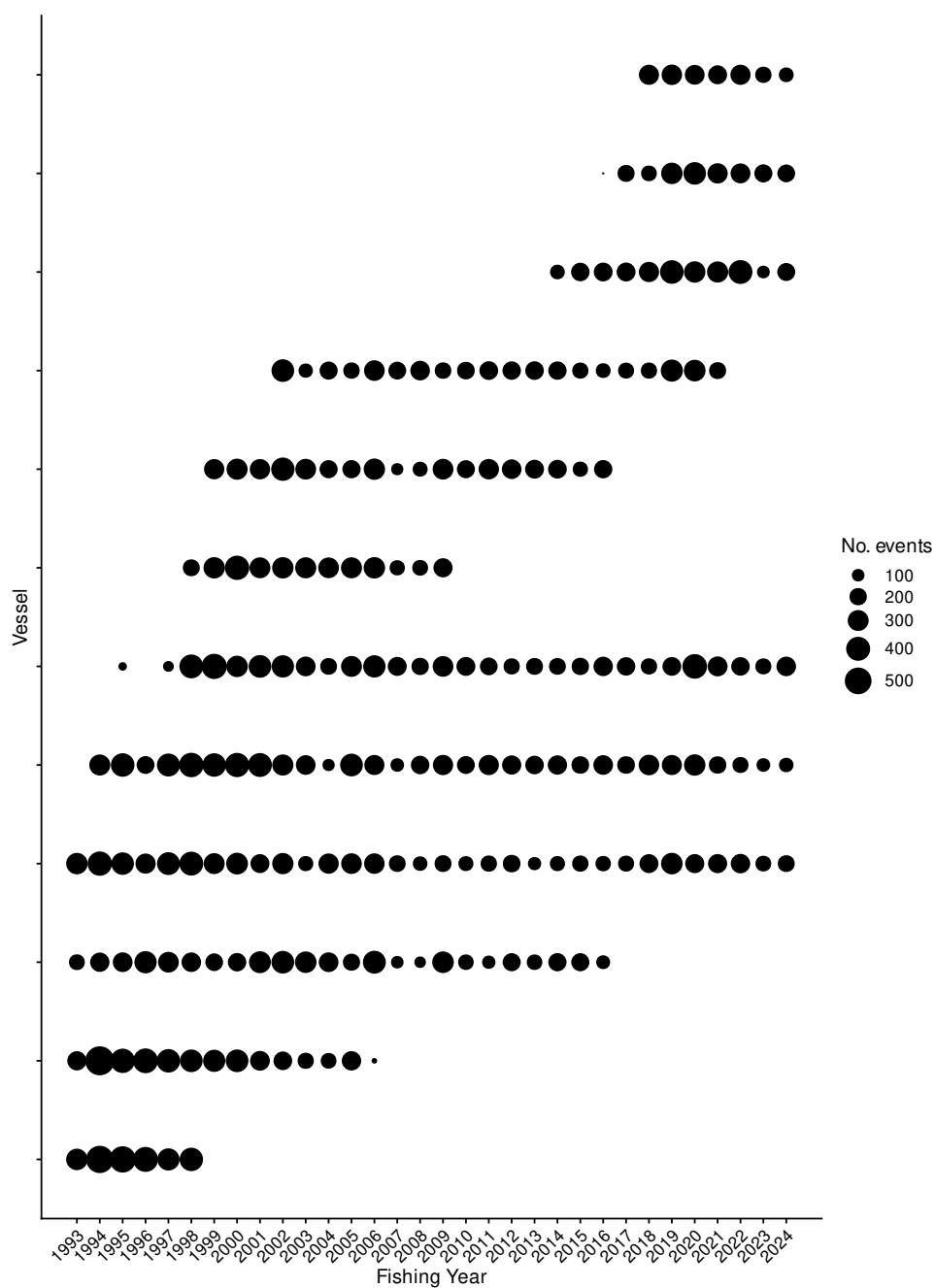


Figure D.182: Number of events by fishing year for core vessels in the JMA3 MW pred JMD event threshold series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table D.38: Summary of the JMA3 MW pred JMD event threshold dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	2259 (100%) n: 7113	815 (100%) n: 6413	1627 (100%) n: 7617	2645 (100%) n: 7993	1531 (100%) n: 5763	2318 (100%) n: 5648	3564 (100%) n: 5256	2513 (100%) n: 3758	449 (100%) n: 3011
Fishing speed not null	2259 (100%) n: 7113	815 (100%) n: 6413	1617 (99%) n: 7615	2644 (100%) n: 7985	1529 (100%) n: 5757	2318 (100%) n: 5644	3564 (100%) n: 5252	2513 (100%) n: 3758	449 (100%) n: 3010
Fishing speed lt 10kts	2259 (100%) n: 7113	815 (100%) n: 6413	1617 (99%) n: 7615	2636 (100%) n: 7953	1526 (100%) n: 5745	2318 (100%) n: 5639	3564 (100%) n: 5251	2513 (100%) n: 3758	449 (100%) n: 3010
Start date not null	2259 (100%) n: 7113	815 (100%) n: 6413	1617 (99%) n: 7615	2636 (100%) n: 7953	1526 (100%) n: 5745	2318 (100%) n: 5639	3564 (100%) n: 5251	2513 (100%) n: 3758	449 (100%) n: 3010
End date not null	2259 (100%) n: 7113	815 (100%) n: 6413	1617 (99%) n: 7615	2636 (100%) n: 7953	1526 (100%) n: 5745	2318 (100%) n: 5639	3564 (100%) n: 5251	2513 (100%) n: 3758	449 (100%) n: 3010
Start depth not null	2259 (100%) n: 7113	815 (100%) n: 6413	1617 (99%) n: 7615	2636 (100%) n: 7946	1526 (100%) n: 5729	2250 (97%) n: 5626	3560 (100%) n: 5240	2512 (100%) n: 3755	448 (100%) n: 3000
Headline height not null	2259 (100%) n: 7113	815 (100%) n: 6413	1617 (99%) n: 7615	2635 (100%) n: 7797	1526 (100%) n: 5721	2250 (97%) n: 5615	3555 (100%) n: 5233	2509 (100%) n: 3751	448 (100%) n: 2999
Fishing speed >3.5kn	2119 (94%) n: 6832	811 (100%) n: 6125	1612 (99%) n: 7473	2624 (99%) n: 7506	1518 (99%) n: 5470	2245 (97%) n: 5391	3530 (99%) n: 5118	2490 (99%) n: 3698	445 (99%) n: 2985
Headline height >15m	2114 (94%) n: 6811	805 (99%) n: 6075	1603 (99%) n: 7430	2566 (97%) n: 7400	1508 (98%) n: 5384	2232 (96%) n: 5366	3514 (99%) n: 5022	2489 (99%) n: 3688	445 (99%) n: 2978
Headline height <90m	1840 (81%) n: 6659	797 (98%) n: 6073	1603 (99%) n: 7430	2564 (97%) n: 7389	1338 (87%) n: 5181	2058 (89%) n: 4978	3503 (98%) n: 5008	2486 (99%) n: 3678	445 (99%) n: 2977
Fishing duration >15mins	1790 (79%) n: 6627	794 (97%) n: 6056	1598 (98%) n: 7413	2535 (96%) n: 7360	1326 (87%) n: 5165	2057 (89%) n: 4964	3501 (98%) n: 4997	2486 (99%) n: 3675	445 (99%) n: 2970
Fishing duration <15h	1785 (79%) n: 6609	792 (97%) n: 6040	1588 (98%) n: 7404	2527 (96%) n: 7342	1306 (85%) n: 5134	2051 (88%) n: 4949	3489 (98%) n: 4988	2467 (98%) n: 3656	445 (99%) n: 2970
Seabed depth >50m	1785 (79%) n: 6609	792 (97%) n: 6040	1588 (98%) n: 7403	2527 (96%) n: 7342	1306 (85%) n: 5134	2048 (88%) n: 4946	3489 (98%) n: 4987	2467 (98%) n: 3655	445 (99%) n: 2970
Seabed depth <350m	1782 (79%) n: 6570	790 (97%) n: 6000	1586 (97%) n: 7227	2524 (95%) n: 7313	1301 (85%) n: 5121	2046 (88%) n: 4942	3484 (98%) n: 4964	2467 (98%) n: 3645	444 (99%) n: 2967
Start time >0	1724 (76%) n: 6508	773 (95%) n: 5958	1558 (96%) n: 7156	2424 (92%) n: 7221	1253 (82%) n: 5067	2005 (86%) n: 4901	3347 (94%) n: 4916	2441 (97%) n: 3623	436 (97%) n: 2956
SA subset	1724 (76%) n: 6508	773 (95%) n: 5958	1558 (96%) n: 7156	2424 (92%) n: 7221	1253 (82%) n: 5067	2005 (86%) n: 4901	3347 (94%) n: 4916	2441 (97%) n: 3623	436 (97%) n: 2956
No effort allocation	1724 (76%) n: 6462	767 (94%) n: 5829	1558 (96%) n: 7023	2424 (92%) n: 7221	1253 (82%) n: 5066	2005 (86%) n: 4901	3347 (94%) n: 4916	2441 (97%) n: 3619	436 (97%) n: 2956
Core fleet selection	991 (44%) n: 1050	506 (62%) n: 2090	1049 (64%) n: 1937	1359 (51%) n: 1698	776 (51%) n: 1813	1410 (61%) n: 2393	2161 (61%) n: 2269	2002 (80%) n: 2351	389 (87%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	1361 (100%) n: 3311	418 (100%) n: 3108	168 (100%) n: 3281	134 (100%) n: 3639	1486 (100%) n: 2834	500 (100%) n: 2416	484 (100%) n: 2250	384 (100%) n: 2187	693 (100%) n: 1313
Fishing speed not null	1361 (100%) n: 3311	418 (100%) n: 3108	168 (100%) n: 3281	134 (100%) n: 3639	1486 (100%) n: 2834	500 (100%) n: 2416	484 (100%) n: 2250	384 (100%) n: 2187	693 (100%) n: 1313
Fishing speed lt 10kts	1361 (100%) n: 3311	418 (100%) n: 3108	168 (100%) n: 3281	134 (100%) n: 3639	1486 (100%) n: 2834	500 (100%) n: 2416	484 (100%) n: 2250	384 (100%) n: 2187	693 (100%) n: 1313
Start date not null	1361 (100%) n: 3311	418 (100%) n: 3108	168 (100%) n: 3281	134 (100%) n: 3639	1486 (100%) n: 2834	500 (100%) n: 2416	484 (100%) n: 2250	384 (100%) n: 2187	693 (100%) n: 1313
End date not null	1361 (100%) n: 3311	418 (100%) n: 3108	168 (100%) n: 3281	134 (100%) n: 3639	1486 (100%) n: 2834	500 (100%) n: 2416	484 (100%) n: 2250	384 (100%) n: 2187	693 (100%) n: 1313
Start depth not null	1359 (100%) n: 3306	418 (100%) n: 3106	168 (100%) n: 3278	134 (100%) n: 3635	1486 (100%) n: 2831	499 (100%) n: 2412	484 (100%) n: 2246	384 (100%) n: 2187	693 (100%) n: 1313
Headline height not null	1359 (100%) n: 3306	418 (100%) n: 3106	168 (100%) n: 3278	134 (100%) n: 3635	1486 (100%) n: 2831	499 (100%) n: 2412	484 (100%) n: 2246	384 (100%) n: 2187	693 (100%) n: 1313
Fishing speed >3.5kn	1359 (100%) n: 3266	416 (99%) n: 3061	168 (100%) n: 3167	134 (100%) n: 3520	1485 (100%) n: 2794	499 (100%) n: 2380	478 (99%) n: 2222	373 (97%) n: 2132	693 (100%) n: 1300
Headline height >15m	1349 (99%) n: 3243	416 (99%) n: 3043	166 (99%) n: 3150	134 (100%) n: 3512	1485 (100%) n: 2790	499 (100%) n: 2359	478 (99%) n: 2205	371 (97%) n: 2128	693 (100%) n: 1297
Headline height <90m	1349 (99%) n: 3243	416 (99%) n: 3043	165 (98%) n: 3149	134 (100%) n: 3512	1485 (100%) n: 2789	499 (100%) n: 2359	478 (99%) n: 2204	371 (97%) n: 2128	693 (100%) n: 1297
Fishing duration >15mins	1348 (99%) n: 3229	416 (99%) n: 3038	165 (98%) n: 3140	134 (100%) n: 3501	1484 (100%) n: 2782	499 (100%) n: 2354	478 (99%) n: 2198	371 (97%) n: 2126	693 (100%) n: 1295
Fishing duration <15h	1348 (99%) n: 3226	414 (99%) n: 3037	165 (98%) n: 3138	134 (100%) n: 3501	1484 (100%) n: 2780	499 (100%) n: 2353	477 (99%) n: 2195	371 (97%) n: 2122	693 (100%) n: 1294
Seabed depth >50m	1345 (99%) n: 3224	414 (99%) n: 3037	165 (98%) n: 3138	134 (100%) n: 3501	1484 (100%) n: 2780	499 (100%) n: 2353	477 (99%) n: 2195	371 (97%) n: 2122	693 (100%) n: 1294
Seabed depth <350m	1342 (99%) n: 3222	414 (99%) n: 3033	165 (98%) n: 3134	134 (100%) n: 3500	1484 (100%) n: 2779	499 (100%) n: 2351	477 (99%) n: 2193	368 (96%) n: 2120	693 (100%) n: 1293
Start time >0	1304 (96%) n: 3198	405 (97%) n: 3025	163 (97%) n: 3119	131 (98%) n: 3458	1451 (98%) n: 2766	482 (96%) n: 2334	472 (98%) n: 2182	354 (92%) n: 2108	683 (99%) n: 1280
SA subset	1304 (96%) n: 3198	405 (97%) n: 3025	163 (97%) n: 3119	131 (98%) n: 3458	1451 (98%) n: 2766	482 (96%) n: 2334	472 (98%) n: 2182	354 (92%) n: 2108	683 (99%) n: 1280
No effort allocation	1304 (96%) n: 3196	405 (97%) n: 2486	163 (97%) n: 2363	131 (98%) n: 2581	1451 (98%) n: 2593	482 (96%) n: 1705	472 (98%) n: 1587	354 (92%) n: 1990	683 (99%) n: 1260
Core fleet selection	1222 (90%) n: 2598	379 (91%) n: 1904	161 (96%) n: 1725	131 (97%) n: 2103	1439 (97%) n: 2204	442 (89%) n: 1109	445 (92%) n: 1223	249 (65%) n: 1809	661 (95%) n: 1191

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	1141 (100%) n: 1434	1106 (100%) n: 1486	1624 (100%) n: 1247	1622 (100%) n: 1484	891 (100%) n: 1445	621 (100%) n: 1549	1634 (100%) n: 1368	2229 (100%) n: 1678	1032 (100%) n: 2307
Fishing speed not null	1141 (100%) n: 1434	1106 (100%) n: 1486	1624 (100%) n: 1247	1622 (100%) n: 1484	891 (100%) n: 1445	621 (100%) n: 1549	1634 (100%) n: 1368	2229 (100%) n: 1678	1032 (100%) n: 2307
Fishing speed lt 10kts	1141 (100%) n: 1434	1106 (100%) n: 1486	1624 (100%) n: 1247	1622 (100%) n: 1484	891 (100%) n: 1445	621 (100%) n: 1549	1634 (100%) n: 1368	2226 (100%) n: 1675	1032 (100%) n: 2303
Start date not null	1141 (100%) n: 1434	1106 (100%) n: 1486	1624 (100%) n: 1247	1622 (100%) n: 1484	891 (100%) n: 1445	621 (100%) n: 1549	1634 (100%) n: 1368	2226 (100%) n: 1675	1032 (100%) n: 2303
End date not null	1141 (100%) n: 1434	1106 (100%) n: 1486	1624 (100%) n: 1247	1622 (100%) n: 1484	891 (100%) n: 1445	621 (100%) n: 1549	1634 (100%) n: 1368	2226 (100%) n: 1675	1032 (100%) n: 2303
Start depth not null	1141 (100%) n: 1434	1106 (100%) n: 1486	1624 (100%) n: 1247	1622 (100%) n: 1484	891 (100%) n: 1445	621 (100%) n: 1549	1634 (100%) n: 1368	2226 (100%) n: 1675	1032 (100%) n: 2303
Headline height not null	1141 (100%) n: 1434	1106 (100%) n: 1486	1624 (100%) n: 1247	1622 (100%) n: 1484	891 (100%) n: 1445	621 (100%) n: 1549	1634 (100%) n: 1368	2226 (100%) n: 1675	1032 (100%) n: 2303
Fishing speed >3.5kn	1139 (100%) n: 1412	1100 (99%) n: 1465	1623 (100%) n: 1229	1622 (100%) n: 1454	888 (100%) n: 1381	621 (100%) n: 1503	1634 (100%) n: 1357	2219 (100%) n: 1625	1030 (100%) n: 2269
Headline height >15m	1127 (99%) n: 1395	1100 (99%) n: 1464	1623 (100%) n: 1229	1622 (100%) n: 1454	888 (100%) n: 1379	621 (100%) n: 1503	1619 (99%) n: 1354	2219 (100%) n: 1625	1030 (100%) n: 2263
Headline height <90m	1127 (99%) n: 1395	1100 (99%) n: 1463	1623 (100%) n: 1229	1622 (100%) n: 1454	888 (100%) n: 1379	621 (100%) n: 1503	1619 (99%) n: 1354	2219 (100%) n: 1624	1030 (100%) n: 2263
Fishing duration >15mins	1127 (99%) n: 1394	1100 (99%) n: 1459	1621 (100%) n: 1224	1622 (100%) n: 1449	888 (100%) n: 1378	621 (100%) n: 1498	1619 (99%) n: 1352	2219 (100%) n: 1624	1030 (100%) n: 2260
Fishing duration <15h	1127 (99%) n: 1392	1100 (99%) n: 1457	1621 (100%) n: 1224	1622 (100%) n: 1448	888 (100%) n: 1378	621 (100%) n: 1497	1619 (99%) n: 1352	2219 (100%) n: 1624	1027 (100%) n: 2257
Seabed depth >50m	1127 (99%) n: 1392	1100 (99%) n: 1457	1621 (100%) n: 1224	1622 (100%) n: 1448	888 (100%) n: 1378	621 (100%) n: 1497	1619 (99%) n: 1352	2219 (100%) n: 1624	1027 (100%) n: 2257
Seabed depth <350m	1127 (99%) n: 1390	1100 (99%) n: 1457	1621 (100%) n: 1224	1622 (100%) n: 1448	888 (100%) n: 1378	620 (100%) n: 1491	1619 (99%) n: 1352	2219 (100%) n: 1623	1027 (100%) n: 2256
Start time >0	1117 (98%) n: 1382	1096 (99%) n: 1453	1608 (99%) n: 1217	1575 (97%) n: 1438	879 (99%) n: 1370	611 (98%) n: 1483	1618 (99%) n: 1349	2210 (99%) n: 1617	1027 (100%) n: 2252
SA subset	1117 (98%) n: 1382	1096 (99%) n: 1453	1608 (99%) n: 1217	1575 (97%) n: 1438	879 (99%) n: 1370	611 (98%) n: 1483	1618 (99%) n: 1349	2210 (99%) n: 1617	1027 (100%) n: 2252
No effort allocation	1117 (98%) n: 1382	1096 (99%) n: 1390	1608 (99%) n: 1216	1575 (97%) n: 1436	879 (99%) n: 1370	611 (98%) n: 1447	1618 (99%) n: 1336	2210 (99%) n: 1616	1027 (100%) n: 2252
Core fleet selection	1109 (97%) n: 1301	1059 (96%) n: 1344	1591 (98%) n: 1169	1572 (97%) n: 1420	877 (98%) n: 1362	600 (97%) n: 1409	1607 (98%) n: 1212	2203 (99%) n: 1599	968 (94%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	914 (100%) n: 2542	2652 (100%) n: 1919	2141 (100%) n: 1800	2671 (100%) n: 1038	1316 (100%) n: 1343
Fishing speed not null	914 (100%) n: 2542	2652 (100%) n: 1919	2141 (100%) n: 1800	2671 (100%) n: 1038	1316 (100%) n: 1343
Fishing speed lt 10kts	914 (100%) n: 2542	2652 (100%) n: 1919	2141 (100%) n: 1800	2671 (100%) n: 1038	1316 (100%) n: 1343
Start date not null	914 (100%) n: 2542	2652 (100%) n: 1919	2141 (100%) n: 1800	2671 (100%) n: 1038	1316 (100%) n: 1343
End date not null	914 (100%) n: 2542	2652 (100%) n: 1919	2141 (100%) n: 1800	2671 (100%) n: 1038	1313 (100%) n: 1342
Start depth not null	914 (100%) n: 2542	2652 (100%) n: 1919	2141 (100%) n: 1800	2671 (100%) n: 1038	1313 (100%) n: 1342
Headline height not null	914 (100%) n: 2542	2652 (100%) n: 1919	2141 (100%) n: 1800	2671 (100%) n: 1038	1313 (100%) n: 1342
Fishing speed >3.5kn	913 (100%) n: 2430	2652 (100%) n: 1919	2141 (100%) n: 1794	2670 (100%) n: 1037	1313 (100%) n: 1342
Headline height >15m	911 (100%) n: 2426	2652 (100%) n: 1917	2141 (100%) n: 1792	2670 (100%) n: 1035	1305 (99%) n: 1336
Headline height <90m	911 (100%) n: 2426	2652 (100%) n: 1917	2141 (100%) n: 1792	2670 (100%) n: 1035	1305 (99%) n: 1336
Fishing duration >15mins	911 (100%) n: 2421	2639 (100%) n: 1912	2141 (100%) n: 1785	2669 (100%) n: 1032	1305 (99%) n: 1331
Fishing duration <15h	911 (100%) n: 2421	2636 (99%) n: 1910	2141 (100%) n: 1785	2667 (100%) n: 1031	1305 (99%) n: 1330
Seabed depth >50m	911 (100%) n: 2421	2636 (99%) n: 1910	2141 (100%) n: 1784	2667 (100%) n: 1031	1305 (99%) n: 1330
Seabed depth <350m	911 (100%) n: 2419	2636 (99%) n: 1910	2141 (100%) n: 1783	2667 (100%) n: 1030	1305 (99%) n: 1329
Start time >0	911 (100%) n: 2415	2554 (96%) n: 1902	2127 (99%) n: 1781	2660 (100%) n: 1029	1305 (99%) n: 1326
SA subset	911 (100%) n: 2415	2554 (96%) n: 1902	2127 (99%) n: 1781	2660 (100%) n: 1029	1305 (99%) n: 1326
No effort allocation	911 (100%) n: 2414	2554 (96%) n: 1898	2127 (99%) n: 1775	2660 (100%) n: 1029	1305 (99%) n: 1306
Core fleet selection	779 (85%) n: 2235	2451 (92%) n: 1744	1856 (87%) n: 1603	2616 (98%) n: 953	1189 (90%) n: 1157

Table D.39: Summary of the JMA3 MW pred JMD event threshold dataset after core fleet selection. 'Records' indicates the number of rows (events) in the dataset, and 'Records caught' indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	990.52	30.00
1994	5	40	2 090	5 313.80	505.53	28.42
1995	6	38	1 937	5 281.88	1 049.09	28.50
1996	5	31	1 698	4 946.23	1 359.02	49.59
1997	6	23	1 813	5 486.45	776.40	38.72
1998	7	36	2 393	6 500.45	1 409.80	40.91
1999	7	29	2 269	6 680.20	2 161.23	53.42
2000	7	34	2 351	7 026.89	2 002.04	56.15
2001	7	29	2 174	7 230.32	389.32	23.55
2002	8	32	2 598	8 281.02	1 222.16	30.64
2003	8	33	1 904	6 719.12	379.42	16.75
2004	8	23	1 725	6 488.50	161.24	7.65
2005	8	28	2 103	7 303.95	130.90	7.13
2006	8	33	2 204	8 642.28	1 439.15	29.67
2007	7	27	1 109	4 762.03	442.45	22.99
2008	7	27	1 223	5 763.20	444.59	15.04
2009	7	37	1 809	8 957.70	249.47	10.50
2010	6	25	1 191	5 181.56	661.18	30.56
2011	6	21	1 301	5 811.68	1 109.36	30.36
2012	6	27	1 344	5 844.70	1 058.79	27.16
2013	6	25	1 169	4 960.32	1 591.29	39.52
2014	7	36	1 420	6 220.82	1 571.82	42.18
2015	7	37	1 362	6 240.75	876.85	36.05
2016	8	48	1 409	6 312.63	600.24	23.42
2017	6	29	1 212	6 426.48	1 607.02	46.86
2018	7	33	1 599	7 557.02	2 203.49	49.34
2019	7	36	2 156	9 997.48	967.89	27.92
2020	7	44	2 235	10 344.52	779.06	25.41
2021	7	32	1 744	7 955.15	2 450.89	41.92
2022	6	35	1 603	7 543.75	1 855.73	46.04
2023	6	25	953	4 692.92	2 616.19	77.33
2024	6	34	1 157	5 419.63	1 188.76	63.79

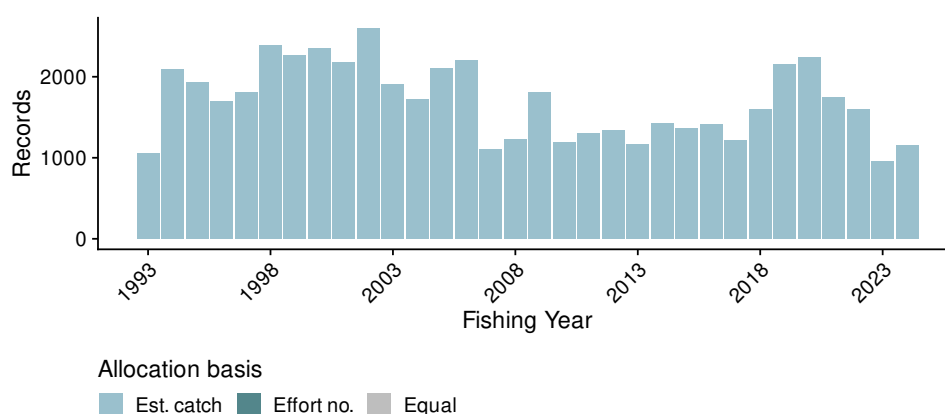


Figure D.183: The allocation approach used for attributing catches to records in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.40: Summary table for occurrence of positive catch in the JMA3 MW pred JMD event threshold series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	16 629.31	0.00	0.00	*
fyear	31	13 647.59	11.44	11.44	*
target_species	2	14 025.06	27.03	15.59	*
vessel_key	11	14 004.28	27.31	0.28	*
month	11	13 915.06	28.33	1.01	*
start_obs_fma	3	13 530.32	31.30	2.97	*
ns(log(fishing_duration), 3)	3	13 535.17	31.33	0.04	*
ns(log(start_time), 3)	3	13 492.54	31.58	0.25	*
ns(log(bottom_depth), 3)	3	13 388.04	31.97	0.39	*
ns(log(effort_height), 3)	3	13 357.56	32.16	0.19	*
ns(effort_speed, 3)	3	13 270.30	32.65	0.49	*

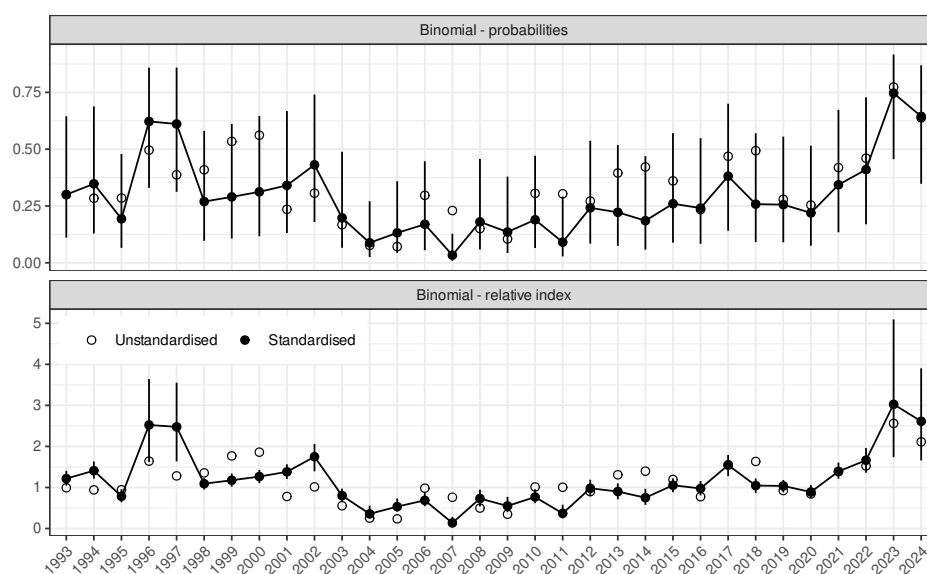


Figure D.184: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW pred JMD event threshold dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

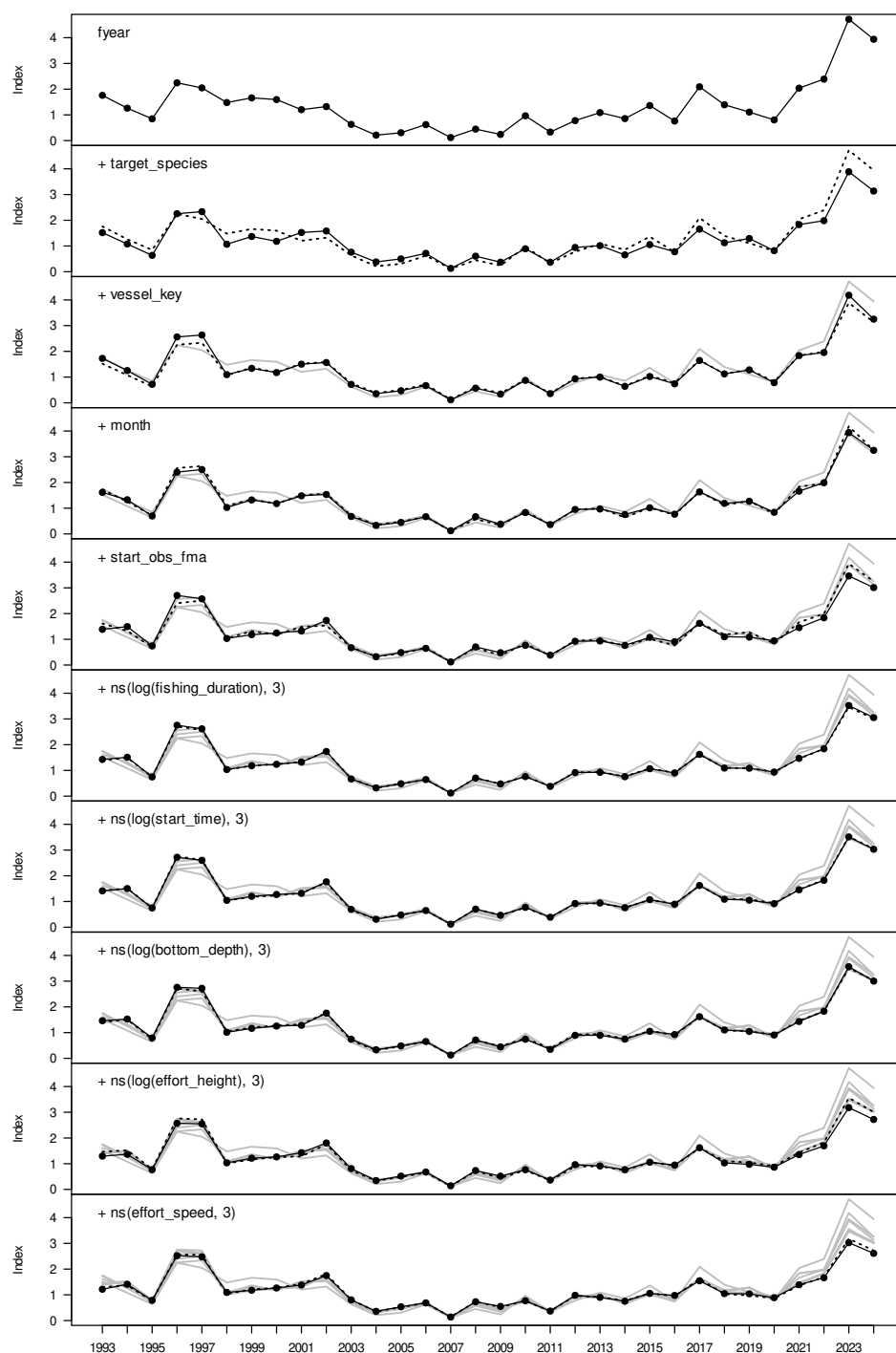


Figure D.185: Step plot for occurrence of catch in the JMA3 MW pred JMD event threshold dataset.

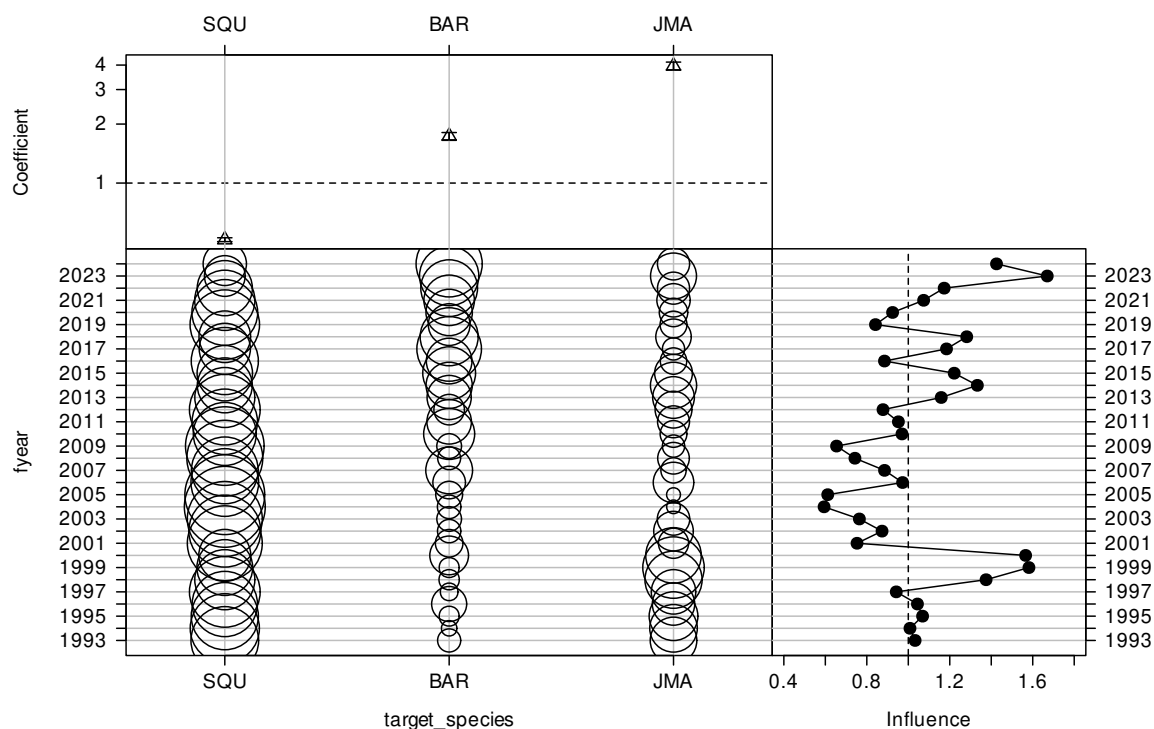


Figure D.186: CDI plot for target species for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

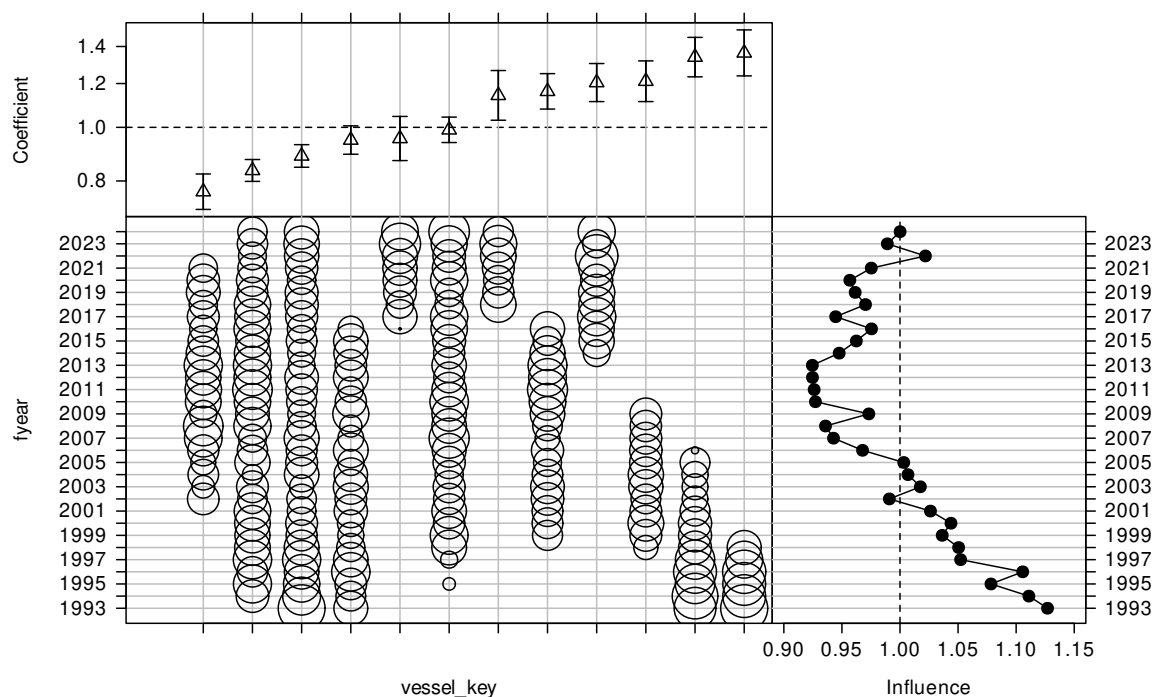


Figure D.187: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

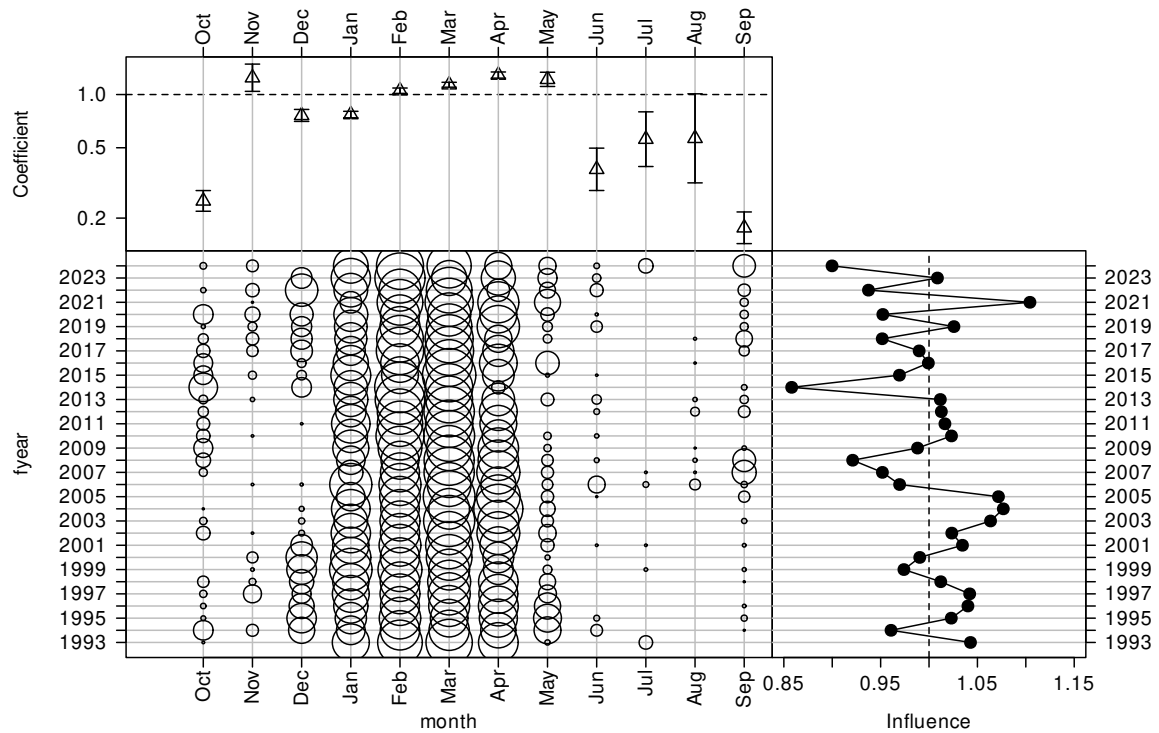


Figure D.188: CDI plot for month for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

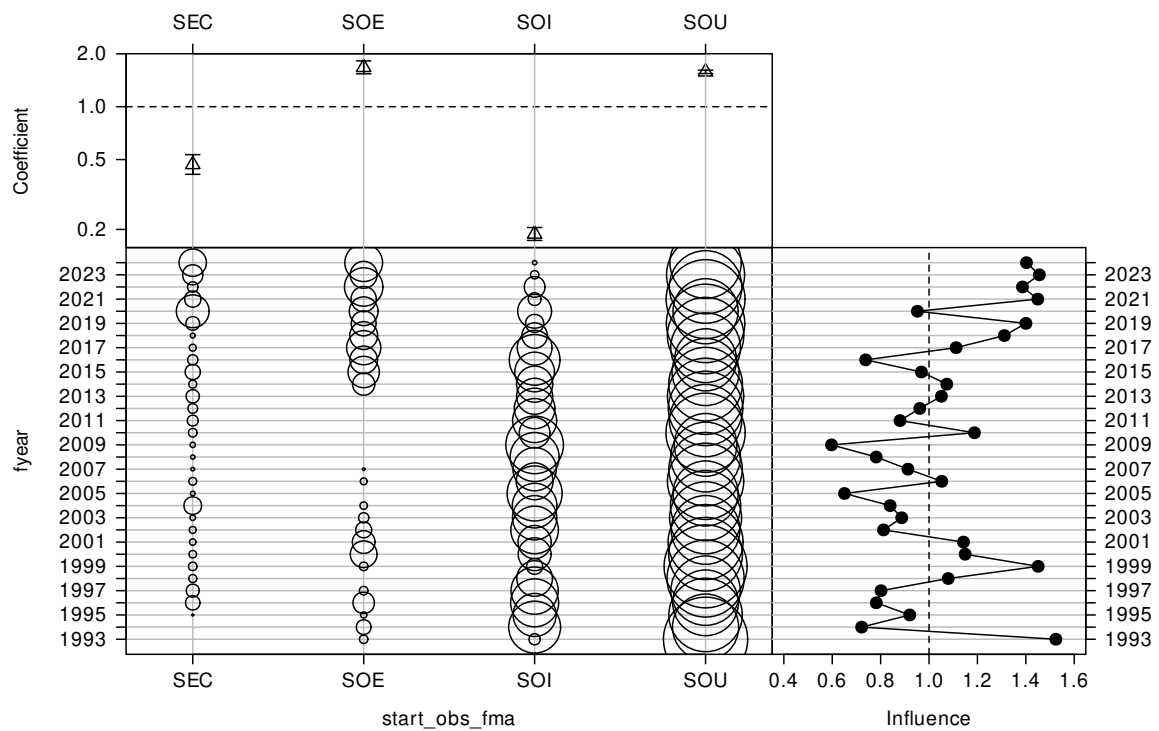


Figure D.189: CDI plot for start obs fma for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

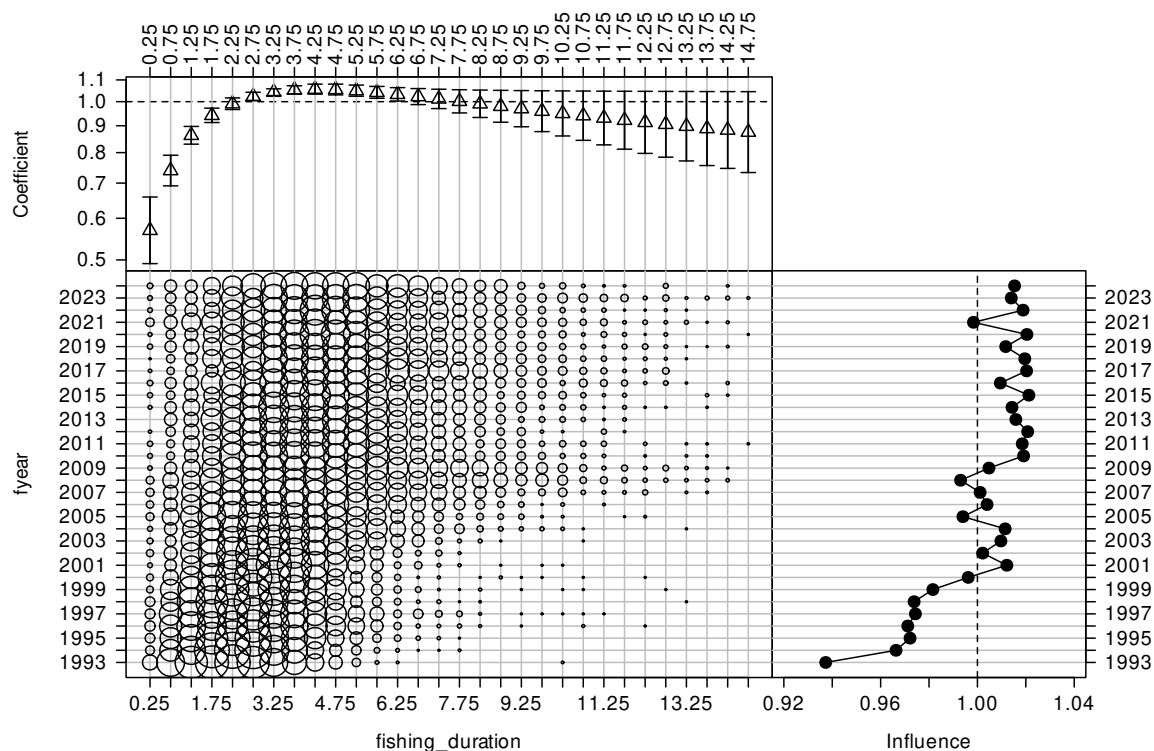


Figure D.190: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

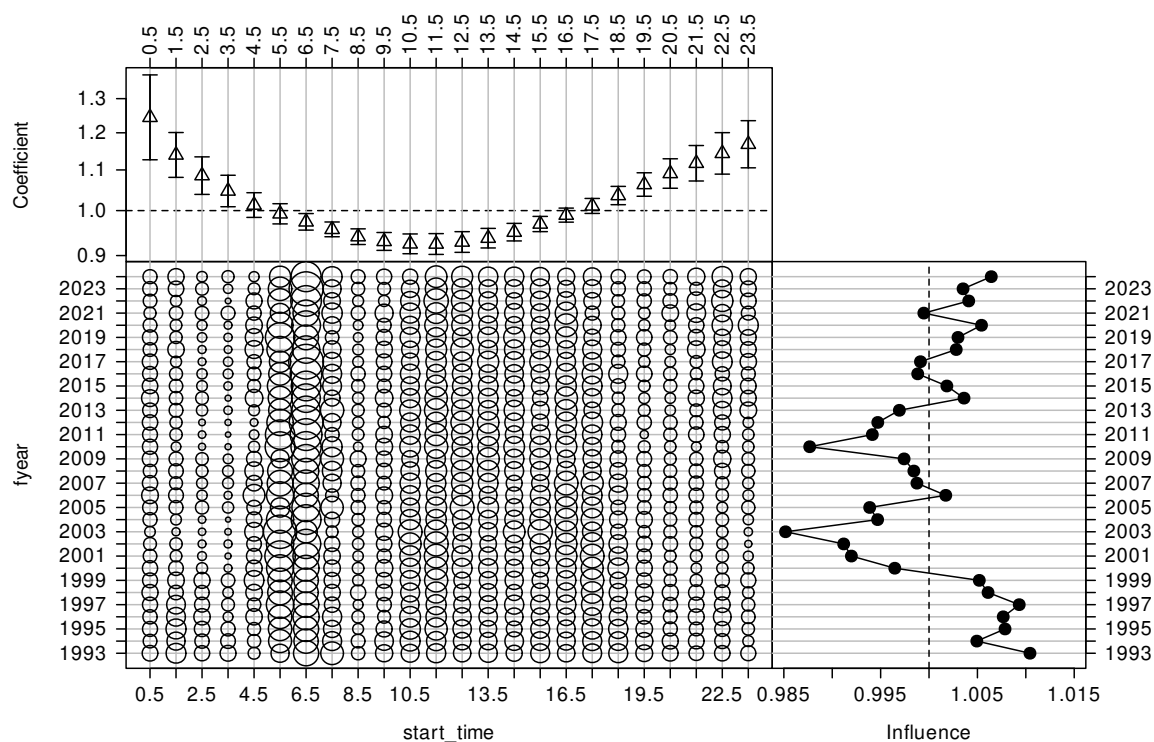


Figure D.191: CDI plot for start time for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

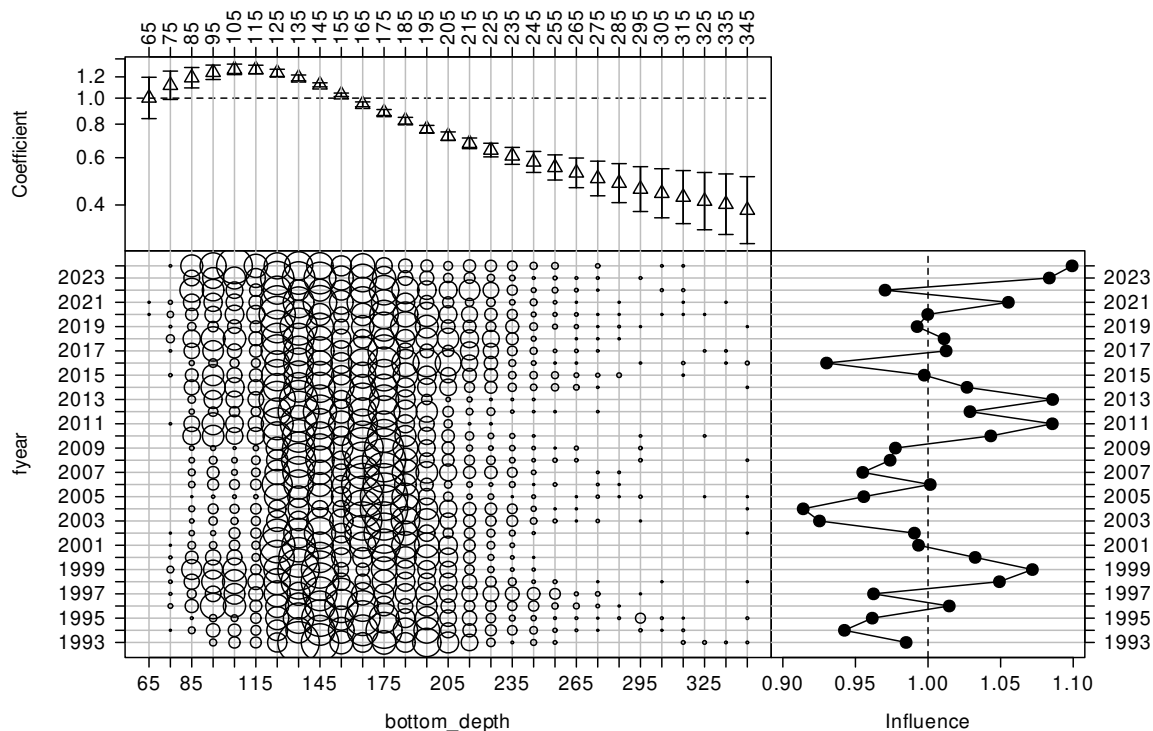


Figure D.192: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

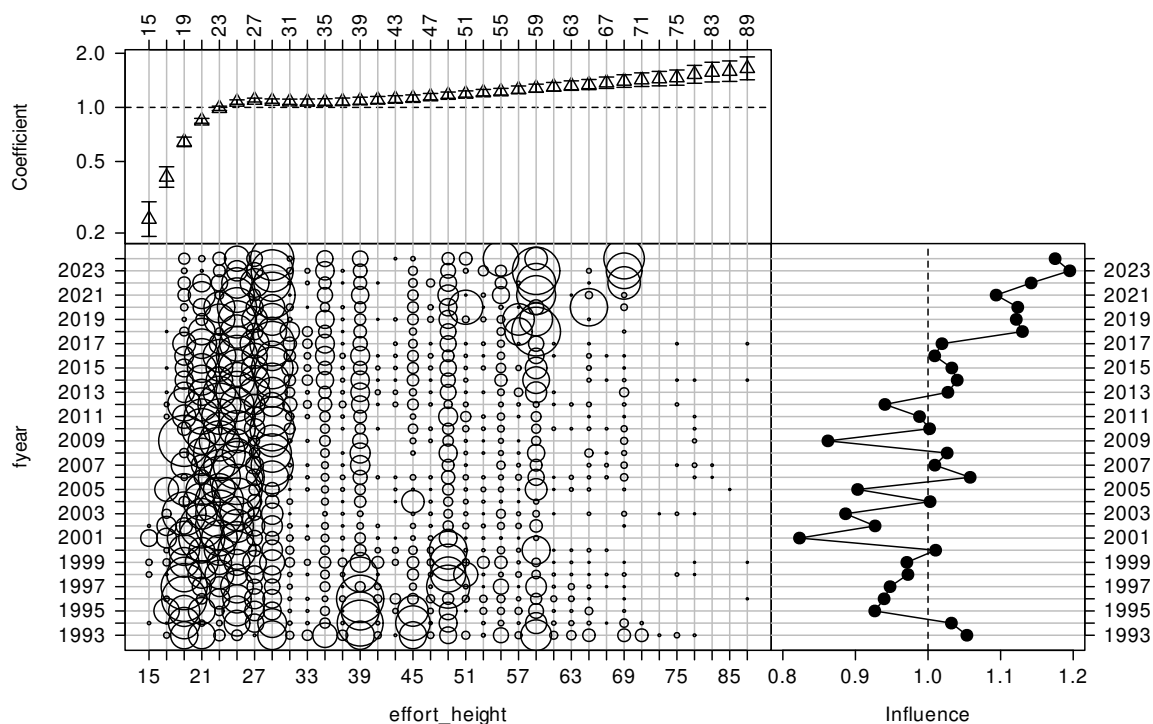


Figure D.193: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

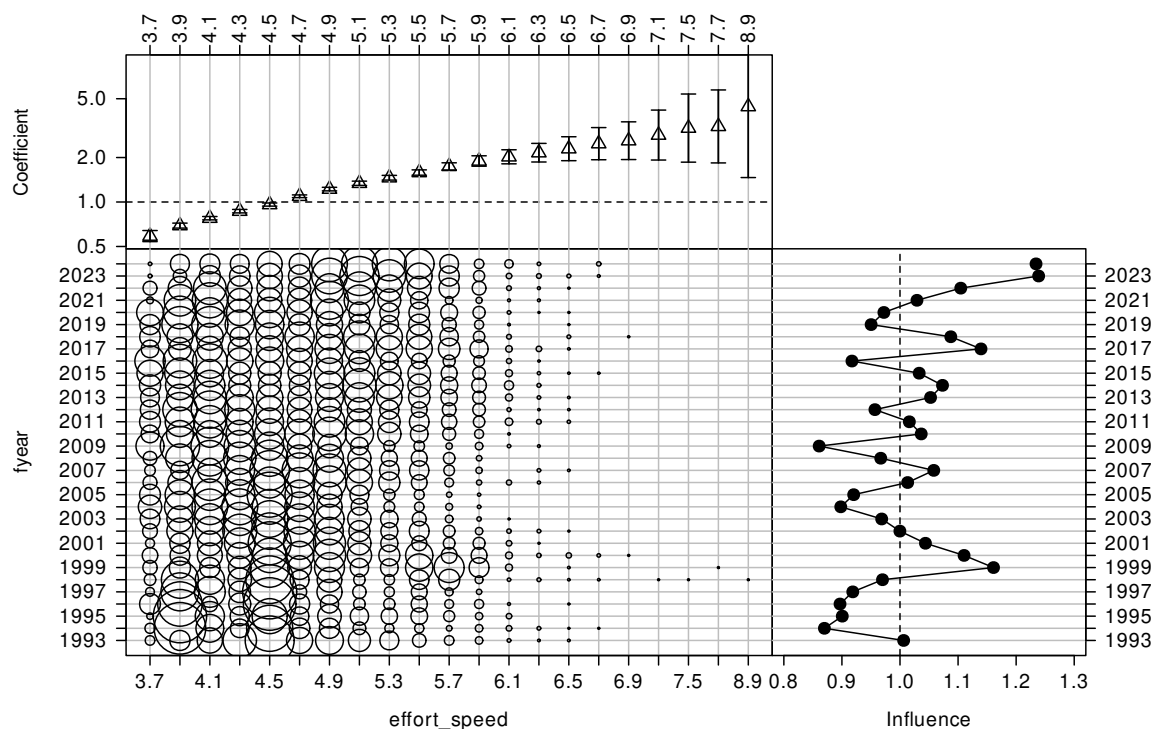


Figure D.194: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

Table D.41: Summary table for the Weibull model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	83 896.90	0.00	0.00	*
fyear	31	83 421.06	7.91	7.91	*
target_species	2	82 750.32	17.83	9.92	*
vessel_key	11	82 642.64	19.74	1.91	*
month	11	82 500.82	22.14	2.41	*
start_obs_fma	3	82 463.04	22.79	0.64	*
ns(log(fishing_duration), 3)	3	82 440.86	23.20	0.41	*
ns(log(start_time), 3)	3	82 393.42	23.99	0.79	*
ns(log(bottom_depth), 3)	3	82 383.75	24.22	0.23	*
ns(log(effort_height), 3)	3	82 376.76	24.41	0.19	*
ns(effort_speed, 3)	3	82 357.26	24.79	0.37	*

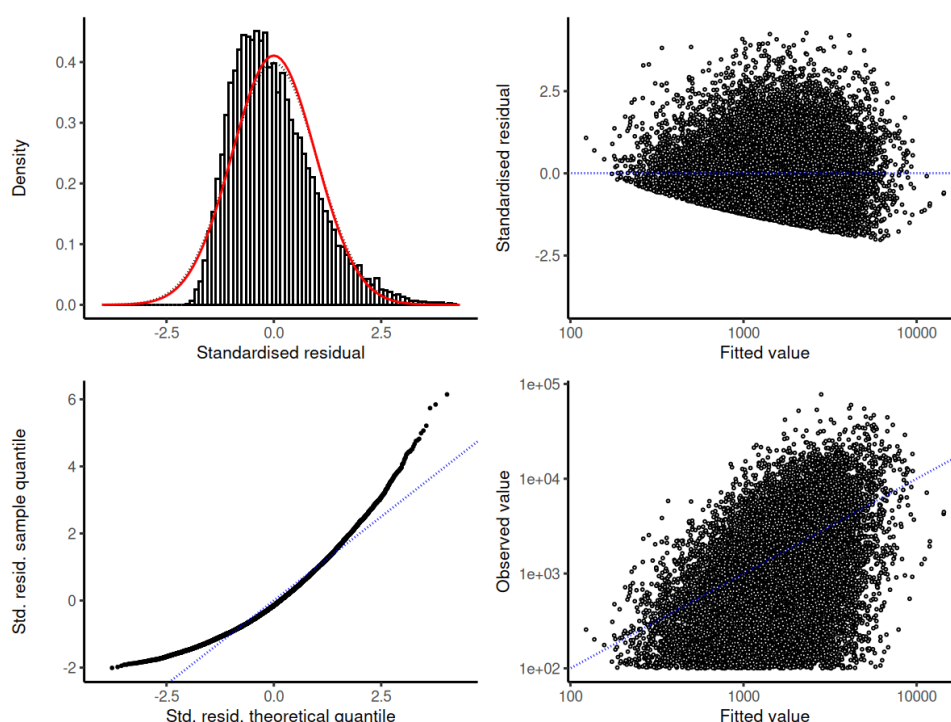


Figure D.195: Diagnostic plots for the selected Weibull model for positive catches in the JMA3 MW pred JMD event threshold dataset.

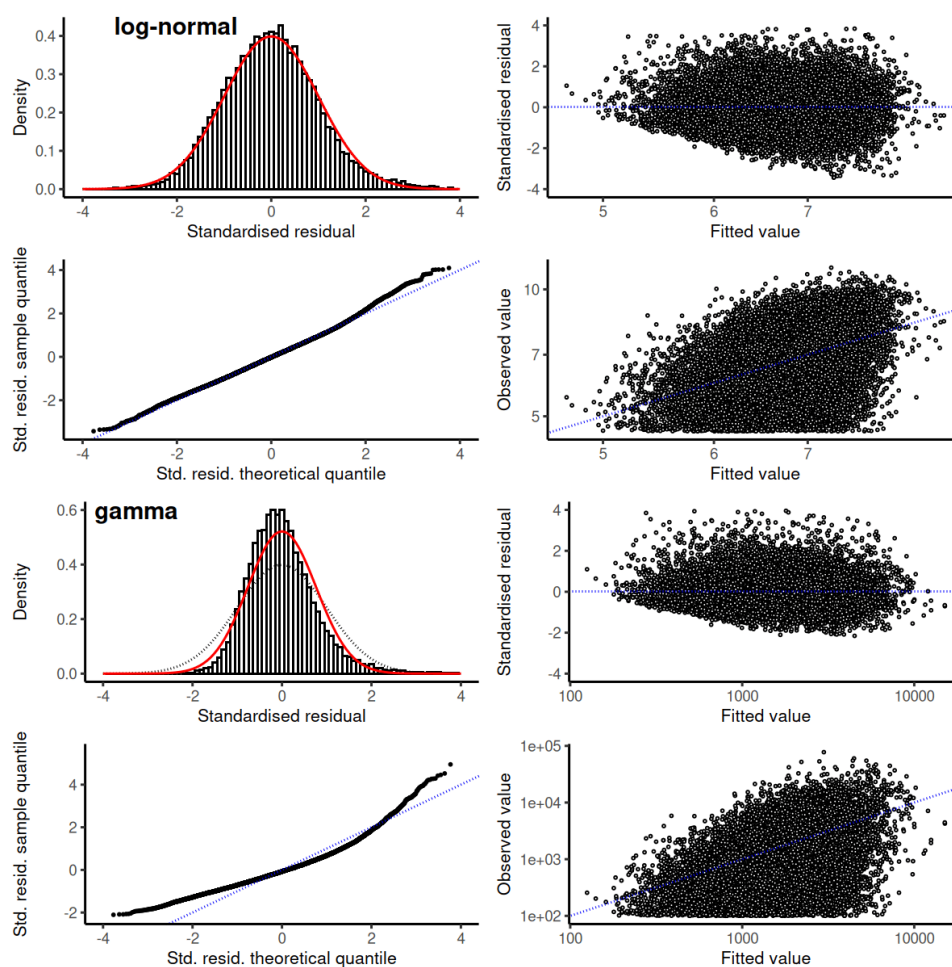


Figure D.196: Diagnostic plots for the alternative log-normal and gamma models considered for positive catches in the JMA3 MW pred JMD event threshold dataset.

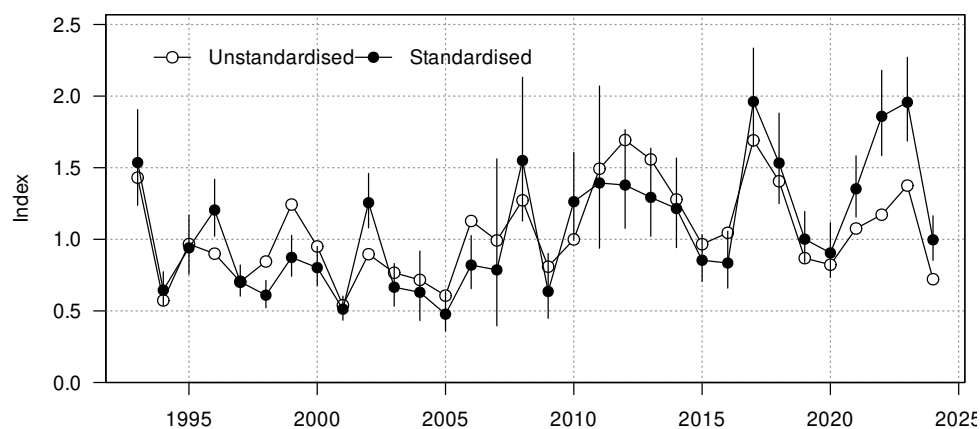


Figure D.197: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the Weibull model for the JMA3 MW pred JMD event threshold dataset.

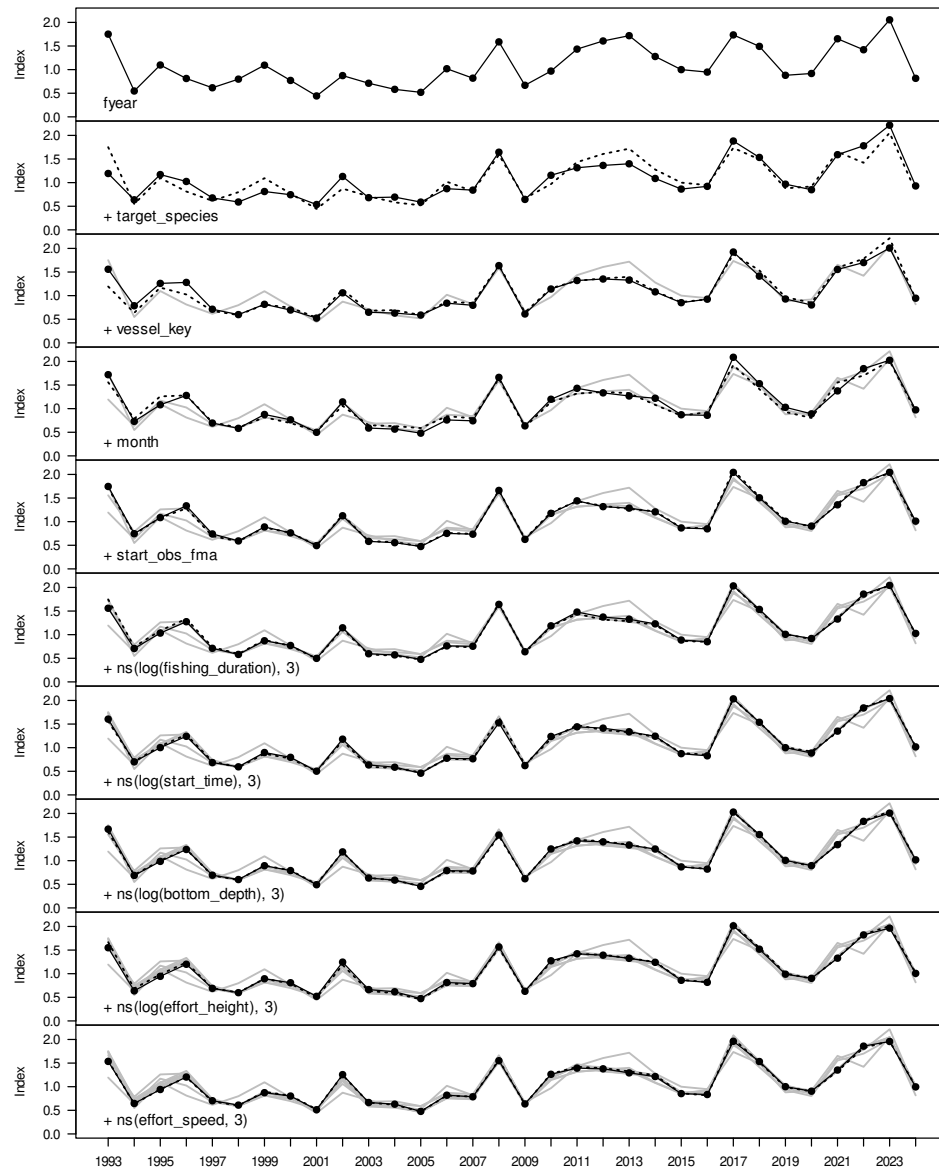


Figure D.198: Changes to the JMA3 MW pred JMD event threshold positive catch index as terms are successively entered into the Weibull model.

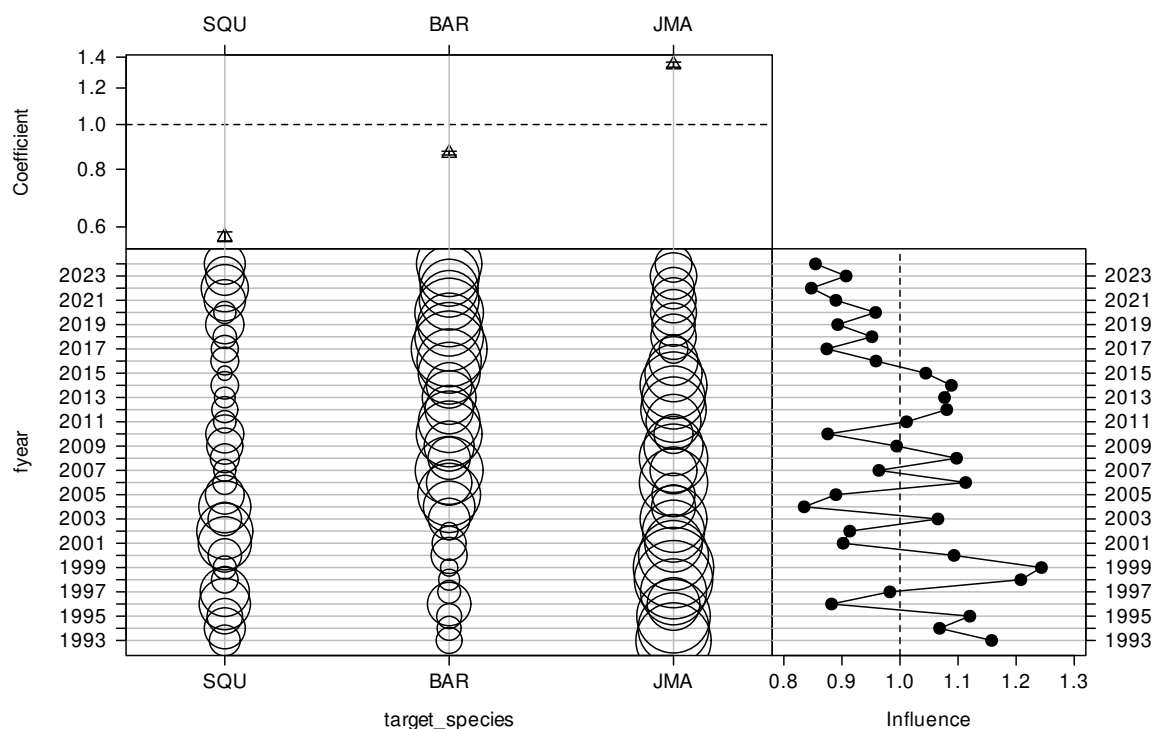


Figure D.199: CDI plot for target species for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

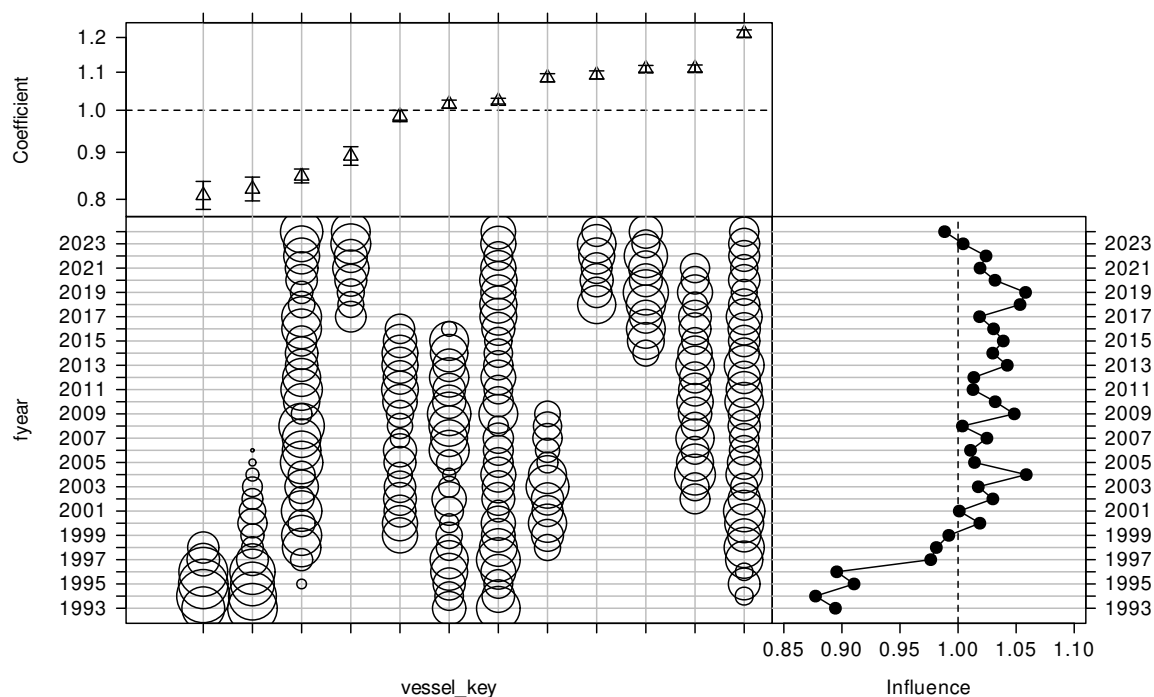


Figure D.200: CDI plot for vessel key for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

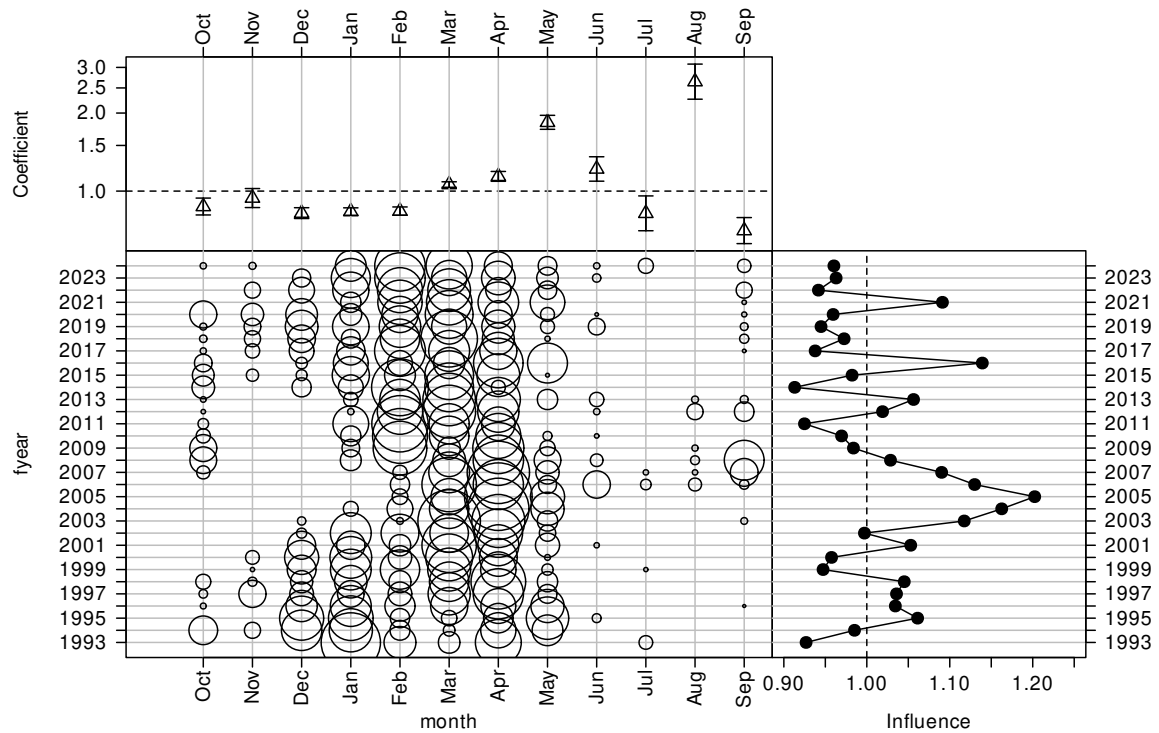


Figure D.201: CDI plot for month for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

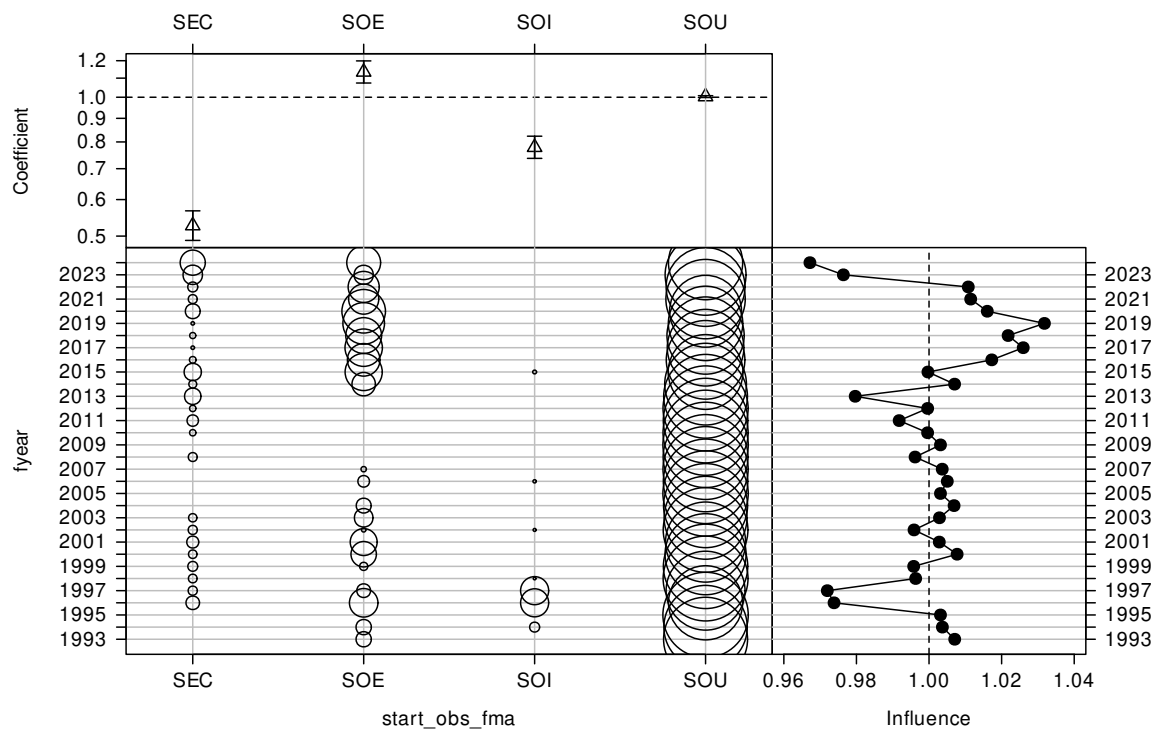


Figure D.202: CDI plot for start obs fma for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

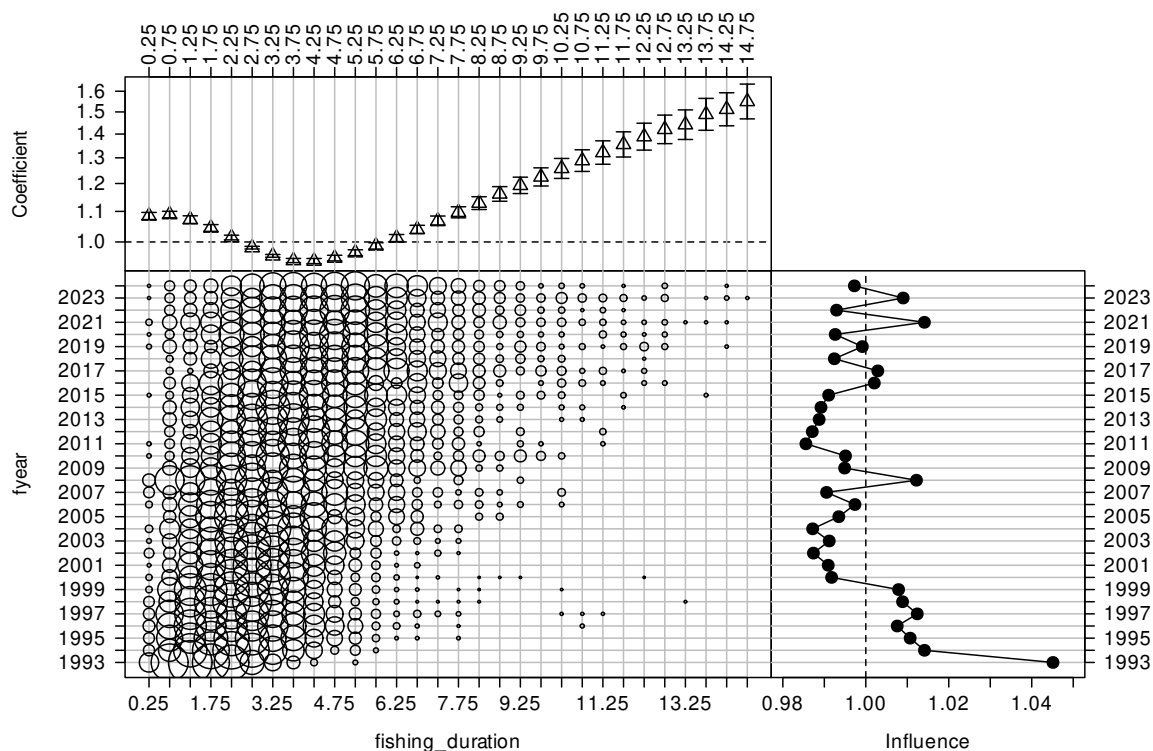


Figure D.203: CDI plot for fishing duration (h) for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

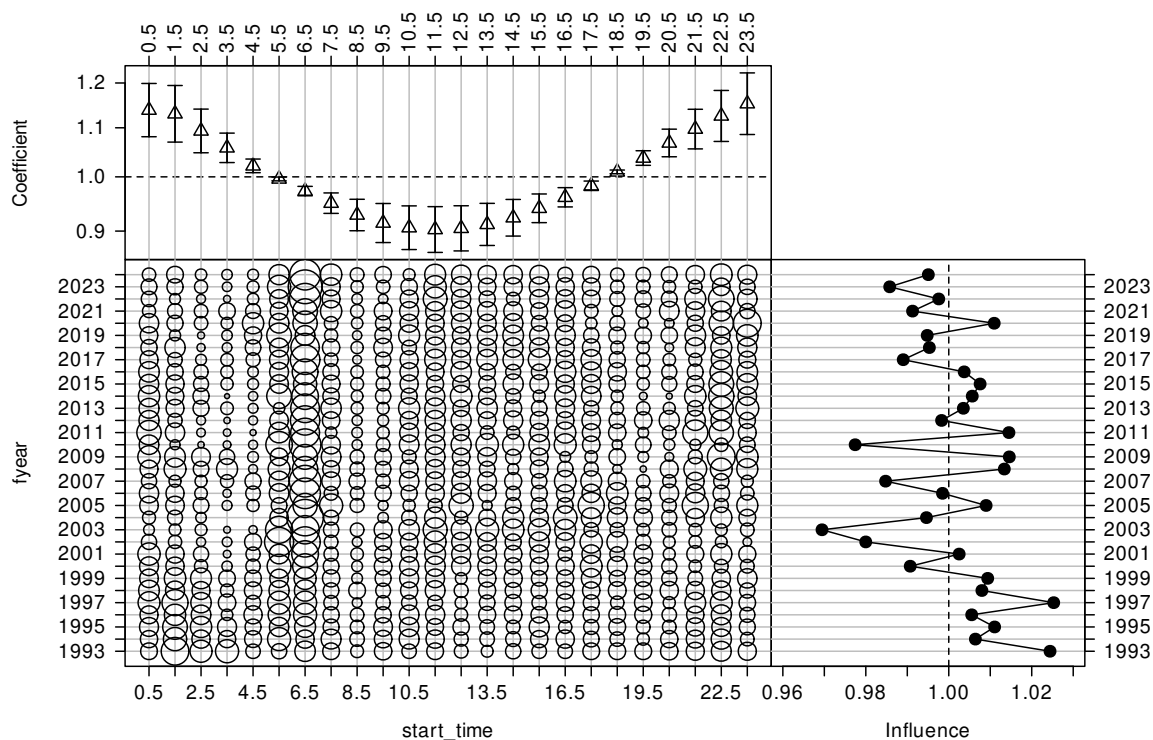


Figure D.204: CDI plot for start time for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

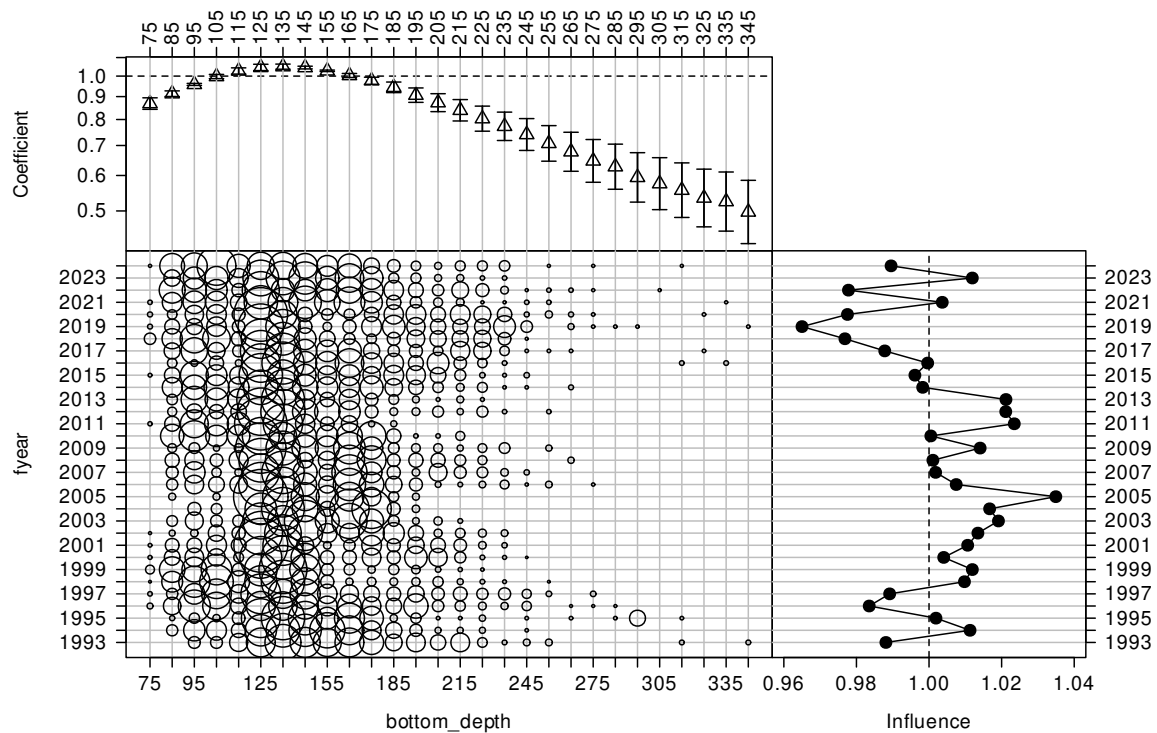


Figure D.205: CDI plot for bottom depth (m) for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

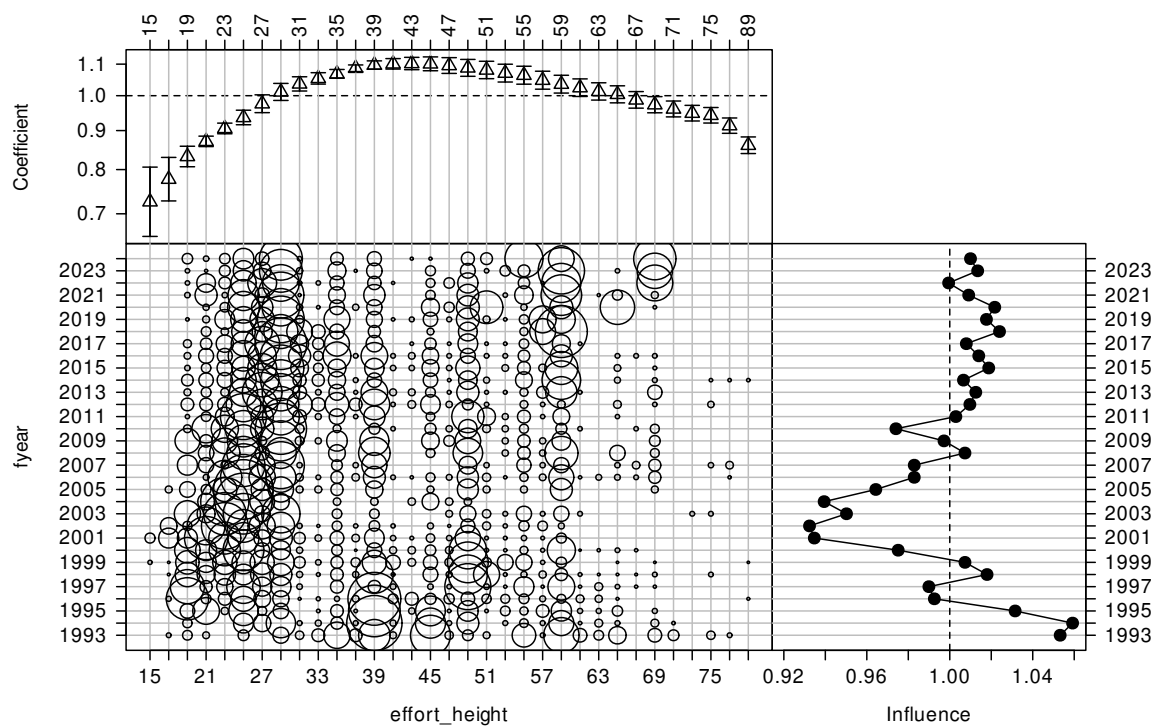


Figure D.206: CDI plot for effort height (m) for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

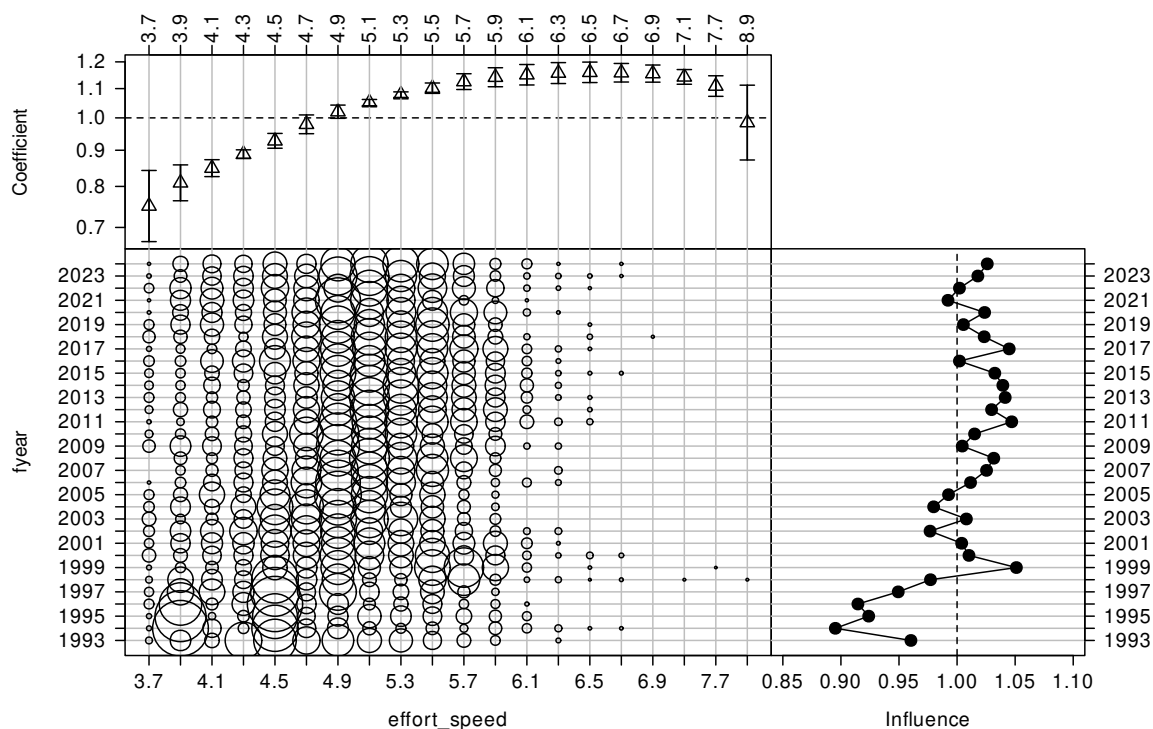


Figure D.207: CDI plot for effort speed for the Weibull model of positive catches in the JMA3 MW pred JMD event threshold catch-per-unit-effort dataset.

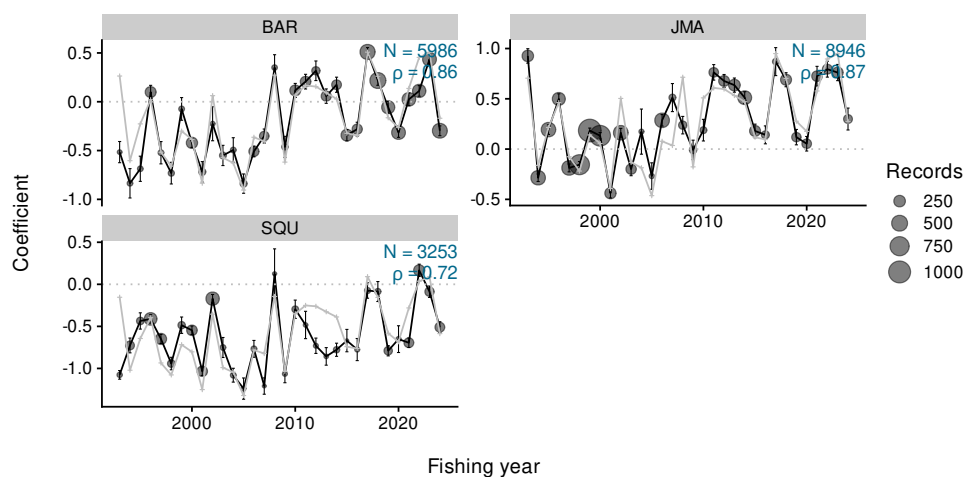


Figure D.208: Residual implied coefficients for target-year in the Weibull positive catch model for the JMA3 MW pred JMD event threshold dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

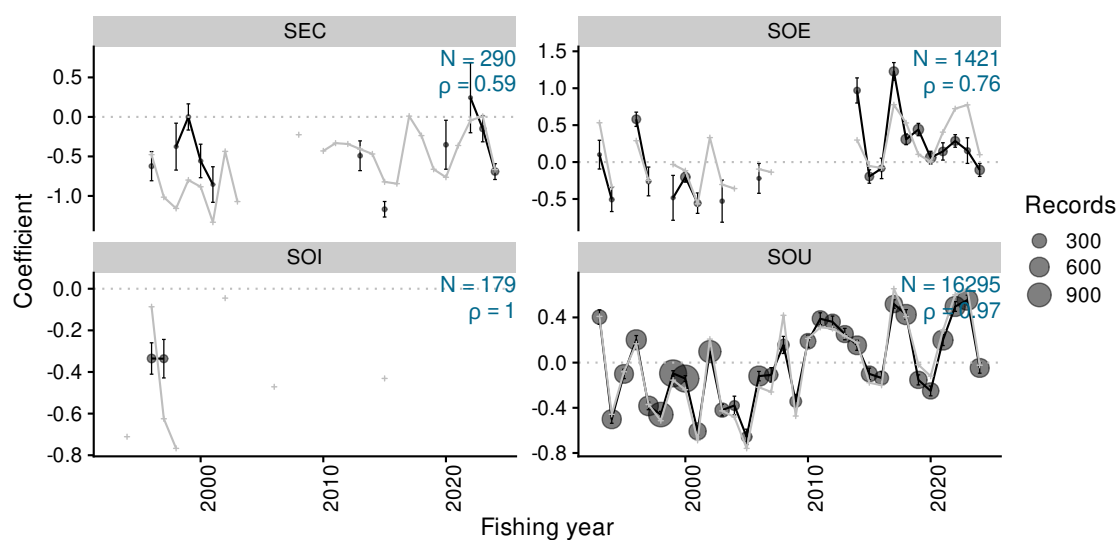


Figure D.209: Residual implied coefficients for area-year in the Weibull positive catch model for the JMA3 MW pred JMD event threshold dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

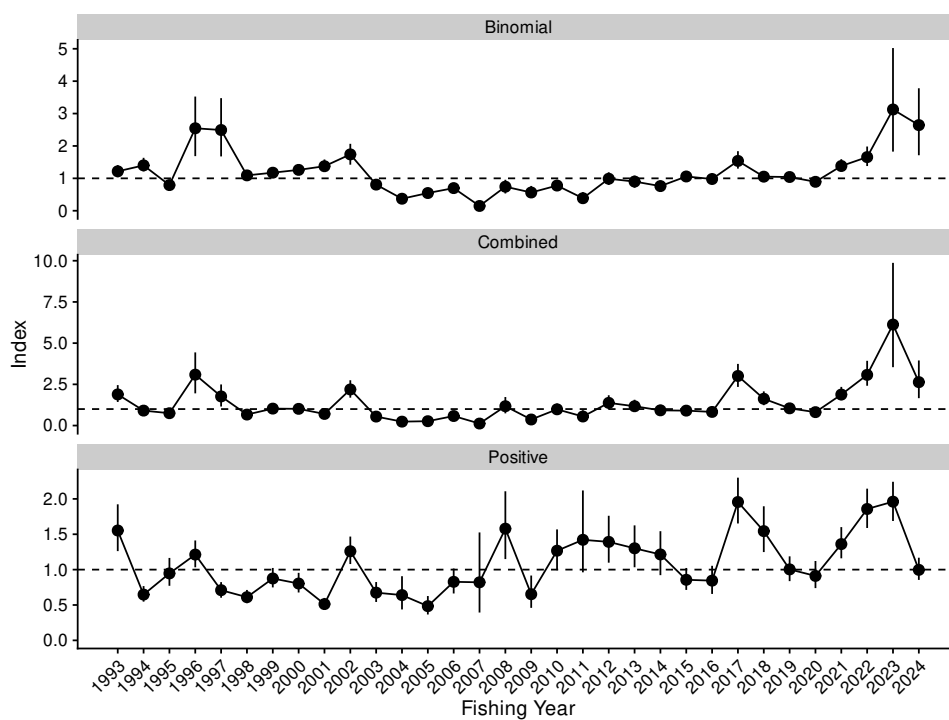


Figure D.210: Standardised indices and 95% confidence intervals for the JMA3 MW pred JMD event threshold dataset.

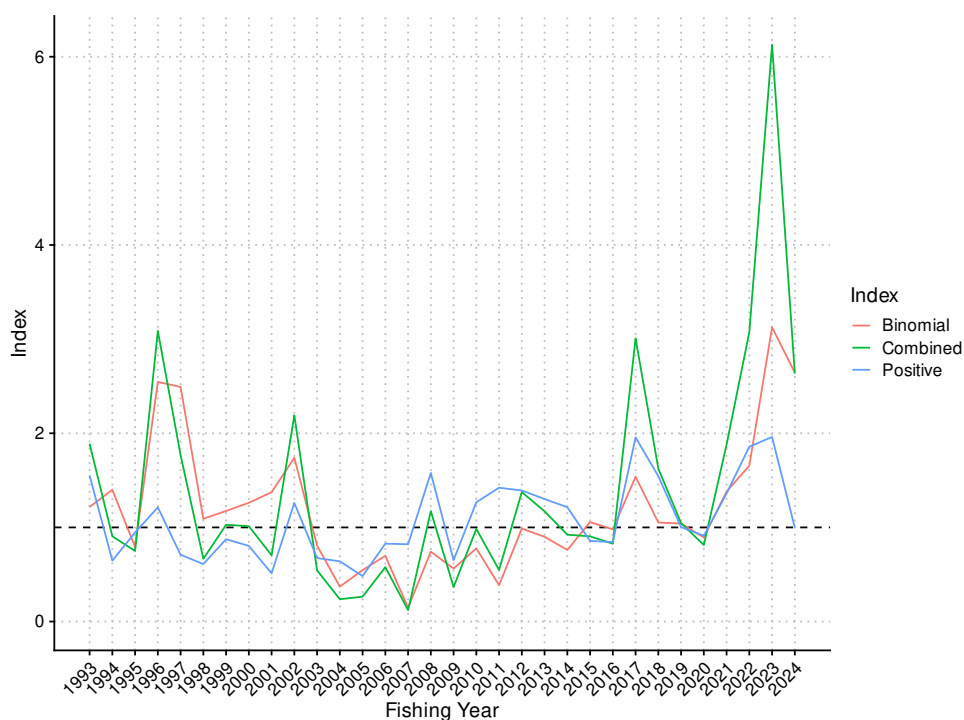


Figure D.211: Standardised indices for the JMA3 MW pred JMD event threshold dataset.

Table D.42: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW pred JMD event threshold series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	1.216	0.096	1.034	1.409	1.889	0.261	1.431	2.453	1.553	0.169	1.262	1.923
1994	1.400	0.107	1.215	1.634	0.906	0.106	0.721	1.135	0.647	0.056	0.547	0.767
1995	0.792	0.083	0.633	0.959	0.749	0.115	0.551	1.004	0.946	0.100	0.771	1.165
1996	2.546	0.469	1.685	3.525	3.087	0.634	1.953	4.438	1.213	0.097	1.033	1.412
1997	2.492	0.459	1.677	3.475	1.767	0.342	1.154	2.494	0.709	0.056	0.603	0.823
1998	1.091	0.073	0.940	1.227	0.666	0.067	0.545	0.807	0.610	0.048	0.525	0.713
1999	1.175	0.082	1.018	1.340	1.028	0.107	0.836	1.254	0.875	0.070	0.749	1.023
2000	1.261	0.081	1.112	1.431	1.013	0.108	0.821	1.243	0.803	0.071	0.677	0.955
2001	1.374	0.095	1.209	1.583	0.704	0.071	0.575	0.855	0.513	0.042	0.433	0.600
2002	1.740	0.164	1.422	2.066	2.190	0.270	1.692	2.749	1.260	0.099	1.079	1.467
2003	0.806	0.083	0.642	0.966	0.544	0.082	0.393	0.715	0.674	0.072	0.543	0.825
2004	0.371	0.077	0.247	0.549	0.237	0.067	0.130	0.393	0.640	0.120	0.437	0.907
2005	0.546	0.081	0.398	0.716	0.264	0.055	0.171	0.386	0.484	0.067	0.366	0.627
2006	0.698	0.082	0.542	0.865	0.578	0.090	0.420	0.770	0.828	0.090	0.663	1.016
2007	0.147	0.056	0.069	0.287	0.121	0.064	0.041	0.291	0.821	0.289	0.393	1.526
2008	0.742	0.108	0.533	0.956	1.173	0.253	0.740	1.730	1.579	0.244	1.149	2.108
2009	0.563	0.093	0.401	0.765	0.367	0.089	0.221	0.571	0.653	0.117	0.460	0.916
2010	0.777	0.088	0.613	0.956	0.984	0.163	0.698	1.335	1.267	0.147	0.992	1.568
2011	0.386	0.083	0.250	0.574	0.548	0.159	0.302	0.926	1.421	0.295	0.962	2.119
2012	0.987	0.100	0.796	1.187	1.376	0.218	0.985	1.838	1.392	0.169	1.098	1.761
2013	0.900	0.095	0.710	1.084	1.171	0.182	0.851	1.566	1.301	0.151	1.034	1.626
2014	0.760	0.089	0.590	0.938	0.923	0.160	0.635	1.263	1.215	0.159	0.922	1.543
2015	1.057	0.085	0.895	1.230	0.905	0.114	0.712	1.159	0.856	0.079	0.713	1.023
2016	0.979	0.089	0.811	1.159	0.827	0.121	0.611	1.085	0.844	0.101	0.656	1.054
2017	1.538	0.137	1.300	1.838	3.008	0.356	2.345	3.740	1.956	0.165	1.653	2.300
2018	1.052	0.085	0.884	1.219	1.625	0.213	1.237	2.073	1.544	0.165	1.248	1.896
2019	1.041	0.071	0.900	1.179	1.045	0.121	0.827	1.301	1.004	0.089	0.837	1.188
2020	0.893	0.075	0.747	1.041	0.813	0.111	0.618	1.054	0.911	0.098	0.739	1.122
2021	1.381	0.097	1.210	1.591	1.879	0.206	1.537	2.345	1.361	0.113	1.160	1.601
2022	1.656	0.154	1.380	1.982	3.075	0.386	2.415	3.928	1.857	0.142	1.589	2.145
2023	3.126	0.816	1.825	5.022	6.126	1.615	3.541	9.871	1.961	0.141	1.687	2.242
2024	2.644	0.527	1.713	3.781	2.634	0.584	1.661	3.949	0.997	0.080	0.855	1.168

D.8 JMA3 MW pred JMM event threshold

Table D.43: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW pred JMM event threshold CPUE series.

Series	JMA3 MW pred JMM event threshold
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	$\text{pred_catch_JMM_TH} \sim \text{fyear} + \text{vessel_key} + \text{target_species} + \text{month} + \text{start_obs_fma} + \text{ns}(\log(\text{fishing_duration}), 3) + \text{ns}(\log(\text{start_time}), 3) + \text{ns}(\log(\text{bottom_depth}), 3) + \text{ns}(\log(\text{effort_height}), 3) + \text{ns}(\text{effort_speed}, 3)$
Stepwise selection	No
Positive catch distribution	Weibull

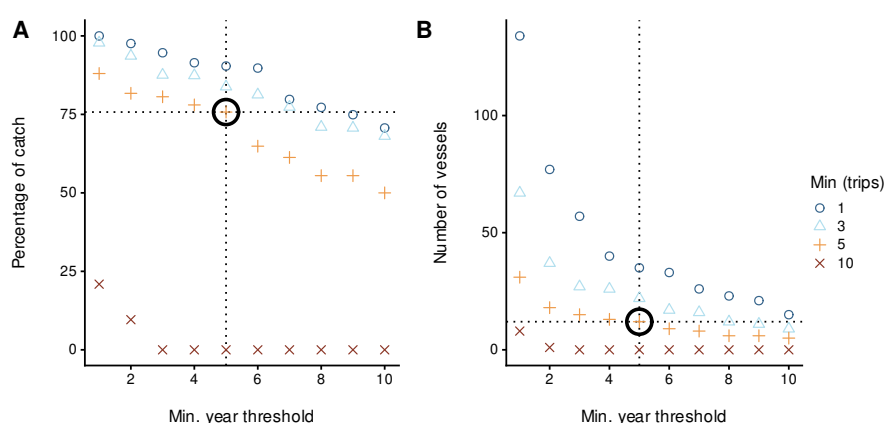


Figure D.212: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW pred JMM event threshold CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

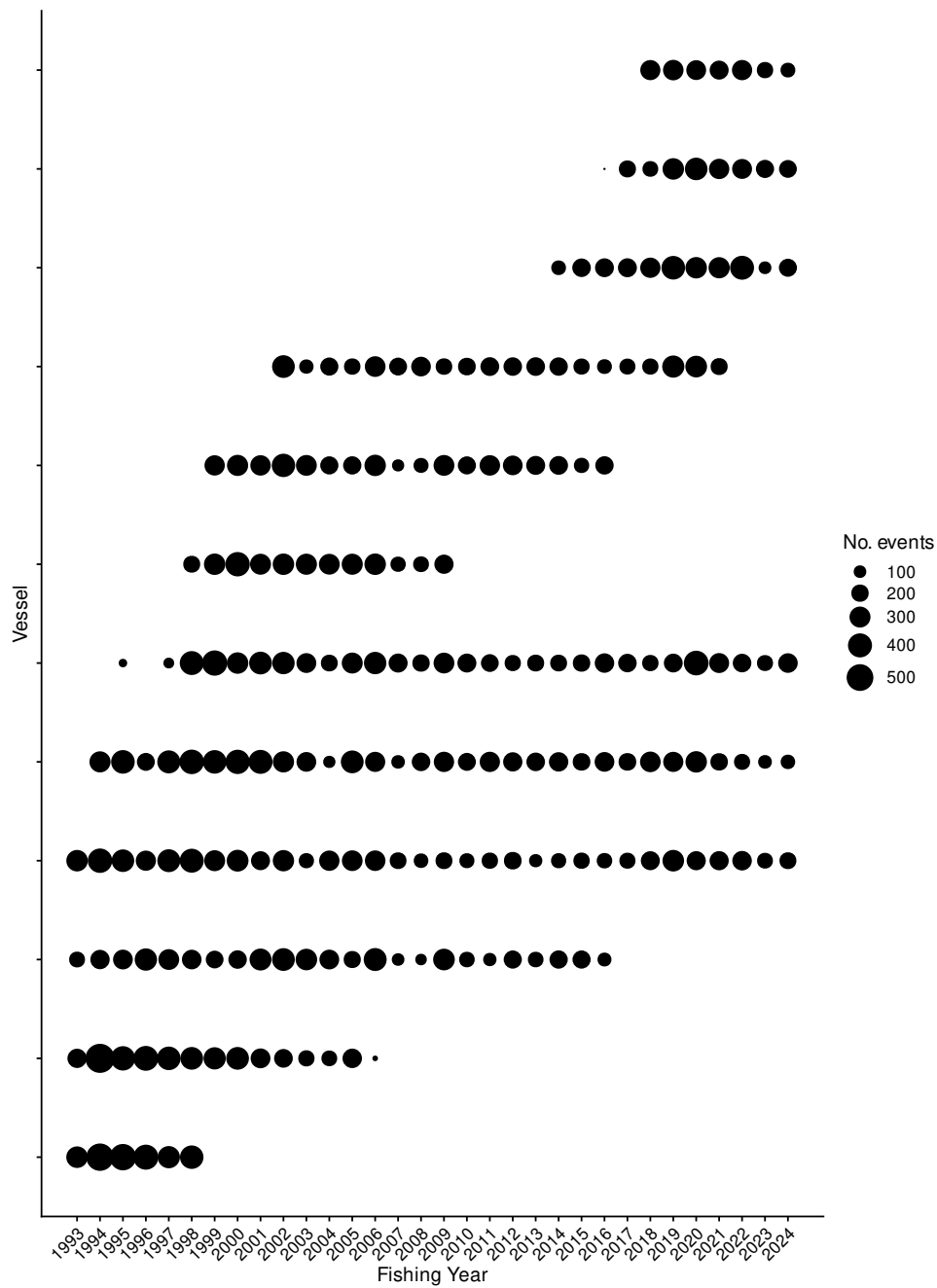


Figure D.213: Number of events by fishing year for core vessels in the JMA3 MW pred JMM event threshold series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table D.44: Summary of the JMA3 MW pred JMM event threshold dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	7265 (100%) n: 7113	4149 (100%) n: 6413	5499 (100%) n: 7617	11077 (100%) n: 7993	10579 (100%) n: 5763	9725 (100%) n: 5648	10978 (100%) n: 5256	5710 (100%) n: 3758	1536 (100%) n: 3011
Fishing speed not null	7265 (100%) n: 7113	4149 (100%) n: 6413	5473 (100%) n: 7615	11072 (100%) n: 7985	10558 (100%) n: 5757	9725 (100%) n: 5644	10976 (100%) n: 5252	5710 (100%) n: 3758	1536 (100%) n: 3010
Fishing speed lt 10kts	7265 (100%) n: 7113	4149 (100%) n: 6413	5473 (100%) n: 7615	11028 (100%) n: 7953	10536 (100%) n: 5745	9725 (100%) n: 5639	10976 (100%) n: 5251	5710 (100%) n: 3758	1536 (100%) n: 3010
Start date not null	7265 (100%) n: 7113	4149 (100%) n: 6413	5473 (100%) n: 7615	11028 (100%) n: 7953	10536 (100%) n: 5745	9725 (100%) n: 5639	10976 (100%) n: 5251	5710 (100%) n: 3758	1536 (100%) n: 3010
End date not null	7265 (100%) n: 7113	4149 (100%) n: 6413	5473 (100%) n: 7615	11028 (100%) n: 7953	10536 (100%) n: 5745	9725 (100%) n: 5639	10976 (100%) n: 5251	5710 (100%) n: 3758	1536 (100%) n: 3010
Start depth not null	7265 (100%) n: 7113	4149 (100%) n: 6413	5473 (100%) n: 7615	11028 (100%) n: 7946	10533 (100%) n: 5729	9645 (99%) n: 5626	10958 (100%) n: 5240	5709 (100%) n: 3755	1534 (100%) n: 3000
Headline height not null	7265 (100%) n: 7113	4149 (100%) n: 6413	5473 (100%) n: 7615	11019 (99%) n: 7797	10532 (100%) n: 5721	9643 (99%) n: 5615	10946 (100%) n: 5233	5702 (100%) n: 3751	1534 (100%) n: 2999
Fishing speed >3.5kn	7026 (97%) n: 6832	4126 (99%) n: 6125	5463 (99%) n: 7473	10946 (99%) n: 7506	10461 (99%) n: 5470	9606 (99%) n: 5391	10860 (99%) n: 5118	5662 (99%) n: 3698	1527 (99%) n: 2985
Headline height >15m	7009 (96%) n: 6811	4094 (99%) n: 6075	5421 (99%) n: 7430	10733 (97%) n: 7400	10393 (98%) n: 5384	9579 (99%) n: 5366	10820 (99%) n: 5022	5658 (99%) n: 3688	1527 (99%) n: 2978
Headline height <90m	6639 (91%) n: 6659	4069 (98%) n: 6073	5421 (99%) n: 7430	10723 (97%) n: 7389	9289 (88%) n: 5181	8739 (90%) n: 4978	10780 (98%) n: 5008	5649 (99%) n: 3678	1527 (99%) n: 2977
Fishing duration >15mins	6552 (90%) n: 6627	4054 (98%) n: 6056	5394 (98%) n: 7413	10641 (96%) n: 7360	9226 (87%) n: 5165	8725 (90%) n: 4964	10773 (98%) n: 4997	5649 (99%) n: 3675	1527 (99%) n: 2970
Fishing duration <15h	6540 (90%) n: 6609	4046 (98%) n: 6040	5379 (98%) n: 7404	10608 (96%) n: 7342	9072 (86%) n: 5134	8688 (89%) n: 4949	10745 (98%) n: 4988	5607 (98%) n: 3656	1527 (99%) n: 2970
Seabed depth >50m	6540 (90%) n: 6609	4046 (98%) n: 6040	5379 (98%) n: 7403	10608 (96%) n: 7342	9072 (86%) n: 5134	8668 (89%) n: 4946	10745 (98%) n: 4987	5607 (98%) n: 3655	1527 (99%) n: 2970
Seabed depth <350m	6507 (90%) n: 6570	4036 (97%) n: 6000	5371 (98%) n: 7227	10585 (96%) n: 7313	9040 (85%) n: 5121	8658 (89%) n: 4942	10719 (98%) n: 4964	5606 (98%) n: 3645	1523 (99%) n: 2967
Start time >0	6226 (86%) n: 6508	3949 (95%) n: 5958	5196 (94%) n: 7156	10241 (92%) n: 7221	8741 (83%) n: 5067	8485 (87%) n: 4901	10362 (94%) n: 4916	5543 (97%) n: 3623	1507 (98%) n: 2956
SA subset	6226 (86%) n: 6508	3949 (95%) n: 5958	5196 (94%) n: 7156	10241 (92%) n: 7221	8741 (83%) n: 5067	8485 (87%) n: 4901	10362 (94%) n: 4916	5543 (97%) n: 3623	1507 (98%) n: 2956
No effort allocation	6213 (86%) n: 6462	3900 (94%) n: 5829	5179 (94%) n: 7023	10241 (92%) n: 7221	8741 (83%) n: 5066	8485 (87%) n: 4901	10362 (94%) n: 4916	5543 (97%) n: 3619	1507 (98%) n: 2956
Core fleet selection	2056 (28%) n: 1050	2574 (62%) n: 2090	3002 (55%) n: 1937	5109 (46%) n: 1698	5091 (48%) n: 1813	5885 (61%) n: 2393	6912 (63%) n: 2269	4500 (79%) n: 2351	1330 (87%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	2279 (100%) n: 3311	1218 (100%) n: 3108	353 (100%) n: 3281	431 (100%) n: 3639	3113 (100%) n: 2834	941 (100%) n: 2416	1684 (100%) n: 2250	1398 (100%) n: 2187	1520 (100%) n: 1313
Fishing speed not null	2279 (100%) n: 3311	1218 (100%) n: 3108	353 (100%) n: 3281	431 (100%) n: 3639	3113 (100%) n: 2834	941 (100%) n: 2416	1684 (100%) n: 2250	1398 (100%) n: 2187	1520 (100%) n: 1313
Fishing speed lt 10kts	2279 (100%) n: 3311	1218 (100%) n: 3108	353 (100%) n: 3281	431 (100%) n: 3639	3113 (100%) n: 2834	941 (100%) n: 2416	1684 (100%) n: 2250	1398 (100%) n: 2187	1520 (100%) n: 1313
Start date not null	2279 (100%) n: 3311	1218 (100%) n: 3108	353 (100%) n: 3281	431 (100%) n: 3639	3113 (100%) n: 2834	941 (100%) n: 2416	1684 (100%) n: 2250	1398 (100%) n: 2187	1520 (100%) n: 1313
End date not null	2279 (100%) n: 3311	1218 (100%) n: 3108	353 (100%) n: 3281	431 (100%) n: 3639	3113 (100%) n: 2834	941 (100%) n: 2416	1684 (100%) n: 2250	1398 (100%) n: 2187	1520 (100%) n: 1313
Start depth not null	2279 (100%) n: 3306	1218 (100%) n: 3106	353 (100%) n: 3278	431 (100%) n: 3635	3113 (100%) n: 2831	940 (100%) n: 2412	1684 (100%) n: 2246	1398 (100%) n: 2187	1520 (100%) n: 1313
Headline height not null	2279 (100%) n: 3306	1218 (100%) n: 3106	353 (100%) n: 3278	431 (100%) n: 3635	3113 (100%) n: 2831	940 (100%) n: 2412	1684 (100%) n: 2246	1398 (100%) n: 2187	1520 (100%) n: 1313
Fishing speed >3.5kn	2278 (100%) n: 3266	1211 (99%) n: 3061	351 (100%) n: 3167	431 (100%) n: 3520	3107 (100%) n: 2794	939 (100%) n: 2380	1660 (99%) n: 2222	1361 (97%) n: 2132	1520 (100%) n: 1300
Headline height >15m	2242 (98%) n: 3243	1209 (99%) n: 3043	345 (98%) n: 3150	431 (100%) n: 3512	3107 (100%) n: 2790	939 (100%) n: 2359	1660 (99%) n: 2205	1353 (97%) n: 2128	1520 (100%) n: 1297
Headline height <90m	2242 (98%) n: 3243	1209 (99%) n: 3043	343 (97%) n: 3149	431 (100%) n: 3512	3107 (100%) n: 2789	939 (100%) n: 2359	1660 (99%) n: 2204	1353 (97%) n: 2128	1520 (100%) n: 1297
Fishing duration >15mins	2204 (97%) n: 3229	1209 (99%) n: 3038	343 (97%) n: 3140	431 (100%) n: 3501	3106 (100%) n: 2782	938 (100%) n: 2354	1659 (99%) n: 2198	1353 (97%) n: 2126	1520 (100%) n: 1295
Fishing duration <15h	2204 (97%) n: 3226	1206 (99%) n: 3037	343 (97%) n: 3138	431 (100%) n: 3501	3105 (100%) n: 2780	938 (100%) n: 2353	1647 (98%) n: 2195	1352 (97%) n: 2122	1520 (100%) n: 1294
Seabed depth >50m	2202 (97%) n: 3224	1206 (99%) n: 3037	343 (97%) n: 3138	431 (100%) n: 3501	3105 (100%) n: 2780	938 (100%) n: 2353	1647 (98%) n: 2195	1352 (97%) n: 2122	1520 (100%) n: 1294
Seabed depth <350m	2200 (96%) n: 3222	1206 (99%) n: 3033	343 (97%) n: 3134	431 (100%) n: 3500	3105 (100%) n: 2779	938 (100%) n: 2351	1647 (98%) n: 2193	1337 (96%) n: 2120	1520 (100%) n: 1293
Start time >0	2174 (95%) n: 3198	1190 (98%) n: 3025	339 (96%) n: 3119	420 (97%) n: 3458	3049 (98%) n: 2766	915 (97%) n: 2334	1627 (97%) n: 2182	1288 (92%) n: 2108	1486 (98%) n: 1280
SA subset	2174 (95%) n: 3198	1190 (98%) n: 3025	339 (96%) n: 3119	420 (97%) n: 3458	3049 (98%) n: 2766	915 (97%) n: 2334	1627 (97%) n: 2182	1288 (92%) n: 2108	1486 (98%) n: 1280
No effort allocation	2174 (95%) n: 3196	1190 (98%) n: 2486	339 (96%) n: 2363	420 (97%) n: 2581	3049 (98%) n: 2593	915 (97%) n: 1705	1627 (97%) n: 1587	1288 (92%) n: 1990	1486 (98%) n: 1260
Core fleet selection	2084 (91%) n: 2598	1069 (88%) n: 1904	331 (94%) n: 1725	417 (97%) n: 2103	3000 (96%) n: 2204	801 (85%) n: 1109	1245 (74%) n: 1223	1000 (71%) n: 1809	1405 (92%) n: 1191

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	2230 (100%) n: 1434	1569 (100%) n: 1486	1859 (100%) n: 1247	2687 (100%) n: 1484	2728 (100%) n: 1445	1831 (100%) n: 1549	2437 (100%) n: 1368	2789 (100%) n: 1678	3255 (100%) n: 2307
Fishing speed not null	2230 (100%) n: 1434	1569 (100%) n: 1486	1859 (100%) n: 1247	2687 (100%) n: 1484	2728 (100%) n: 1445	1831 (100%) n: 1549	2437 (100%) n: 1368	2789 (100%) n: 1678	3255 (100%) n: 2307
Fishing speed lt 10kts	2230 (100%) n: 1434	1569 (100%) n: 1486	1859 (100%) n: 1247	2687 (100%) n: 1484	2728 (100%) n: 1445	1831 (100%) n: 1549	2437 (100%) n: 1368	2777 (100%) n: 1675	3255 (100%) n: 2303
Start date not null	2230 (100%) n: 1434	1569 (100%) n: 1486	1859 (100%) n: 1247	2687 (100%) n: 1484	2728 (100%) n: 1445	1831 (100%) n: 1549	2437 (100%) n: 1368	2777 (100%) n: 1675	3255 (100%) n: 2303
End date not null	2230 (100%) n: 1434	1569 (100%) n: 1486	1859 (100%) n: 1247	2687 (100%) n: 1484	2728 (100%) n: 1445	1831 (100%) n: 1549	2437 (100%) n: 1368	2777 (100%) n: 1675	3255 (100%) n: 2303
Start depth not null	2230 (100%) n: 1434	1569 (100%) n: 1486	1859 (100%) n: 1247	2687 (100%) n: 1484	2728 (100%) n: 1445	1831 (100%) n: 1549	2437 (100%) n: 1368	2777 (100%) n: 1675	3255 (100%) n: 2303
Headline height not null	2230 (100%) n: 1434	1569 (100%) n: 1486	1859 (100%) n: 1247	2687 (100%) n: 1484	2728 (100%) n: 1445	1831 (100%) n: 1549	2437 (100%) n: 1368	2777 (100%) n: 1675	3255 (100%) n: 2303
Fishing speed >3.5kn	2223 (100%) n: 1412	1562 (100%) n: 1465	1857 (100%) n: 1229	2685 (100%) n: 1454	2720 (100%) n: 1381	1825 (100%) n: 1503	2436 (100%) n: 1357	2770 (99%) n: 1625	3249 (100%) n: 2269
Headline height >15m	2187 (98%) n: 1395	1562 (100%) n: 1464	1857 (100%) n: 1229	2685 (100%) n: 1454	2718 (100%) n: 1379	1825 (100%) n: 1503	2411 (99%) n: 1354	2770 (99%) n: 1625	3249 (100%) n: 2263
Headline height <90m	2187 (98%) n: 1395	1562 (100%) n: 1463	1857 (100%) n: 1229	2685 (100%) n: 1454	2718 (100%) n: 1379	1825 (100%) n: 1503	2411 (99%) n: 1354	2769 (99%) n: 1624	3249 (100%) n: 2263
Fishing duration >15mins	2185 (98%) n: 1394	1562 (100%) n: 1459	1856 (100%) n: 1224	2685 (100%) n: 1449	2718 (100%) n: 1378	1825 (100%) n: 1498	2411 (99%) n: 1352	2769 (99%) n: 1624	3249 (100%) n: 2260
Fishing duration <15h	2185 (98%) n: 1392	1562 (100%) n: 1457	1856 (100%) n: 1224	2685 (100%) n: 1448	2718 (100%) n: 1378	1825 (100%) n: 1497	2411 (99%) n: 1352	2769 (99%) n: 1624	3238 (99%) n: 2257
Seabed depth >50m	2185 (98%) n: 1392	1562 (100%) n: 1457	1856 (100%) n: 1224	2685 (100%) n: 1448	2718 (100%) n: 1378	1825 (100%) n: 1497	2411 (99%) n: 1352	2769 (99%) n: 1624	3238 (99%) n: 2257
Seabed depth <350m	2185 (98%) n: 1390	1562 (100%) n: 1457	1856 (100%) n: 1224	2685 (100%) n: 1448	2718 (100%) n: 1378	1825 (100%) n: 1491	2411 (99%) n: 1352	2769 (99%) n: 1623	3238 (99%) n: 2256
Start time >0	2153 (97%) n: 1382	1555 (99%) n: 1453	1825 (98%) n: 1217	2567 (96%) n: 1438	2664 (98%) n: 1370	1782 (97%) n: 1483	2409 (99%) n: 1349	2763 (99%) n: 1617	3238 (99%) n: 2252
SA subset	2153 (97%) n: 1382	1555 (99%) n: 1453	1825 (98%) n: 1217	2567 (96%) n: 1438	2664 (98%) n: 1370	1782 (97%) n: 1483	2409 (99%) n: 1349	2763 (99%) n: 1617	3238 (99%) n: 2252
No effort allocation	2153 (97%) n: 1382	1555 (99%) n: 1390	1825 (98%) n: 1216	2567 (96%) n: 1436	2664 (98%) n: 1370	1761 (96%) n: 1447	2409 (99%) n: 1336	2763 (99%) n: 1616	3238 (99%) n: 2252
Core fleet selection	2139 (96%) n: 1301	1510 (96%) n: 1344	1780 (96%) n: 1169	2561 (95%) n: 1420	2655 (97%) n: 1362	1727 (94%) n: 1409	2388 (98%) n: 1212	2756 (99%) n: 1599	3145 (97%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	3533 (100%) n: 2542	2555 (100%) n: 1919	2456 (100%) n: 1800	2077 (100%) n: 1038	1691 (100%) n: 1343
Fishing speed not null	3533 (100%) n: 2542	2555 (100%) n: 1919	2456 (100%) n: 1800	2077 (100%) n: 1038	1691 (100%) n: 1343
Fishing speed lt 10kts	3533 (100%) n: 2542	2555 (100%) n: 1919	2456 (100%) n: 1800	2077 (100%) n: 1038	1691 (100%) n: 1343
Start date not null	3533 (100%) n: 2542	2555 (100%) n: 1919	2456 (100%) n: 1800	2077 (100%) n: 1038	1691 (100%) n: 1343
End date not null	3533 (100%) n: 2542	2555 (100%) n: 1919	2456 (100%) n: 1800	2077 (100%) n: 1038	1677 (99%) n: 1342
Start depth not null	3533 (100%) n: 2542	2555 (100%) n: 1919	2456 (100%) n: 1800	2077 (100%) n: 1038	1677 (99%) n: 1342
Headline height not null	3533 (100%) n: 2542	2555 (100%) n: 1919	2456 (100%) n: 1800	2077 (100%) n: 1038	1677 (99%) n: 1342
Fishing speed >3.5kn	3530 (100%) n: 2430	2555 (100%) n: 1919	2456 (100%) n: 1794	2077 (100%) n: 1037	1677 (99%) n: 1342
Headline height >15m	3525 (100%) n: 2426	2555 (100%) n: 1917	2456 (100%) n: 1792	2077 (100%) n: 1035	1675 (99%) n: 1336
Headline height <90m	3525 (100%) n: 2426	2555 (100%) n: 1917	2456 (100%) n: 1792	2077 (100%) n: 1035	1675 (99%) n: 1336
Fishing duration >15mins	3525 (100%) n: 2421	2521 (99%) n: 1912	2456 (100%) n: 1785	2076 (100%) n: 1032	1675 (99%) n: 1331
Fishing duration <15h	3525 (100%) n: 2421	2519 (99%) n: 1910	2456 (100%) n: 1785	2075 (100%) n: 1031	1675 (99%) n: 1330
Seabed depth >50m	3525 (100%) n: 2421	2519 (99%) n: 1910	2456 (100%) n: 1784	2075 (100%) n: 1031	1675 (99%) n: 1330
Seabed depth <350m	3525 (100%) n: 2419	2519 (99%) n: 1910	2456 (100%) n: 1783	2075 (100%) n: 1030	1675 (99%) n: 1329
Start time >0	3523 (100%) n: 2415	2437 (95%) n: 1902	2453 (100%) n: 1781	2072 (100%) n: 1029	1674 (99%) n: 1326
SA subset	3523 (100%) n: 2415	2437 (95%) n: 1902	2453 (100%) n: 1781	2072 (100%) n: 1029	1674 (99%) n: 1326
No effort allocation	3523 (100%) n: 2414	2437 (95%) n: 1898	2453 (100%) n: 1775	2072 (100%) n: 1029	1674 (99%) n: 1306
Core fleet selection	3201 (91%) n: 2235	2369 (93%) n: 1744	2377 (97%) n: 1603	2036 (98%) n: 953	1643 (97%) n: 1157

Table D.45: Summary of the JMA3 MW pred JMM event threshold dataset after core fleet selection. 'Records' indicates the number of rows (events) in the dataset, and 'Records caught' indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	2 056.44	49.24
1994	5	40	2 090	5 313.80	2 573.59	33.88
1995	6	38	1 937	5 281.88	3 001.59	31.75
1996	5	31	1 698	4 946.23	5 108.93	58.13
1997	6	23	1 813	5 486.45	5 091.46	51.19
1998	7	36	2 393	6 500.45	5 884.71	47.89
1999	7	29	2 269	6 680.20	6 911.94	56.63
2000	7	34	2 351	7 026.89	4 499.54	59.00
2001	7	29	2 174	7 230.32	1 329.58	28.01
2002	8	32	2 598	8 281.02	2 084.10	36.49
2003	8	33	1 904	6 719.12	1 068.91	19.33
2004	8	23	1 725	6 488.50	331.49	9.10
2005	8	28	2 103	7 303.95	417.16	8.75
2006	8	33	2 204	8 642.28	2 999.76	32.40
2007	7	27	1 109	4 762.03	801.42	23.99
2008	7	27	1 223	5 763.20	1 244.97	17.17
2009	7	37	1 809	8 957.70	996.44	12.71
2010	6	25	1 191	5 181.56	1 405.33	33.50
2011	6	21	1 301	5 811.68	2 138.53	32.90
2012	6	27	1 344	5 844.70	1 509.72	28.65
2013	6	25	1 169	4 960.32	1 780.26	40.80
2014	7	36	1 420	6 220.82	2 560.56	44.37
2015	7	37	1 362	6 240.75	2 654.53	40.60
2016	8	48	1 409	6 312.63	1 726.86	25.27
2017	6	29	1 212	6 426.48	2 388.00	47.36
2018	7	33	1 599	7 557.02	2 756.03	49.59
2019	7	36	2 156	9 997.48	3 145.42	33.67
2020	7	44	2 235	10 344.52	3 201.43	30.56
2021	7	32	1 744	7 955.15	2 369.30	42.20
2022	6	35	1 603	7 543.75	2 377.48	45.79
2023	6	25	953	4 692.92	2 035.90	76.50
2024	6	34	1 157	5 419.63	1 642.56	52.12

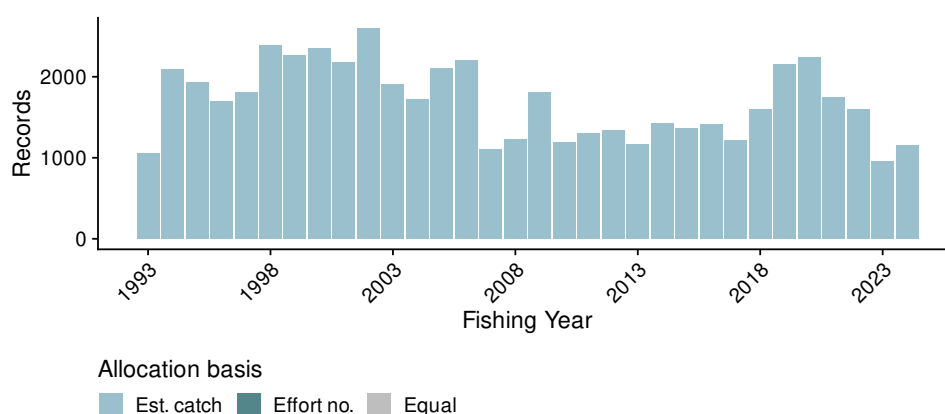


Figure D.214: The allocation approach used for attributing catches to records in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.46: Summary table for occurrence of positive catch in the JMA3 MW pred JMM event threshold series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	19 685.57	0.00	0.00	*
fyear	31	16 223.40	10.79	10.79	*
vessel_key	11	16 215.95	11.03	0.24	*
target_species	2	16 674.99	25.28	14.25	*
month	11	16 508.68	26.28	1.00	*
start_obs_fma	3	16 105.49	29.41	3.13	*
ns(log(fishing_duration), 3)	3	16 104.77	29.46	0.05	*
ns(log(start_time), 3)	3	16 063.01	29.68	0.22	*
ns(log(bottom_depth), 3)	3	15 959.27	30.04	0.36	*
ns(log(effort_height), 3)	3	15 957.41	30.13	0.09	*
ns(effort_speed, 3)	3	15 818.18	30.71	0.59	*

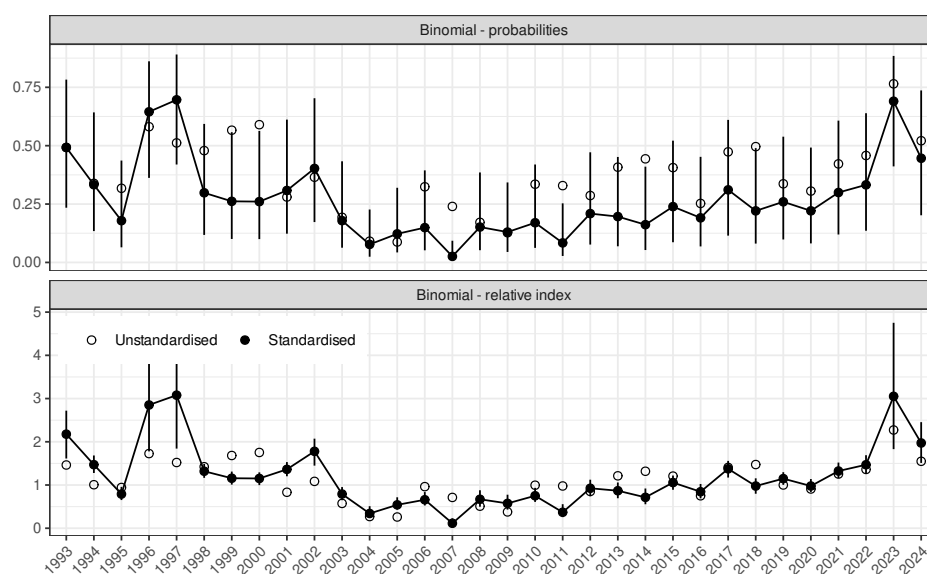


Figure D.215: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW pred JMM event threshold dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

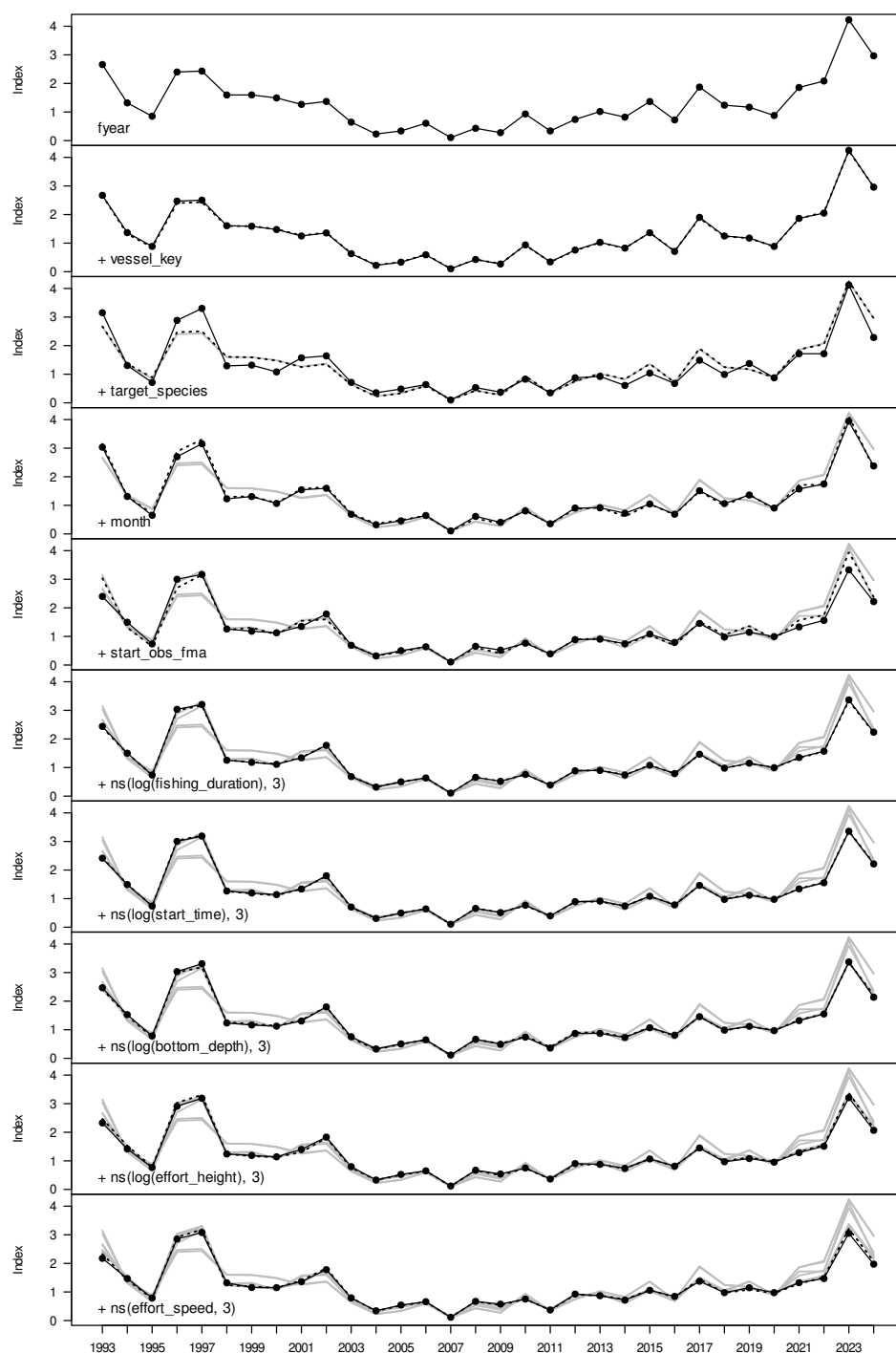


Figure D.216: Step plot for occurrence of catch in the JMA3 MW pred JMM event threshold dataset.

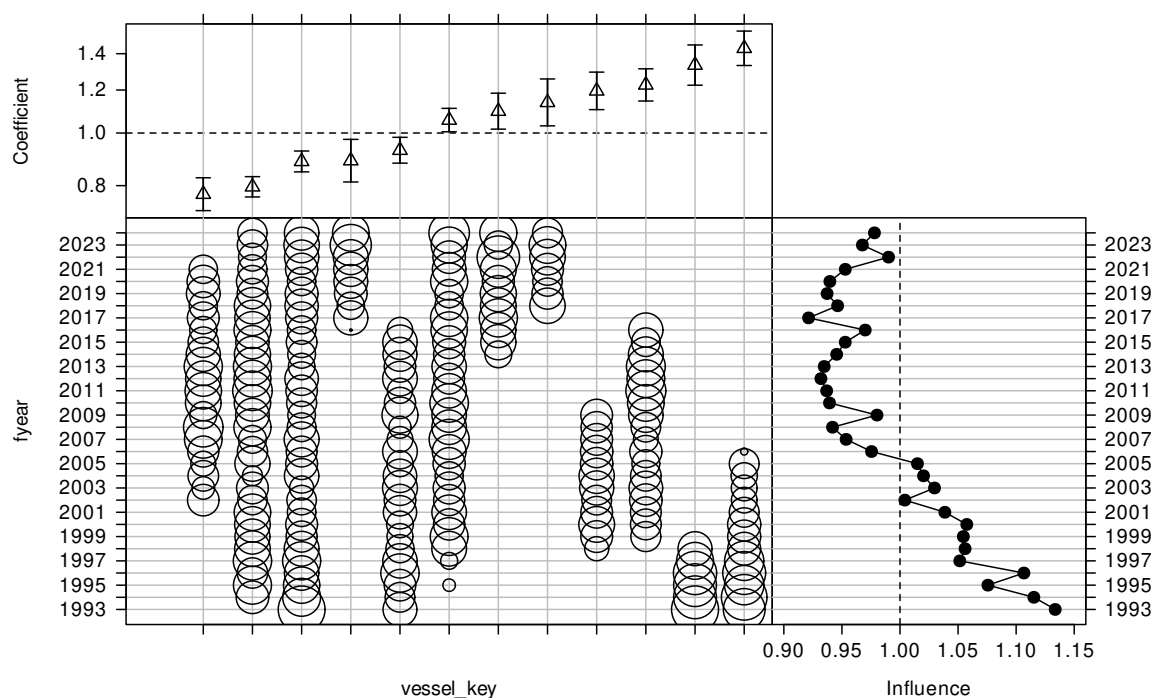


Figure D.217: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

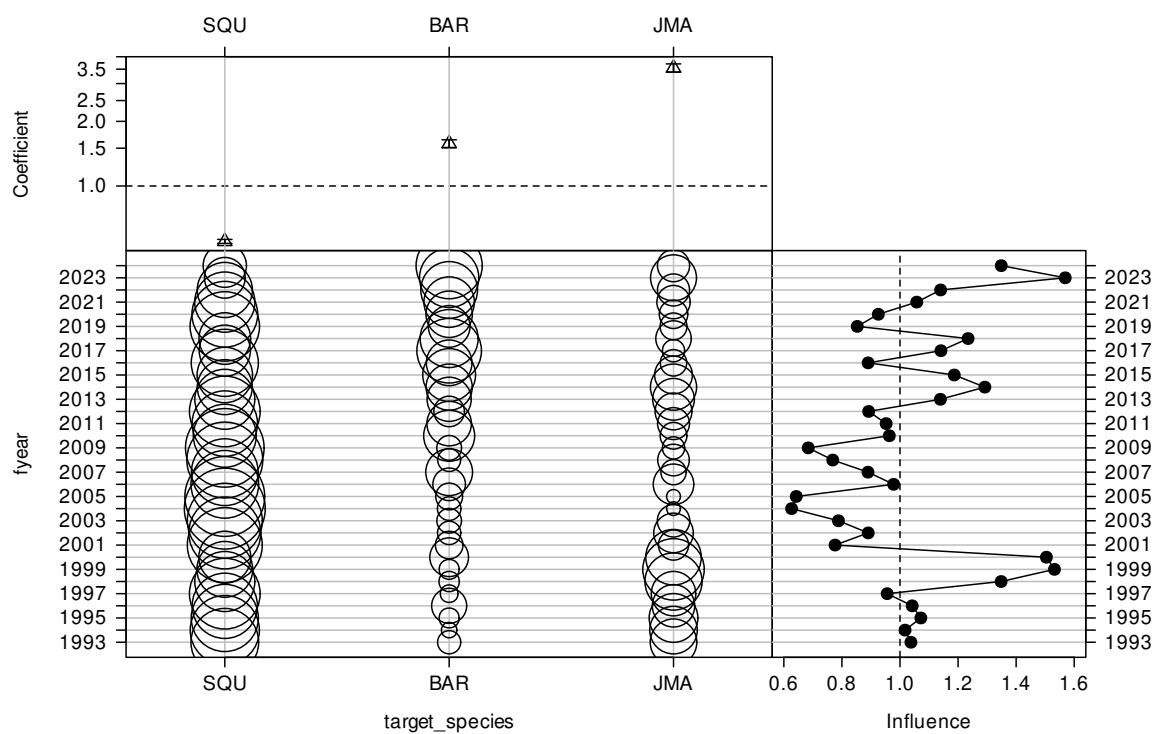


Figure D.218: CDI plot for target species for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

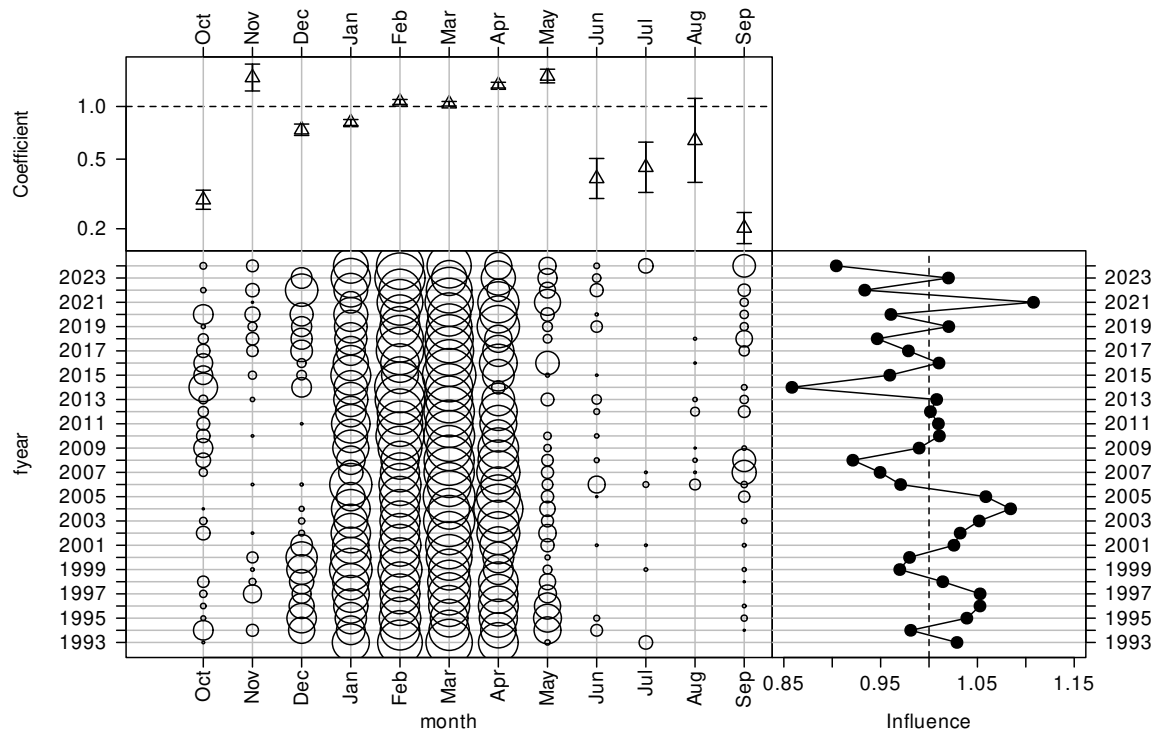


Figure D.219: CDI plot for month for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

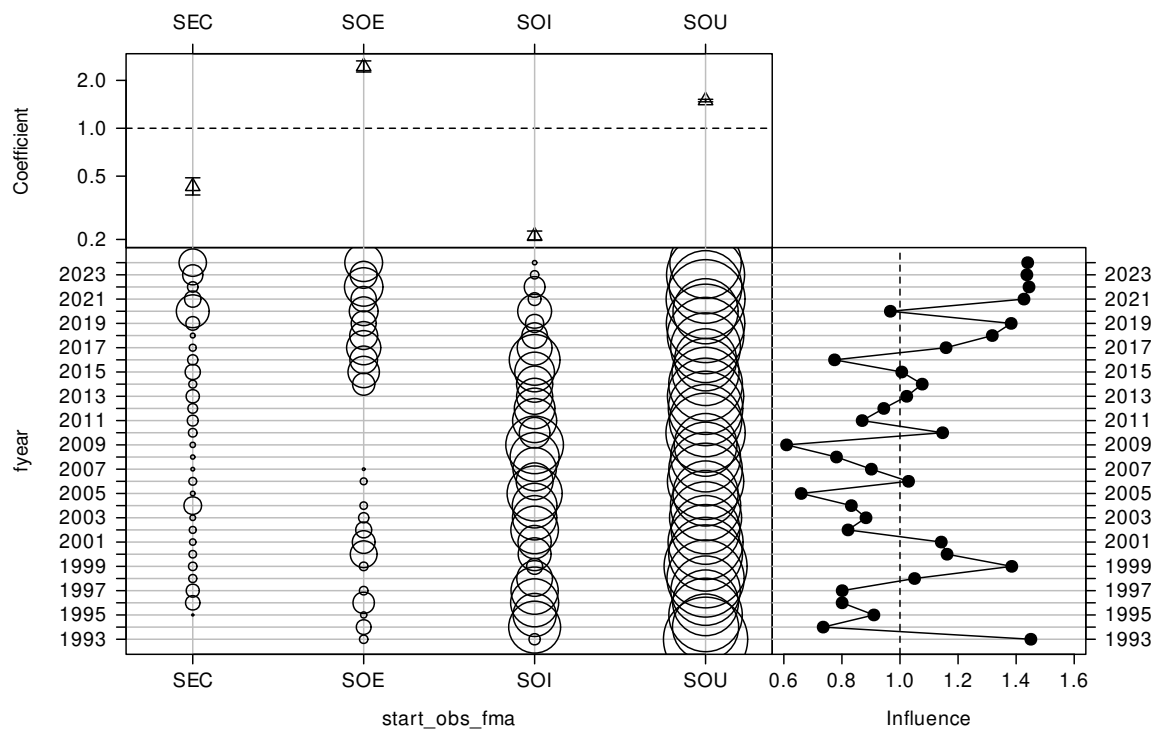


Figure D.220: CDI plot for start obs fma for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

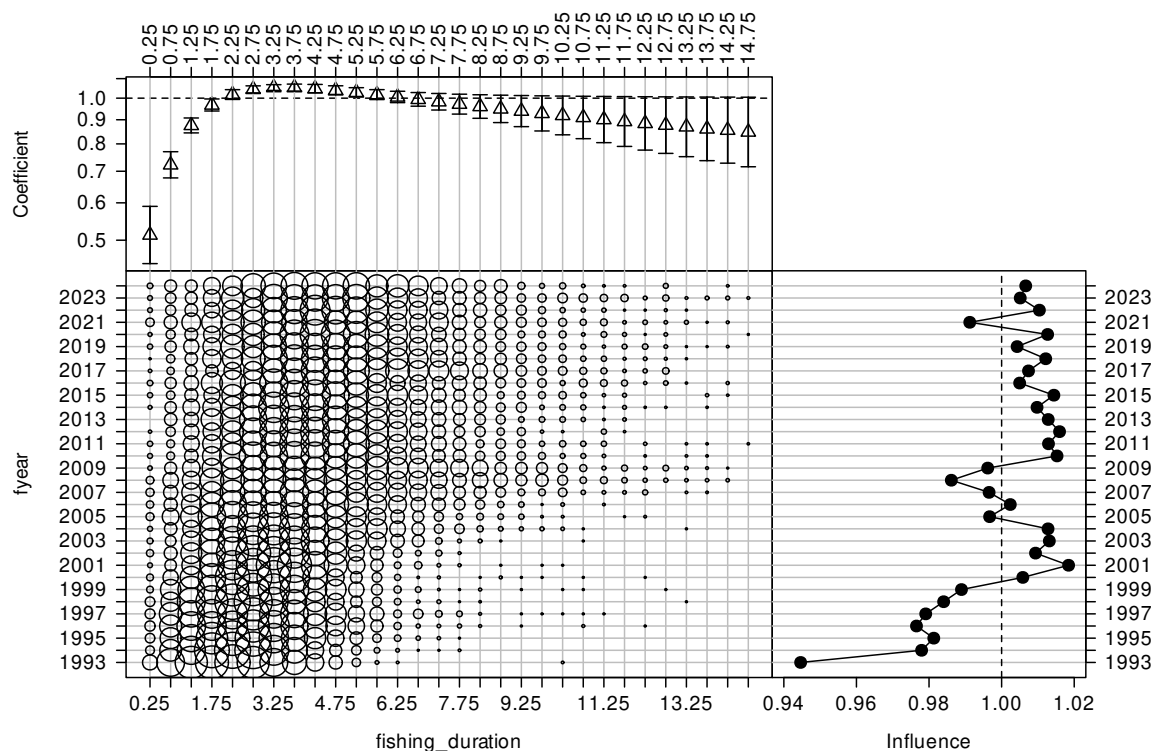


Figure D.221: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

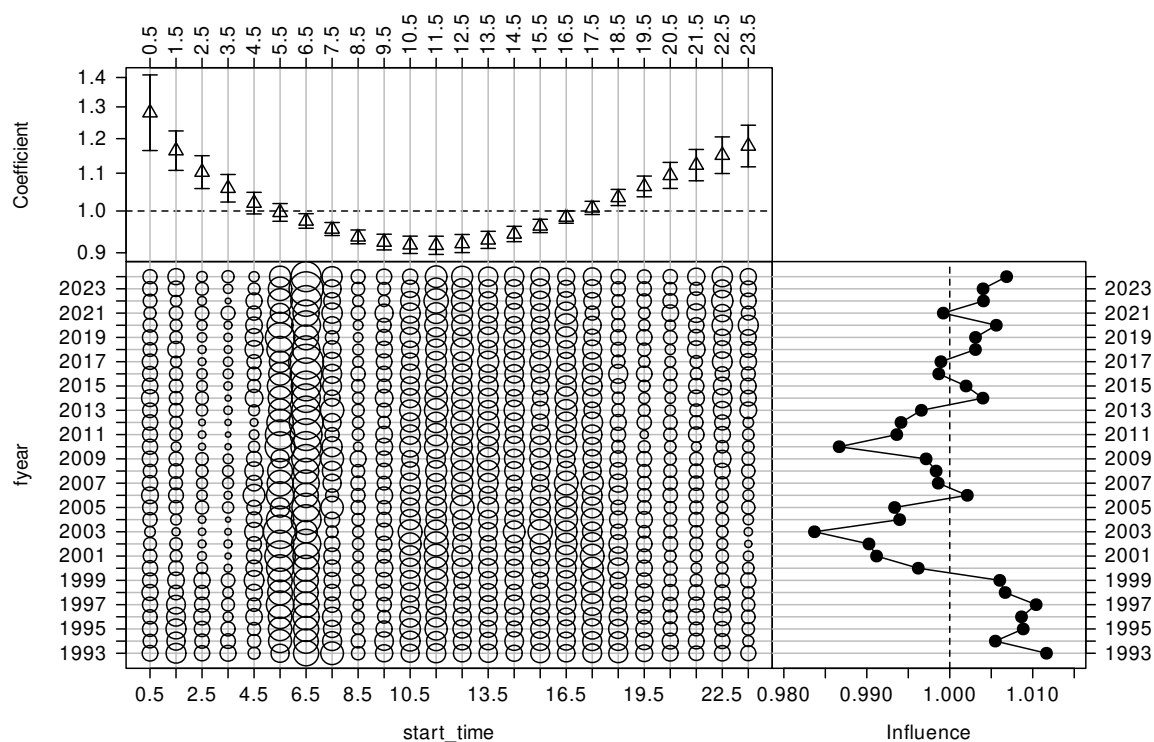


Figure D.222: CDI plot for start time for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

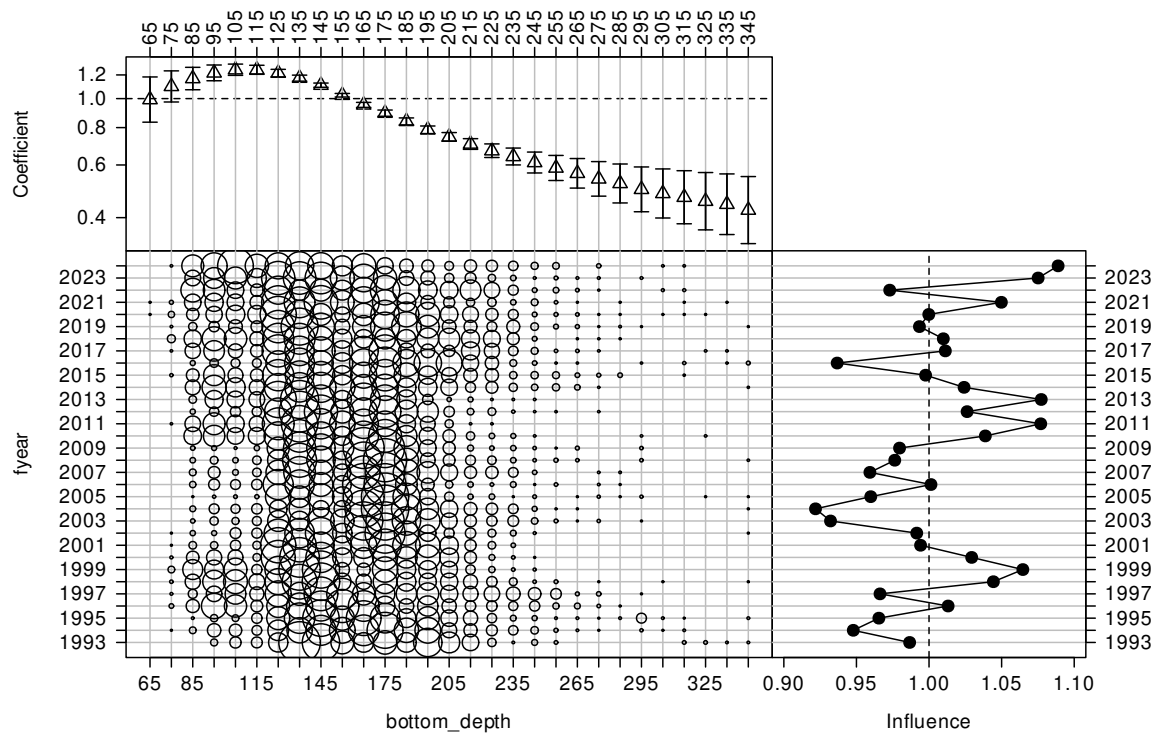


Figure D.223: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

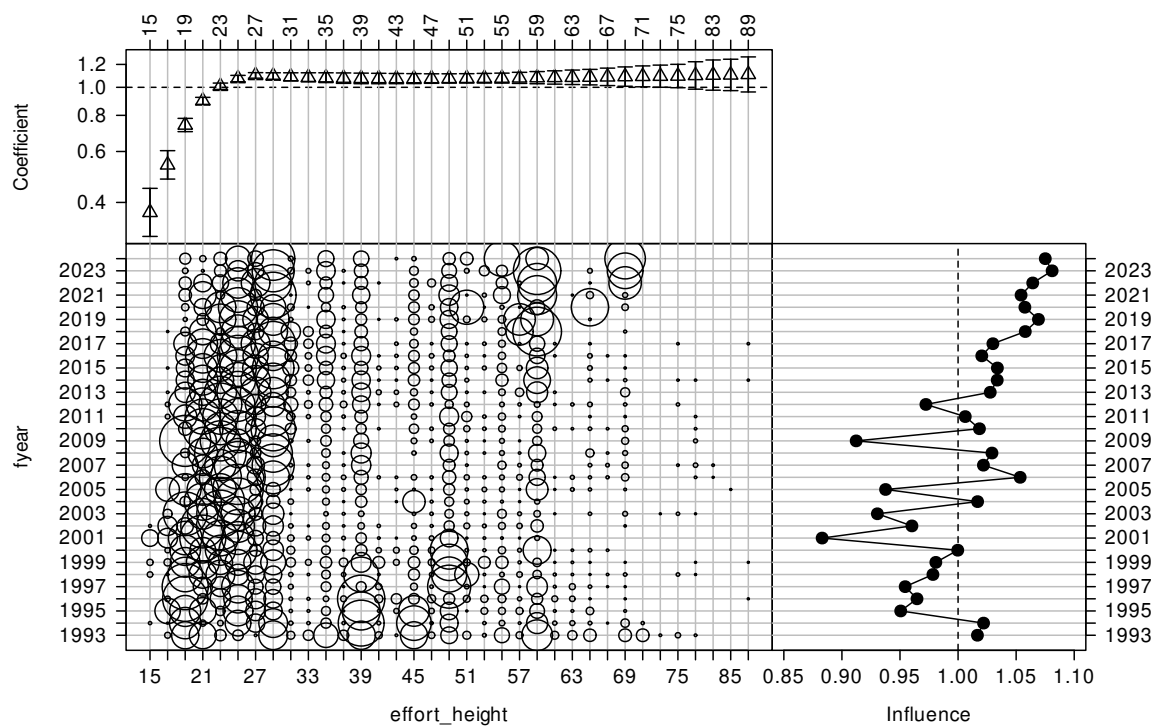


Figure D.224: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

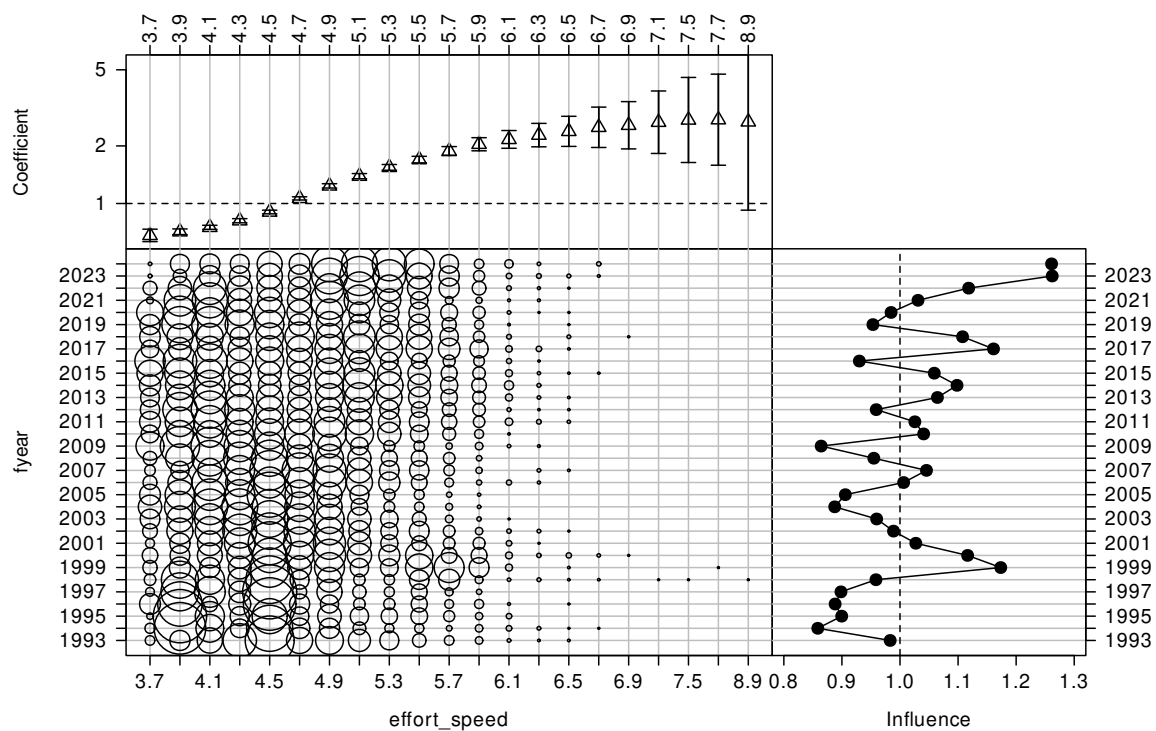


Figure D.225: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

Table D.47: Summary table for the Weibull model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	104459.2	0.00	0.00	*
fyear	31	104111.1	5.47	5.47	*
vessel_key	11	103910.7	8.43	2.97	*
target_species	2	103210.1	17.83	9.40	*
month	11	103144.8	19.00	1.16	*
start_obs_fma	3	102910.5	22.20	3.20	*
ns(log(fishing_duration), 3)	3	102857.2	22.99	0.79	*
ns(log(start_time), 3)	3	102769.4	24.24	1.25	*
ns(log(bottom_depth), 3)	3	102724.5	24.92	0.68	*
ns(log(effort_height), 3)	3	102722.8	25.02	0.10	*
ns(effort_speed, 3)	3	102676.2	25.73	0.70	*

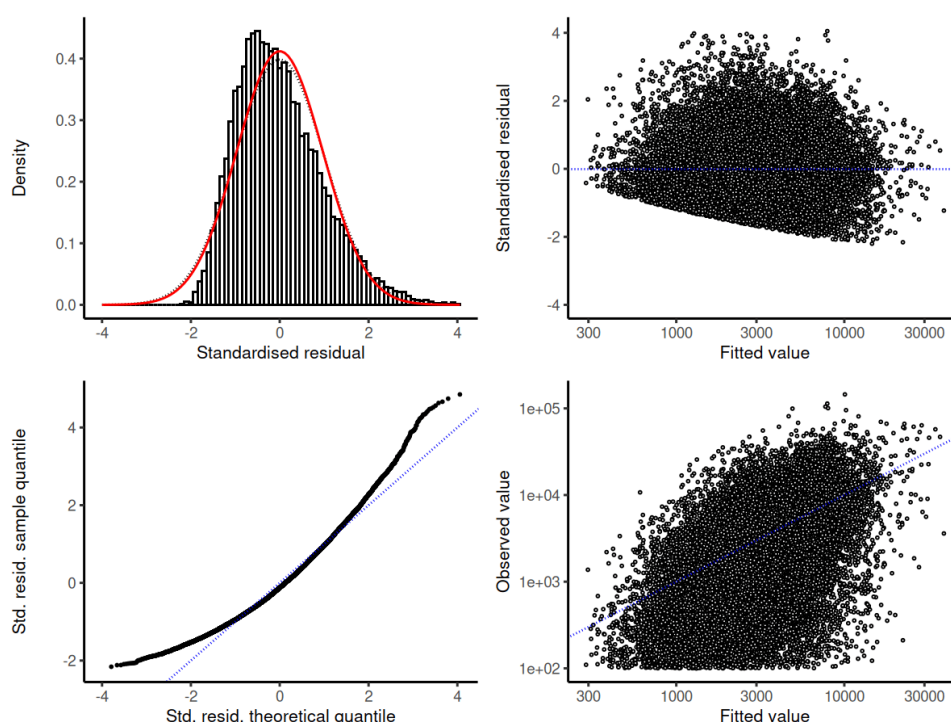


Figure D.226: Diagnostic plots for the selected Weibull model for positive catches in the JMA3 MW pred JMM event threshold dataset.

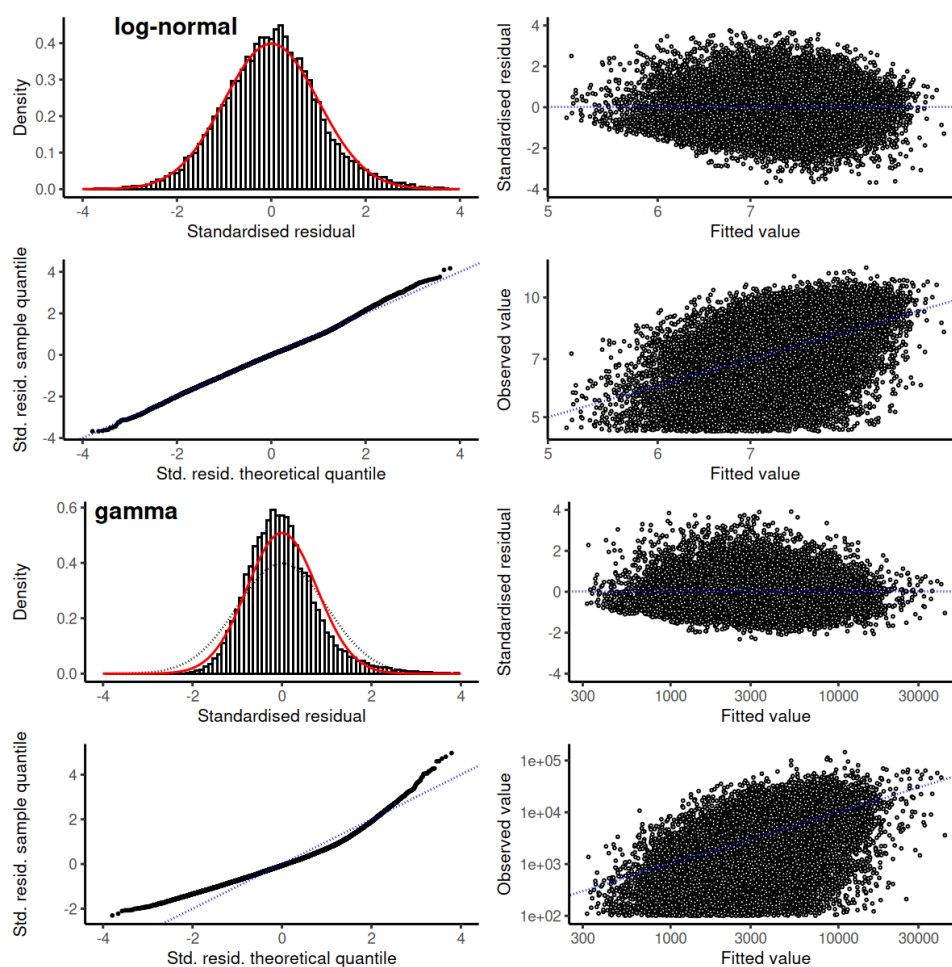


Figure D.227: Diagnostic plots for the alternative log-normal and gamma models considered for positive catches in the JMA3 MW pred JMM event threshold dataset.

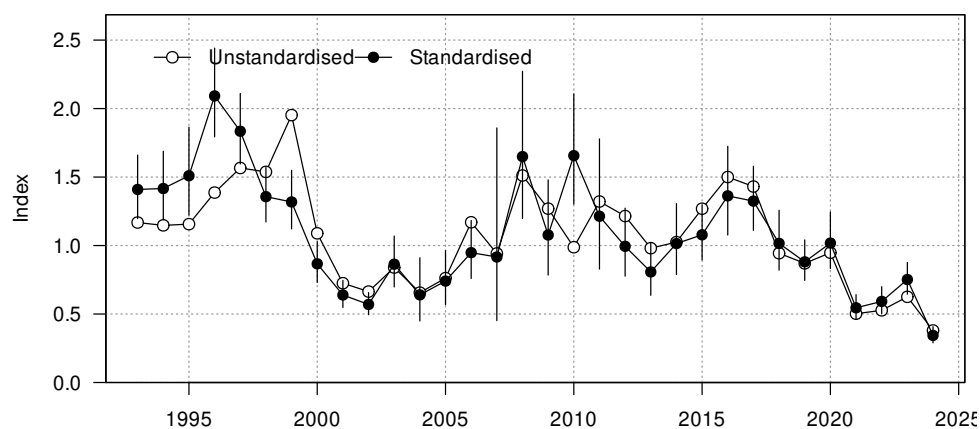


Figure D.228: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the Weibull model for the JMA3 MW pred JMM event threshold dataset.

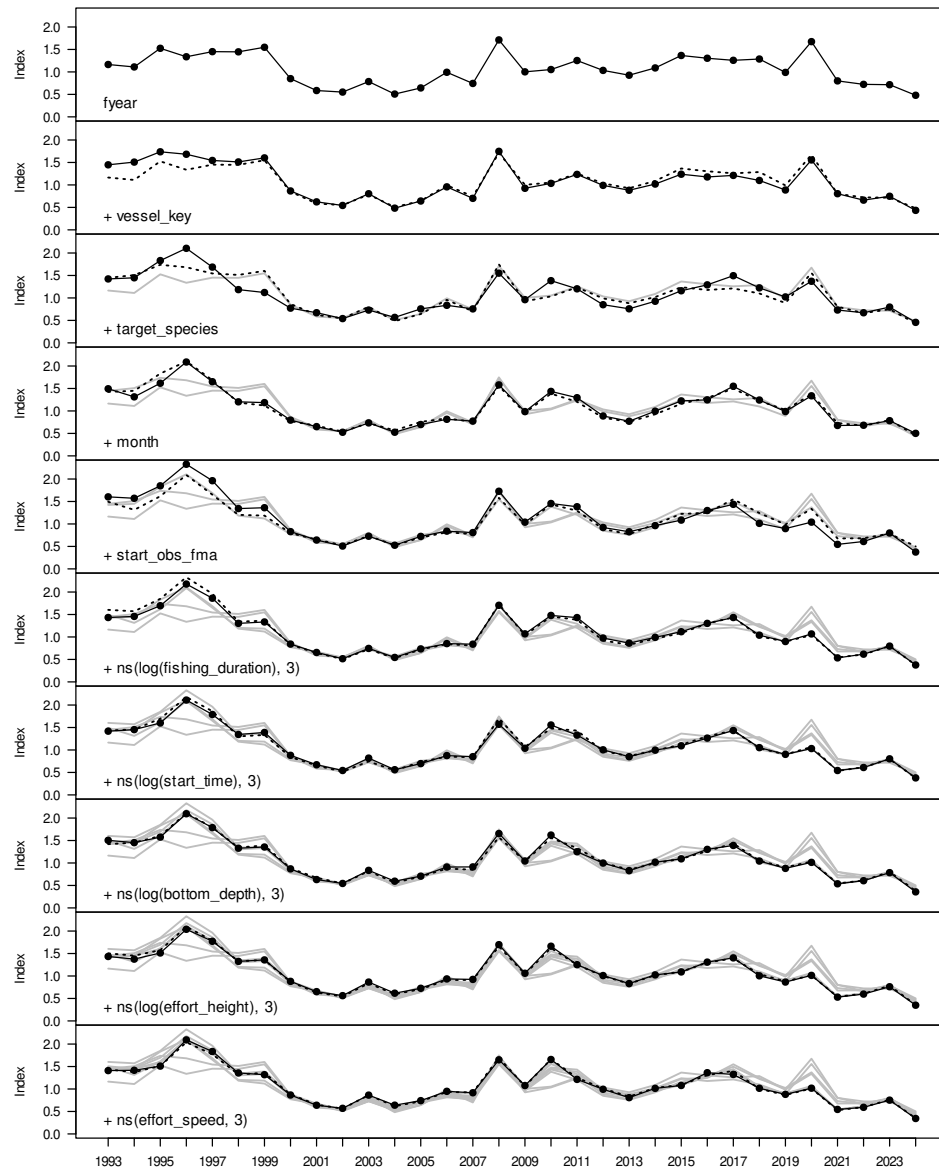


Figure D.229: Changes to the JMA3 MW pred JMM event threshold positive catch index as terms are successively entered into the Weibull model.

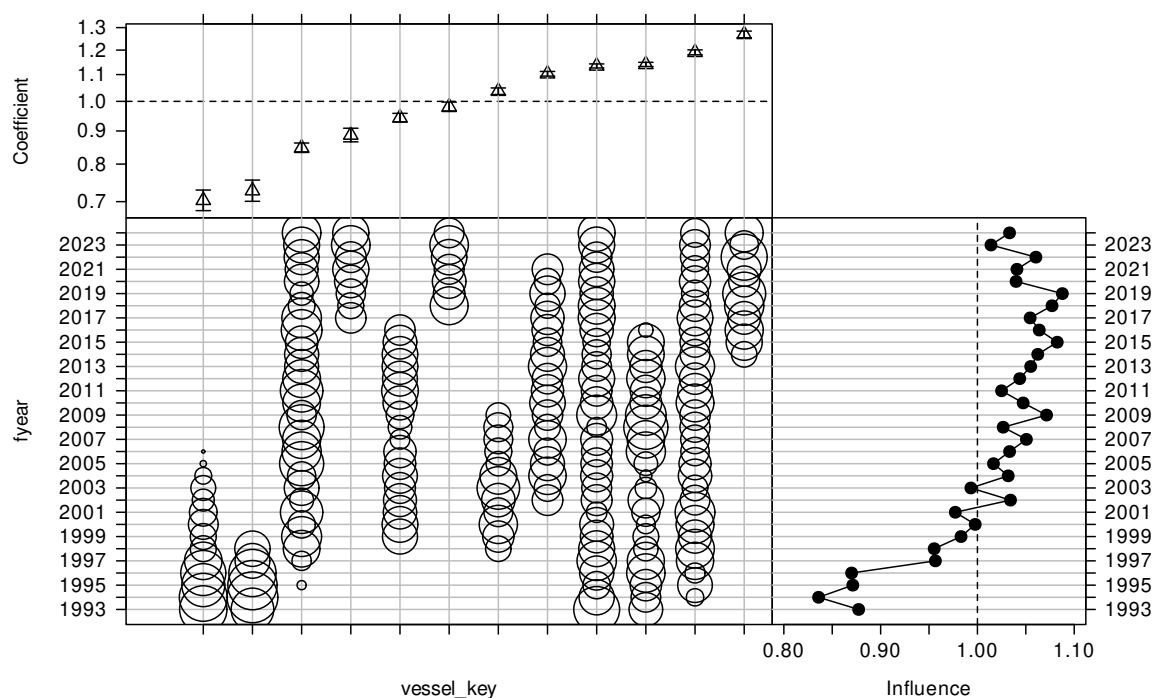


Figure D.230: CDI plot for vessel key for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

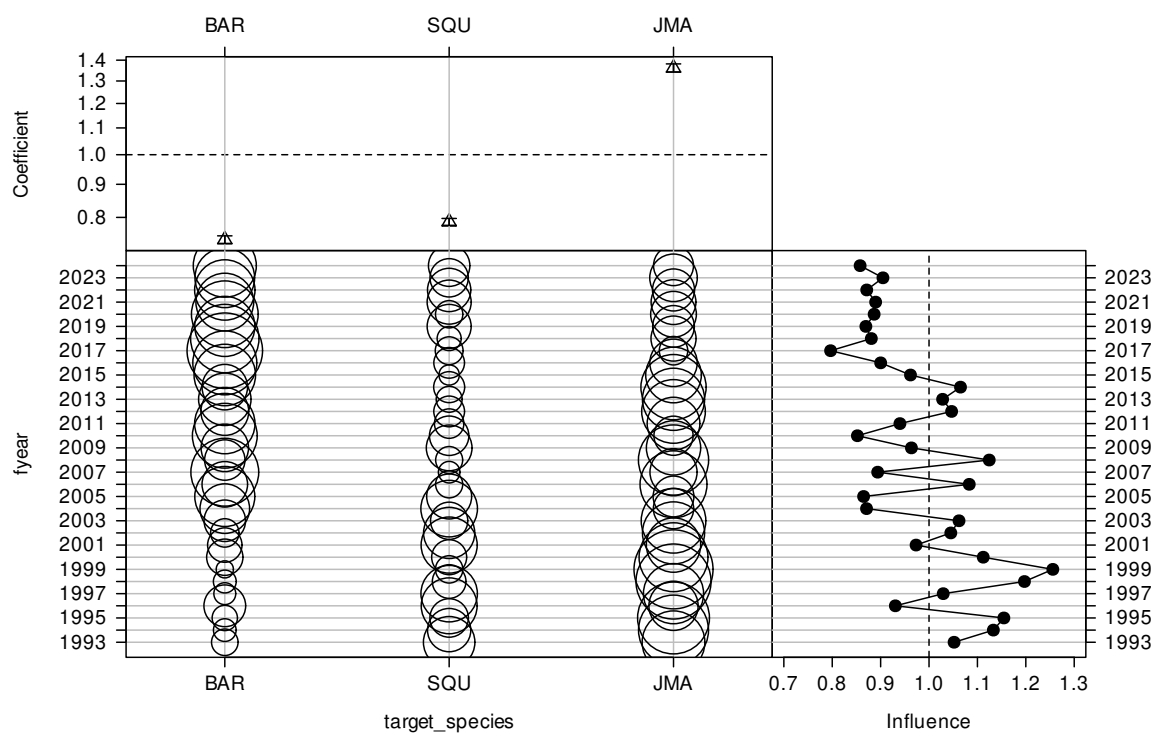


Figure D.231: CDI plot for target species for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

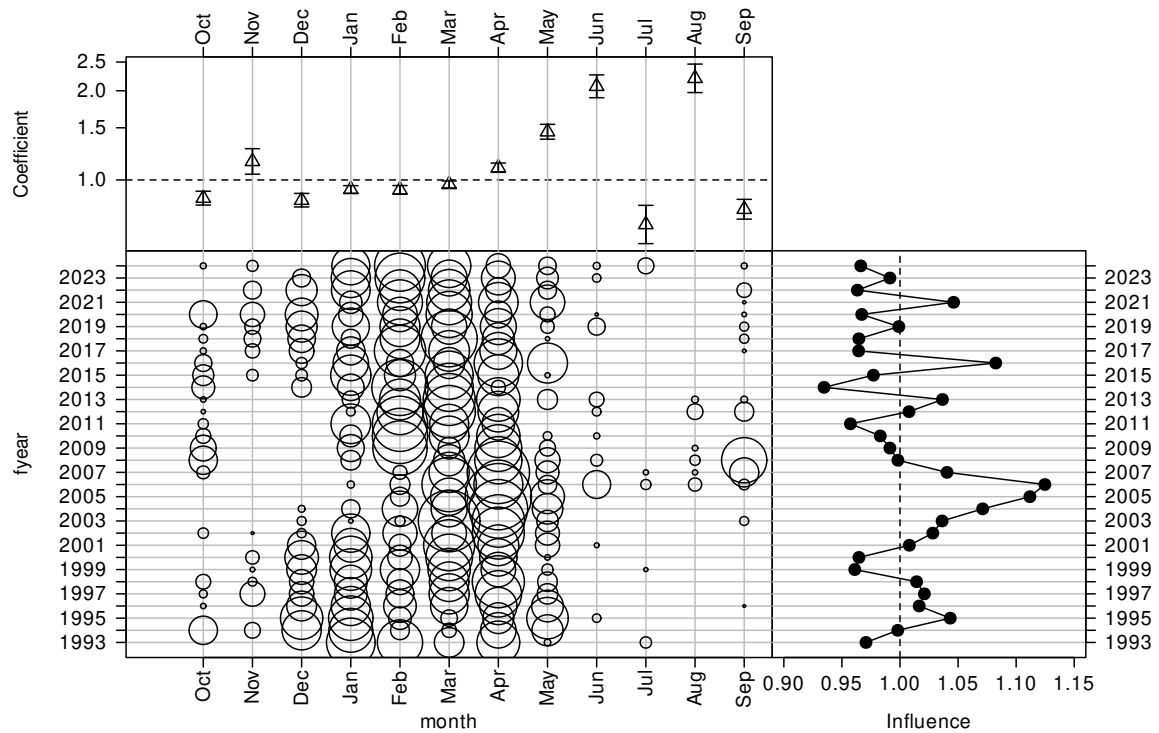


Figure D.232: CDI plot for month for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

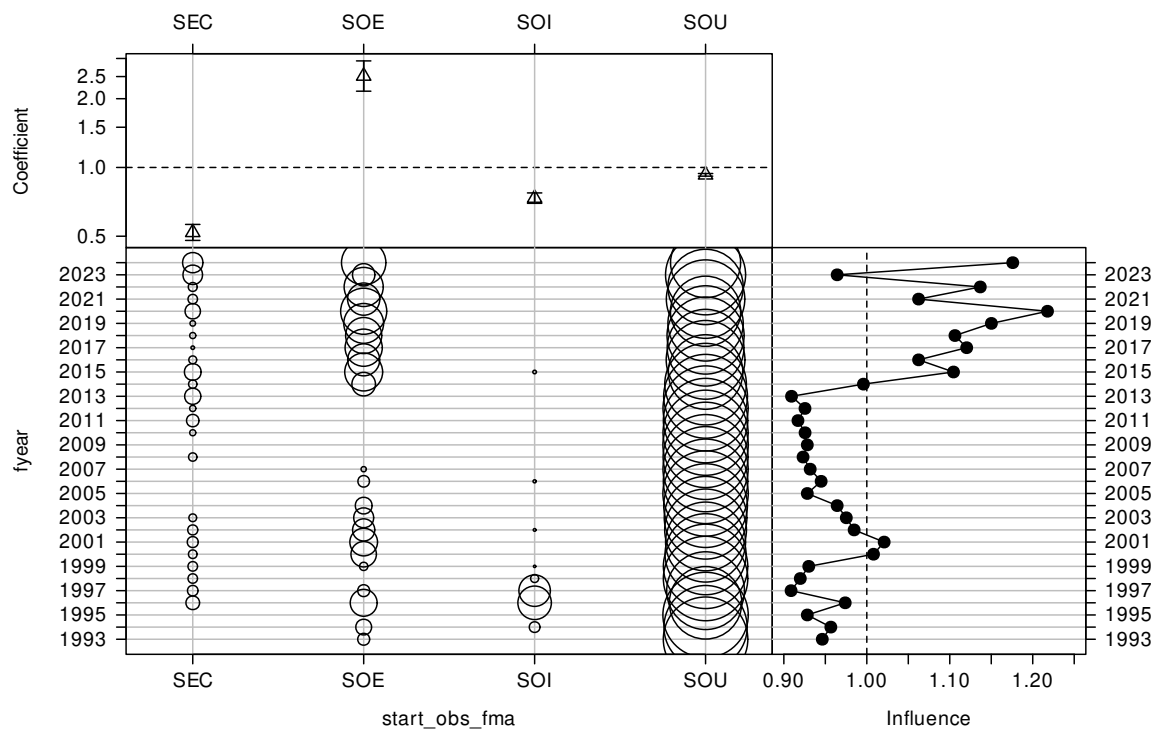


Figure D.233: CDI plot for start obs fma for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

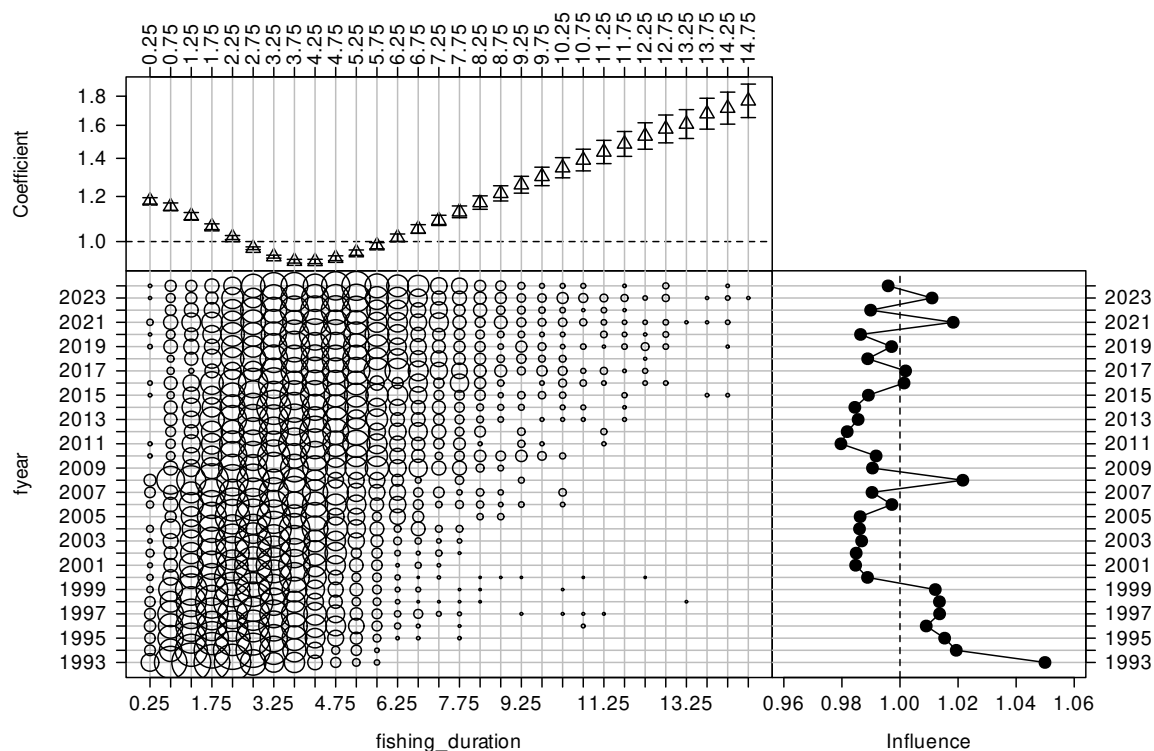


Figure D.234: CDI plot for fishing duration (h) for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

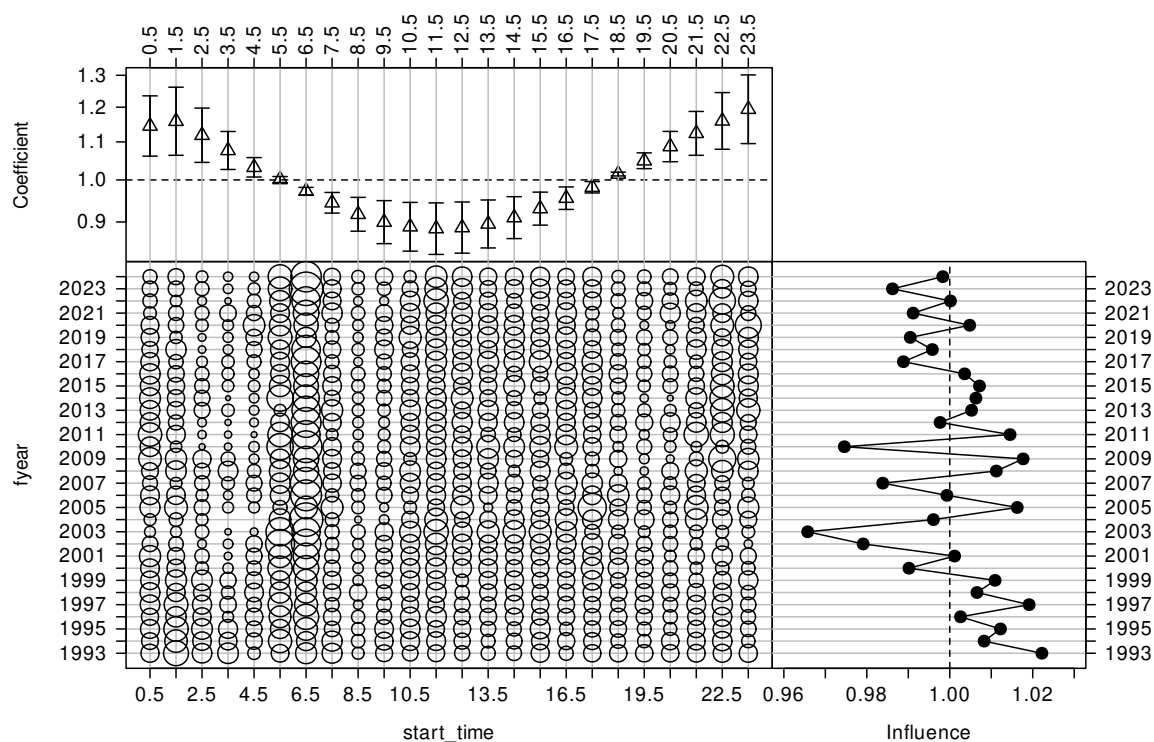


Figure D.235: CDI plot for start time for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

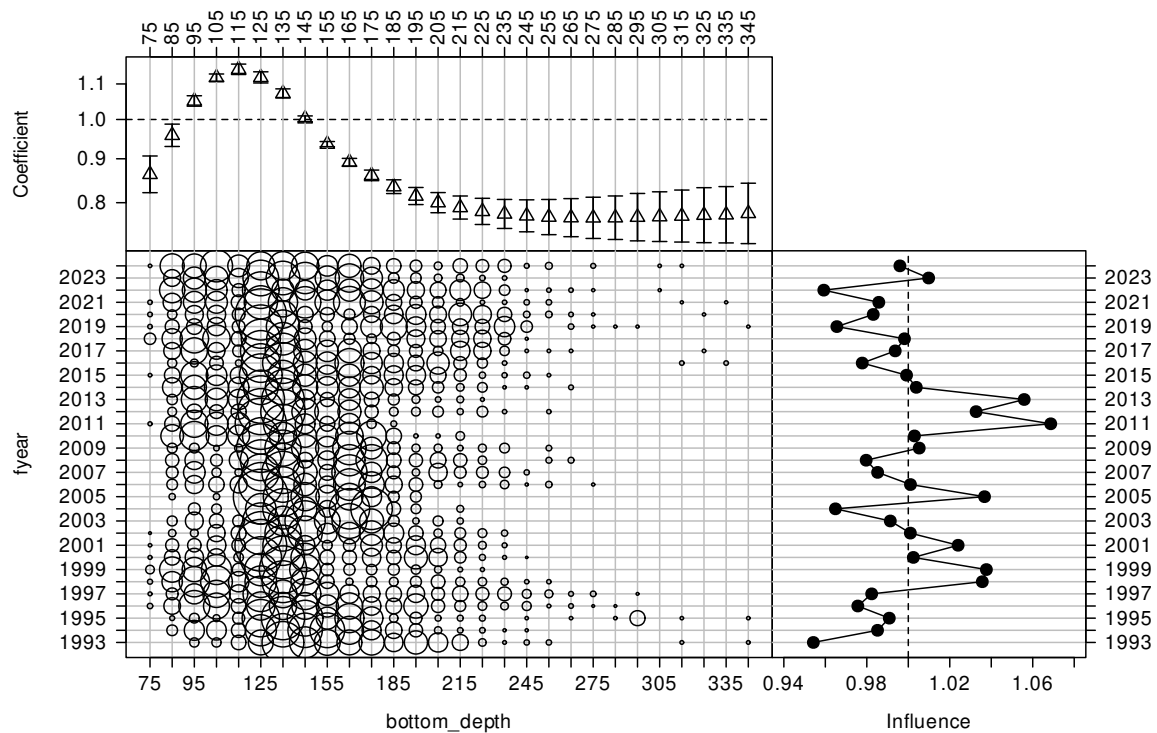


Figure D.236: CDI plot for bottom depth (m) for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

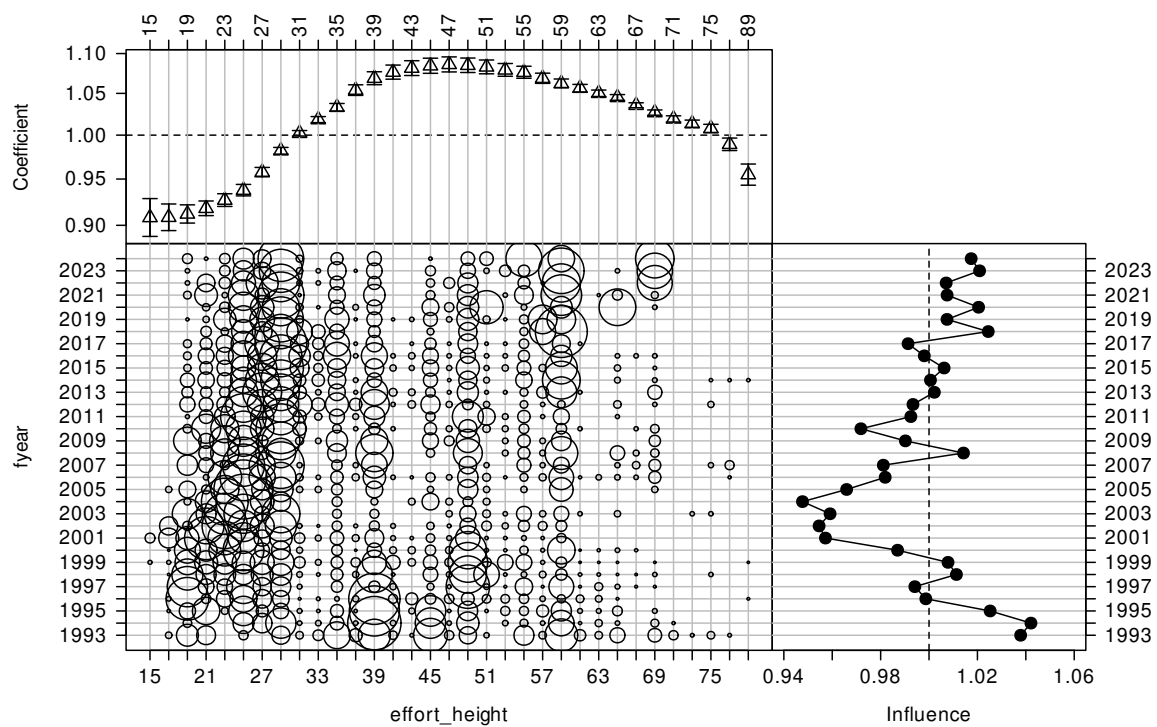


Figure D.237: CDI plot for effort height (m) for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

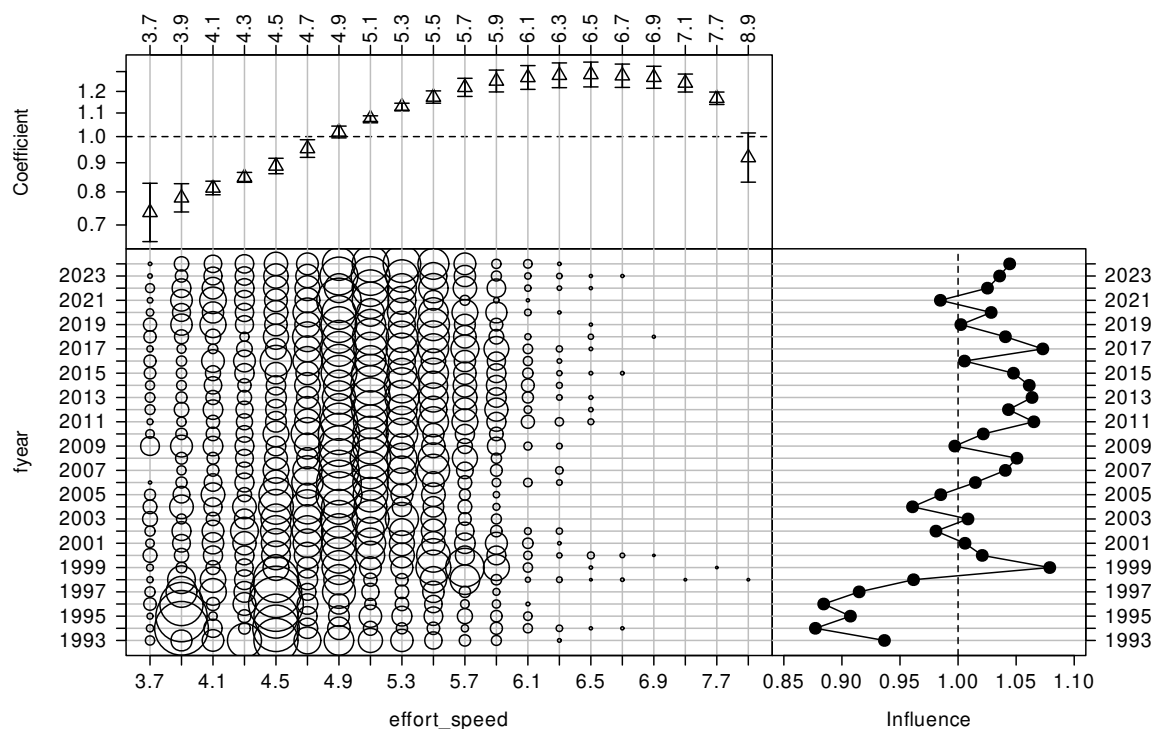


Figure D.238: CDI plot for effort speed for the Weibull model of positive catches in the JMA3 MW pred JMM event threshold catch-per-unit-effort dataset.

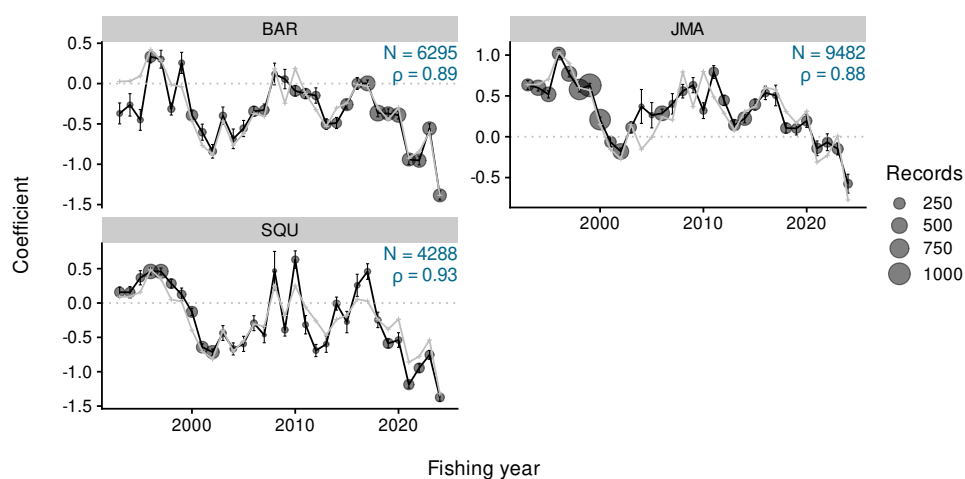


Figure D.239: Residual implied coefficients for target-year in the Weibull positive catch model for the JMA3 MW pred JMM event threshold dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

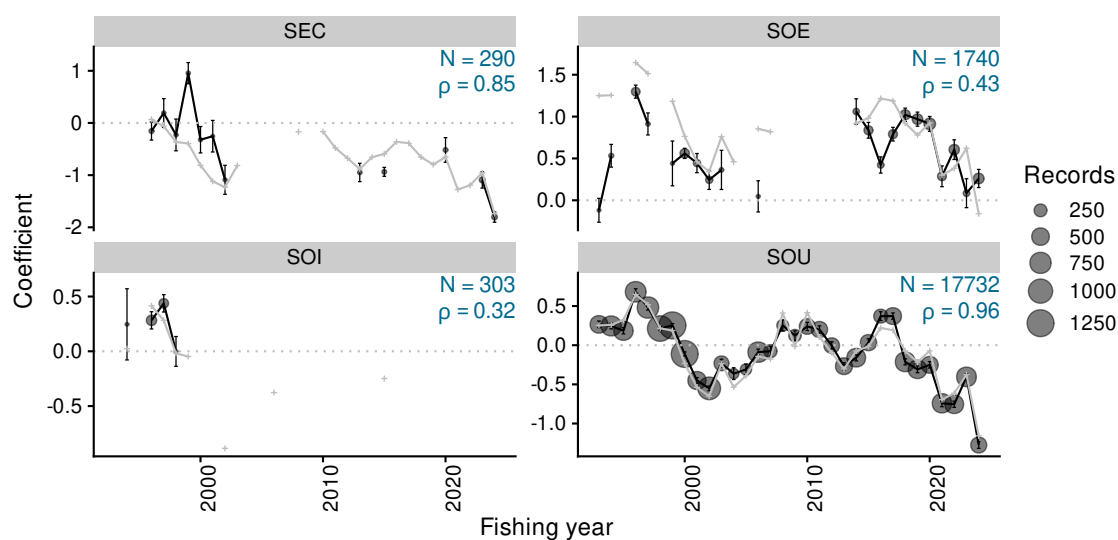


Figure D.240: Residual implied coefficients for area-year in the Weibull positive catch model for the JMA3 MW pred JMM event threshold dataset (black points, mean $\pm$ one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

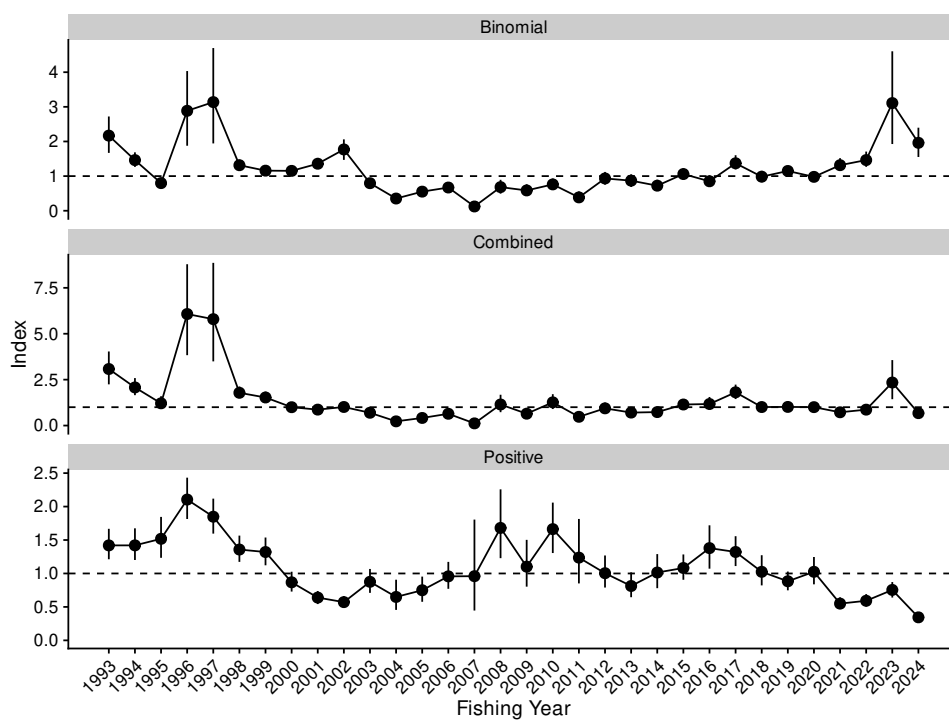


Figure D.241: Standardised indices and 95% confidence intervals for the JMA3 MW pred JMM event threshold dataset.

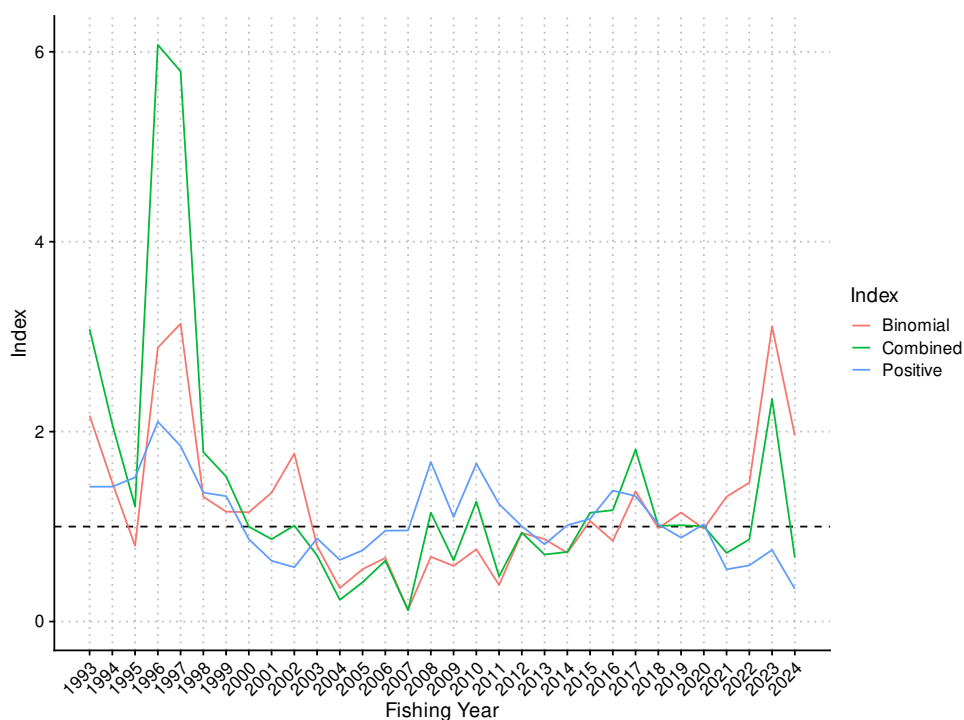


Figure D.242: Standardised indices for the JMA3 MW pred JMM event threshold dataset.

Table D.48: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW pred JMM event threshold series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	2.169	0.268	1.670	2.721	3.079	0.457	2.244	4.034	1.420	0.116	1.212	1.668
1994	1.462	0.107	1.266	1.686	2.076	0.237	1.655	2.584	1.420	0.121	1.202	1.675
1995	0.797	0.080	0.648	0.961	1.210	0.176	0.907	1.597	1.518	0.156	1.234	1.845
1996	2.885	0.550	1.877	4.033	6.073	1.264	3.832	8.785	2.105	0.158	1.814	2.432
1997	3.136	0.703	1.943	4.697	5.794	1.369	3.495	8.860	1.848	0.133	1.596	2.119
1998	1.314	0.081	1.163	1.480	1.784	0.162	1.491	2.126	1.358	0.100	1.173	1.566
1999	1.157	0.076	1.013	1.311	1.528	0.153	1.252	1.851	1.321	0.106	1.122	1.537
2000	1.151	0.077	1.002	1.304	0.999	0.107	0.809	1.228	0.868	0.076	0.729	1.026
2001	1.357	0.081	1.209	1.526	0.868	0.084	0.717	1.048	0.639	0.050	0.543	0.738
2002	1.769	0.151	1.468	2.061	1.011	0.112	0.798	1.236	0.572	0.042	0.497	0.662
2003	0.795	0.077	0.643	0.945	0.696	0.101	0.511	0.909	0.875	0.091	0.710	1.067
2004	0.352	0.068	0.243	0.511	0.229	0.060	0.133	0.369	0.649	0.115	0.456	0.907
2005	0.552	0.074	0.416	0.706	0.414	0.079	0.277	0.587	0.749	0.096	0.577	0.953
2006	0.670	0.077	0.527	0.828	0.641	0.098	0.473	0.857	0.957	0.103	0.771	1.173
2007	0.123	0.046	0.058	0.237	0.119	0.062	0.041	0.286	0.959	0.347	0.446	1.805
2008	0.682	0.102	0.493	0.893	1.147	0.242	0.728	1.677	1.681	0.262	1.229	2.257
2009	0.586	0.084	0.438	0.766	0.645	0.139	0.419	0.963	1.102	0.178	0.803	1.502
2010	0.760	0.083	0.606	0.931	1.263	0.206	0.899	1.708	1.663	0.192	1.305	2.059
2011	0.385	0.077	0.257	0.558	0.476	0.129	0.273	0.779	1.237	0.246	0.851	1.815
2012	0.932	0.094	0.752	1.120	0.937	0.150	0.665	1.254	1.004	0.122	0.790	1.269
2013	0.868	0.093	0.686	1.051	0.706	0.113	0.511	0.952	0.813	0.095	0.645	1.016
2014	0.723	0.083	0.571	0.896	0.733	0.128	0.504	1.004	1.014	0.130	0.780	1.289
2015	1.059	0.083	0.902	1.227	1.146	0.138	0.906	1.449	1.082	0.097	0.906	1.284
2016	0.851	0.085	0.695	1.027	1.173	0.178	0.859	1.555	1.379	0.165	1.072	1.720
2017	1.370	0.105	1.192	1.603	1.810	0.200	1.444	2.229	1.321	0.114	1.111	1.557
2018	0.983	0.085	0.820	1.153	1.008	0.140	0.757	1.307	1.025	0.115	0.822	1.273
2019	1.148	0.070	1.014	1.288	1.014	0.104	0.831	1.239	0.883	0.072	0.748	1.028
2020	0.978	0.072	0.840	1.121	1.002	0.128	0.772	1.276	1.025	0.104	0.838	1.246
2021	1.315	0.090	1.163	1.518	0.723	0.077	0.590	0.893	0.549	0.045	0.467	0.644
2022	1.463	0.112	1.267	1.708	0.865	0.097	0.695	1.075	0.592	0.048	0.504	0.691
2023	3.109	0.683	1.926	4.604	2.343	0.543	1.436	3.565	0.754	0.059	0.640	0.872
2024	1.961	0.216	1.552	2.398	0.674	0.097	0.502	0.881	0.344	0.031	0.288	0.408

D.9 JMA3 MW pred JMD event draws1

Table D.49: Summary of the JMA3 MW pred JMD event draws1 dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	1 962.22	26.76
1994	5	40	2 090	5 313.80	1 678.60	30.86
1995	6	38	1 937	5 281.88	1 877.30	31.03
1996	5	31	1 698	4 946.23	2 156.15	38.81
1997	6	23	1 813	5 486.45	690.13	22.61
1998	7	36	2 393	6 500.45	2 235.46	34.43
1999	7	29	2 269	6 680.20	4 135.27	49.76
2000	7	34	2 351	7 026.89	4 138.44	53.89
2001	7	29	2 174	7 230.32	1 004.06	27.64
2002	8	32	2 598	8 281.02	1 889.10	34.60
2003	8	33	1 904	6 719.12	473.61	14.34
2004	8	23	1 725	6 488.50	127.14	4.93
2005	8	28	2 103	7 303.95	138.94	6.28
2006	8	33	2 204	8 642.28	2 763.99	31.90
2007	7	27	1 109	4 762.03	1 020.24	24.26
2008	7	27	1 223	5 763.20	947.69	16.35
2009	7	37	1 809	8 957.70	620.51	11.33
2010	6	25	1 191	5 181.56	1 119.82	33.08
2011	6	21	1 301	5 811.68	2 260.57	31.36
2012	6	27	1 344	5 844.70	2 473.60	31.47
2013	6	25	1 169	4 960.32	2 780.40	41.92
2014	7	36	1 420	6 220.82	3 114.30	44.08
2015	7	37	1 362	6 240.75	1 772.72	34.36
2016	8	48	1 409	6 312.63	814.94	20.16
2017	6	29	1 212	6 426.48	2 875.59	46.62
2018	7	33	1 599	7 557.02	3 218.36	47.40
2019	7	36	2 156	9 997.48	2 517.58	34.32
2020	7	44	2 235	10 344.52	1 066.41	25.55
2021	7	32	1 744	7 955.15	3 449.49	59.86
2022	6	35	1 603	7 543.75	2 420.37	54.90
2023	6	25	953	4 692.92	4 351.74	88.14
2024	6	34	1 157	5 419.63	1 671.09	79.08

D.10 JMA3 MW pred JMD event draws2

Table D.50: Summary of the JMA3 MW pred JMD event draws2 dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	159.12	11.62
1994	5	40	2 090	5 313.80	261.98	9.38
1995	6	38	1 937	5 281.88	2 296.05	25.40
1996	5	31	1 698	4 946.23	993.47	23.85
1997	6	23	1 813	5 486.45	35.29	1.71
1998	7	36	2 393	6 500.45	93.20	3.47
1999	7	29	2 269	6 680.20	1 773.35	31.69
2000	7	34	2 351	7 026.89	1 212.72	29.14
2001	7	29	2 174	7 230.32	530.79	18.72
2002	8	32	2 598	8 281.02	939.35	22.71
2003	8	33	1 904	6 719.12	137.61	6.62
2004	8	23	1 725	6 488.50	86.20	1.39
2005	8	28	2 103	7 303.95	211.39	5.09
2006	8	33	2 204	8 642.28	355.57	9.62
2007	7	27	1 109	4 762.03	371.86	19.12
2008	7	27	1 223	5 763.20	179.45	6.54
2009	7	37	1 809	8 957.70	376.82	8.90
2010	6	25	1 191	5 181.56	687.81	22.17
2011	6	21	1 301	5 811.68	1 222.84	23.60
2012	6	27	1 344	5 844.70	1 274.89	25.45
2013	6	25	1 169	4 960.32	2 498.09	40.89
2014	7	36	1 420	6 220.82	1 574.84	34.37
2015	7	37	1 362	6 240.75	1 082.92	28.63
2016	8	48	1 409	6 312.63	412.18	11.07
2017	6	29	1 212	6 426.48	1 906.13	40.43
2018	7	33	1 599	7 557.02	1 159.06	31.33
2019	7	36	2 156	9 997.48	1 175.03	21.10
2020	7	44	2 235	10 344.52	489.95	16.20
2021	7	32	1 744	7 955.15	1 750.87	39.56
2022	6	35	1 603	7 543.75	1 637.69	44.60
2023	6	25	953	4 692.92	3 003.24	77.44
2024	6	34	1 157	5 419.63	1 097.25	70.01

D.11 JMA3 MW pred JMD event draws3

Table D.51: Summary of the JMA3 MW pred JMD event draws3 dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	919.04	21.43
1994	5	40	2 090	5 313.80	231.47	7.99
1995	6	38	1 937	5 281.88	2 071.96	24.52
1996	5	31	1 698	4 946.23	474.17	13.19
1997	6	23	1 813	5 486.45	174.06	8.49
1998	7	36	2 393	6 500.45	1 013.09	21.73
1999	7	29	2 269	6 680.20	4 874.12	52.49
2000	7	34	2 351	7 026.89	3 266.46	54.40
2001	7	29	2 174	7 230.32	413.86	16.01
2002	8	32	2 598	8 281.02	1 513.68	28.98
2003	8	33	1 904	6 719.12	241.78	10.66
2004	8	23	1 725	6 488.50	204.11	8.17
2005	8	28	2 103	7 303.95	35.34	2.28
2006	8	33	2 204	8 642.28	495.22	11.71
2007	7	27	1 109	4 762.03	199.09	12.35
2008	7	27	1 223	5 763.20	502.80	13.00
2009	7	37	1 809	8 957.70	280.10	6.14
2010	6	25	1 191	5 181.56	618.17	23.26
2011	6	21	1 301	5 811.68	1 344.02	26.44
2012	6	27	1 344	5 844.70	893.97	21.43
2013	6	25	1 169	4 960.32	2 059.80	38.75
2014	7	36	1 420	6 220.82	2 152.33	40.35
2015	7	37	1 362	6 240.75	842.06	25.84
2016	8	48	1 409	6 312.63	585.34	16.04
2017	6	29	1 212	6 426.48	2 013.10	40.92
2018	7	33	1 599	7 557.02	2 555.72	45.65
2019	7	36	2 156	9 997.48	949.12	21.43
2020	7	44	2 235	10 344.52	1 178.14	24.74
2021	7	32	1 744	7 955.15	2 658.86	55.39
2022	6	35	1 603	7 543.75	1 775.90	46.85
2023	6	25	953	4 692.92	3 423.86	84.58
2024	6	34	1 157	5 419.63	797.36	66.12

D.12 JMA3 MW pred JMD event draws4

Table D.52: Summary of the JMA3 MW pred JMD event draws4 dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	25.90	2.00
1994	5	40	2 090	5 313.80	1.49	0.24
1995	6	38	1 937	5 281.88	5.56	0.26
1996	5	31	1 698	4 946.23	16.37	0.53
1997	6	23	1 813	5 486.45	22.08	0.94
1998	7	36	2 393	6 500.45	6.02	0.88
1999	7	29	2 269	6 680.20	52.18	1.06
2000	7	34	2 351	7 026.89	198.59	5.83
2001	7	29	2 174	7 230.32	0.34	0.18
2002	8	32	2 598	8 281.02	83.84	2.62
2003	8	33	1 904	6 719.12	0.87	0.58
2004	8	23	1 725	6 488.50	0.48	0.06
2005	8	28	2 103	7 303.95	1.94	0.33
2006	8	33	2 204	8 642.28	0.48	0.05
2007	7	27	1 109	4 762.03	0.73	0.27
2008	7	27	1 223	5 763.20	0.00	0.08
2009	7	37	1 809	8 957.70	5.33	0.11
2010	6	25	1 191	5 181.56	24.41	2.43
2011	6	21	1 301	5 811.68	40.96	3.15
2012	6	27	1 344	5 844.70	26.23	1.41
2013	6	25	1 169	4 960.32	12.53	1.45
2014	7	36	1 420	6 220.82	73.06	2.18
2015	7	37	1 362	6 240.75	24.32	1.69
2016	8	48	1 409	6 312.63	0.75	0.21
2017	6	29	1 212	6 426.48	19.09	2.48
2018	7	33	1 599	7 557.02	41.23	3.50
2019	7	36	2 156	9 997.48	8.59	0.97
2020	7	44	2 235	10 344.52	5.64	0.89
2021	7	32	1 744	7 955.15	171.70	9.06
2022	6	35	1 603	7 543.75	558.67	19.96
2023	6	25	953	4 692.92	379.11	12.80
2024	6	34	1 157	5 419.63	29.65	7.26

D.13 JMA3 MW pred JMD event draws5

Table D.53: Summary of the JMA3 MW pred JMD event draws5 dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	778.72	19.62
1994	5	40	2 090	5 313.80	25.02	2.78
1995	6	38	1 937	5 281.88	228.13	4.18
1996	5	31	1 698	4 946.23	402.93	10.13
1997	6	23	1 813	5 486.45	77.58	3.70
1998	7	36	2 393	6 500.45	145.09	3.68
1999	7	29	2 269	6 680.20	334.90	7.80
2000	7	34	2 351	7 026.89	600.26	18.33
2001	7	29	2 174	7 230.32	163.24	6.58
2002	8	32	2 598	8 281.02	575.56	17.28
2003	8	33	1 904	6 719.12	21.48	1.42
2004	8	23	1 725	6 488.50	24.72	2.20
2005	8	28	2 103	7 303.95	24.11	0.95
2006	8	33	2 204	8 642.28	592.81	14.43
2007	7	27	1 109	4 762.03	232.18	14.25
2008	7	27	1 223	5 763.20	139.49	4.42
2009	7	37	1 809	8 957.70	26.46	1.44
2010	6	25	1 191	5 181.56	117.02	6.97
2011	6	21	1 301	5 811.68	474.36	13.37
2012	6	27	1 344	5 844.70	105.63	3.12
2013	6	25	1 169	4 960.32	1 007.98	25.15
2014	7	36	1 420	6 220.82	698.89	22.61
2015	7	37	1 362	6 240.75	64.40	4.48
2016	8	48	1 409	6 312.63	157.65	5.46
2017	6	29	1 212	6 426.48	527.53	19.22
2018	7	33	1 599	7 557.02	858.33	25.20
2019	7	36	2 156	9 997.48	226.24	6.54
2020	7	44	2 235	10 344.52	90.78	3.27
2021	7	32	1 744	7 955.15	463.02	17.26
2022	6	35	1 603	7 543.75	1 247.66	32.75
2023	6	25	953	4 692.92	2 442.33	66.53
2024	6	34	1 157	5 419.63	945.87	64.91

D.14 JMA3 MW pred JMD event draws6

Table D.54: Summary of the JMA3 MW pred JMD event draws6 dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	401.42	13.24
1994	5	40	2 090	5 313.80	105.11	3.49
1995	6	38	1 937	5 281.88	926.90	17.71
1996	5	31	1 698	4 946.23	317.76	11.54
1997	6	23	1 813	5 486.45	249.77	4.52
1998	7	36	2 393	6 500.45	353.59	10.66
1999	7	29	2 269	6 680.20	252.96	4.89
2000	7	34	2 351	7 026.89	378.66	12.46
2001	7	29	2 174	7 230.32	95.19	7.13
2002	8	32	2 598	8 281.02	417.71	15.40
2003	8	33	1 904	6 719.12	98.54	6.20
2004	8	23	1 725	6 488.50	133.20	4.46
2005	8	28	2 103	7 303.95	58.53	2.66
2006	8	33	2 204	8 642.28	149.20	4.72
2007	7	27	1 109	4 762.03	104.35	6.76
2008	7	27	1 223	5 763.20	63.50	1.55
2009	7	37	1 809	8 957.70	95.56	3.10
2010	6	25	1 191	5 181.56	453.13	19.65
2011	6	21	1 301	5 811.68	647.50	15.14
2012	6	27	1 344	5 844.70	146.19	6.47
2013	6	25	1 169	4 960.32	1 143.90	26.69
2014	7	36	1 420	6 220.82	407.61	18.24
2015	7	37	1 362	6 240.75	206.98	7.78
2016	8	48	1 409	6 312.63	69.25	3.48
2017	6	29	1 212	6 426.48	615.45	24.26
2018	7	33	1 599	7 557.02	344.72	16.57
2019	7	36	2 156	9 997.48	237.46	7.79
2020	7	44	2 235	10 344.52	291.34	10.60
2021	7	32	1 744	7 955.15	1 533.77	39.79
2022	6	35	1 603	7 543.75	898.68	29.44
2023	6	25	953	4 692.92	1 148.28	49.21
2024	6	34	1 157	5 419.63	696.44	60.59

D.15 JMA3 MW pred JMD event draws7

Table D.55: Summary of the JMA3 MW pred JMD event draws7 dataset after core fleet selection. 'Records' indicates the number of rows (events) in the dataset, and 'Records caught' indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	896.32	25.81
1994	5	40	2 090	5 313.80	363.55	12.68
1995	6	38	1 937	5 281.88	1 101.26	20.55
1996	5	31	1 698	4 946.23	1 540.94	34.98
1997	6	23	1 813	5 486.45	1 920.48	26.92
1998	7	36	2 393	6 500.45	1 471.49	28.08
1999	7	29	2 269	6 680.20	4 235.19	51.08
2000	7	34	2 351	7 026.89	5 268.01	58.83
2001	7	29	2 174	7 230.32	825.62	23.55
2002	8	32	2 598	8 281.02	2 065.93	31.91
2003	8	33	1 904	6 719.12	328.09	11.03
2004	8	23	1 725	6 488.50	235.26	8.12
2005	8	28	2 103	7 303.95	143.39	5.28
2006	8	33	2 204	8 642.28	1 439.43	22.60
2007	7	27	1 109	4 762.03	539.48	16.32
2008	7	27	1 223	5 763.20	867.09	16.35
2009	7	37	1 809	8 957.70	761.39	11.28
2010	6	25	1 191	5 181.56	958.44	31.40
2011	6	21	1 301	5 811.68	1 794.42	29.75
2012	6	27	1 344	5 844.70	1 651.27	30.21
2013	6	25	1 169	4 960.32	2 088.50	37.30
2014	7	36	1 420	6 220.82	3 134.57	44.44
2015	7	37	1 362	6 240.75	1 452.20	35.02
2016	8	48	1 409	6 312.63	1 211.51	22.50
2017	6	29	1 212	6 426.48	2 504.54	44.22
2018	7	33	1 599	7 557.02	3 207.20	48.91
2019	7	36	2 156	9 997.48	1 428.40	29.73
2020	7	44	2 235	10 344.52	1 885.62	31.95
2021	7	32	1 744	7 955.15	3 688.86	61.24
2022	6	35	1 603	7 543.75	2 833.71	59.08
2023	6	25	953	4 692.92	3 946.72	87.41
2024	6	34	1 157	5 419.63	2 103.27	83.49

D.16 JMA3 MW pred JMD event draws8

Table D.56: Summary of the JMA3 MW pred JMD event draws8 dataset after core fleet selection. 'Records' indicates the number of rows (events) in the dataset, and 'Records caught' indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	1 950.85	29.05
1994	5	40	2 090	5 313.80	605.10	20.57
1995	6	38	1 937	5 281.88	1 339.93	26.38
1996	5	31	1 698	4 946.23	2 409.91	44.99
1997	6	23	1 813	5 486.45	2 893.66	41.75
1998	7	36	2 393	6 500.45	2 473.98	33.51
1999	7	29	2 269	6 680.20	5 878.95	55.66
2000	7	34	2 351	7 026.89	5 151.78	58.44
2001	7	29	2 174	7 230.32	1 350.66	28.56
2002	8	32	2 598	8 281.02	1 937.86	31.45
2003	8	33	1 904	6 719.12	881.40	17.65
2004	8	23	1 725	6 488.50	81.74	5.22
2005	8	28	2 103	7 303.95	144.46	6.47
2006	8	33	2 204	8 642.28	3 579.40	32.99
2007	7	27	1 109	4 762.03	893.54	24.17
2008	7	27	1 223	5 763.20	1 022.38	16.52
2009	7	37	1 809	8 957.70	941.53	12.88
2010	6	25	1 191	5 181.56	1 378.21	32.83
2011	6	21	1 301	5 811.68	2 090.57	31.44
2012	6	27	1 344	5 844.70	2 198.04	31.18
2013	6	25	1 169	4 960.32	3 122.72	42.34
2014	7	36	1 420	6 220.82	3 045.86	44.44
2015	7	37	1 362	6 240.75	1 470.86	34.43
2016	8	48	1 409	6 312.63	1 601.03	23.92
2017	6	29	1 212	6 426.48	2 643.89	46.12
2018	7	33	1 599	7 557.02	3 498.76	50.34
2019	7	36	2 156	9 997.48	1 624.26	30.47
2020	7	44	2 235	10 344.52	1 144.01	27.87
2021	7	32	1 744	7 955.15	4 121.09	62.61
2022	6	35	1 603	7 543.75	3 018.45	60.64
2023	6	25	953	4 692.92	3 777.59	87.62
2024	6	34	1 157	5 419.63	1 897.80	82.11

D.17 JMA3 MW pred JMD event draws9

Table D.57: Summary of the JMA3 MW pred JMD event draws9 dataset after core fleet selection. ‘Records’ indicates the number of rows (events) in the dataset, and ‘Records caught’ indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	265.33	10.57
1994	5	40	2 090	5 313.80	68.90	4.02
1995	6	38	1 937	5 281.88	317.26	6.50
1996	5	31	1 698	4 946.23	126.49	3.47
1997	6	23	1 813	5 486.45	78.40	1.71
1998	7	36	2 393	6 500.45	79.46	2.17
1999	7	29	2 269	6 680.20	128.76	4.94
2000	7	34	2 351	7 026.89	220.81	6.76
2001	7	29	2 174	7 230.32	72.36	4.19
2002	8	32	2 598	8 281.02	330.59	11.39
2003	8	33	1 904	6 719.12	4.86	0.26
2004	8	23	1 725	6 488.50	6.72	1.28
2005	8	28	2 103	7 303.95	18.36	1.57
2006	8	33	2 204	8 642.28	286.88	6.85
2007	7	27	1 109	4 762.03	41.30	4.06
2008	7	27	1 223	5 763.20	23.45	2.45
2009	7	37	1 809	8 957.70	100.67	2.43
2010	6	25	1 191	5 181.56	87.17	6.72
2011	6	21	1 301	5 811.68	156.25	5.23
2012	6	27	1 344	5 844.70	485.92	16.52
2013	6	25	1 169	4 960.32	733.98	21.98
2014	7	36	1 420	6 220.82	342.18	13.24
2015	7	37	1 362	6 240.75	32.07	4.19
2016	8	48	1 409	6 312.63	10.55	1.42
2017	6	29	1 212	6 426.48	222.04	7.51
2018	7	33	1 599	7 557.02	498.20	16.07
2019	7	36	2 156	9 997.48	218.85	4.50
2020	7	44	2 235	10 344.52	101.28	1.97
2021	7	32	1 744	7 955.15	727.65	25.75
2022	6	35	1 603	7 543.75	637.82	24.14
2023	6	25	953	4 692.92	771.16	32.21
2024	6	34	1 157	5 419.63	342.07	34.92

D.18 JMA3 MW pred JMD event draws10

Table D.58: Definition for the dataset, core fleet criteria, and Generalised Linear Modelling approach used in the catch-per-unit-effort (CPUE) standardisation for the JMA3 MW pred JMD event draws10 CPUE series.

Series	JMA3 MW pred JMD event draws10
QMS stock	JMA 3
Reporting forms	TCE, TCP, ERS - Trawl
Fishing methods	MW
Target species	JMA, JMD, JMM, JMN, BAR, SQU
Statistical Areas	020, 021, 022, 025, 026, 027, 028, 029, 049, 050, 052, 504, 602
Period	1992-10-01, 2024-09-30
Resolution	Fishing event
Core fleet years	5
Core fleet trips	5
Default model	$\text{pred_catch_JMD} \sim \text{fyear} + \text{vessel_key} + \text{target_species} + \text{month} +$ $\text{start_obs_fma} + \text{ns}(\log(\text{fishing_duration}), 3) + \text{ns}(\log(\text{start_time}), 3) +$ $\text{ns}(\log(\text{bottom_depth}), 3) + \text{ns}(\log(\text{effort_height}), 3) + \text{ns}(\text{effort_speed}, 3)$
Stepwise selection	No
Positive catch distribution	Weibull

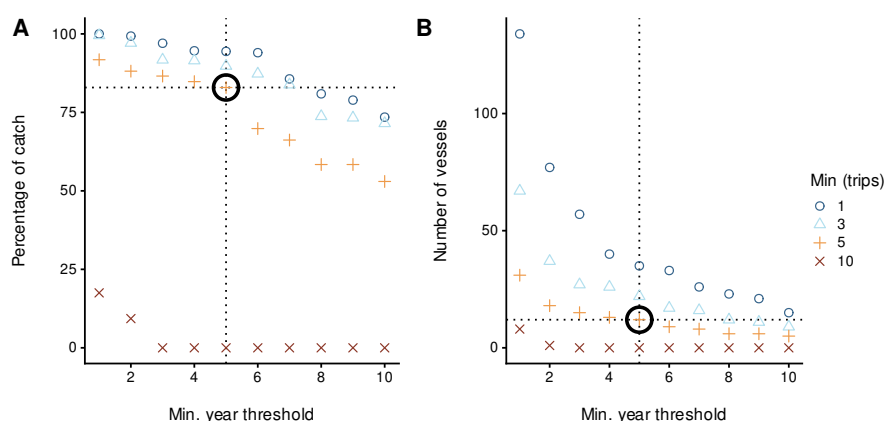


Figure D.243: Percentage of catch and number of vessels for different core vessel selection criteria for the JMA3 MW pred JMD event draws10 CPUE series. The bold open circle represents the core vessel selection criteria applied in the modelling dataset, specified by the number of years a vessel participated in the fishery and the number of trips per year.

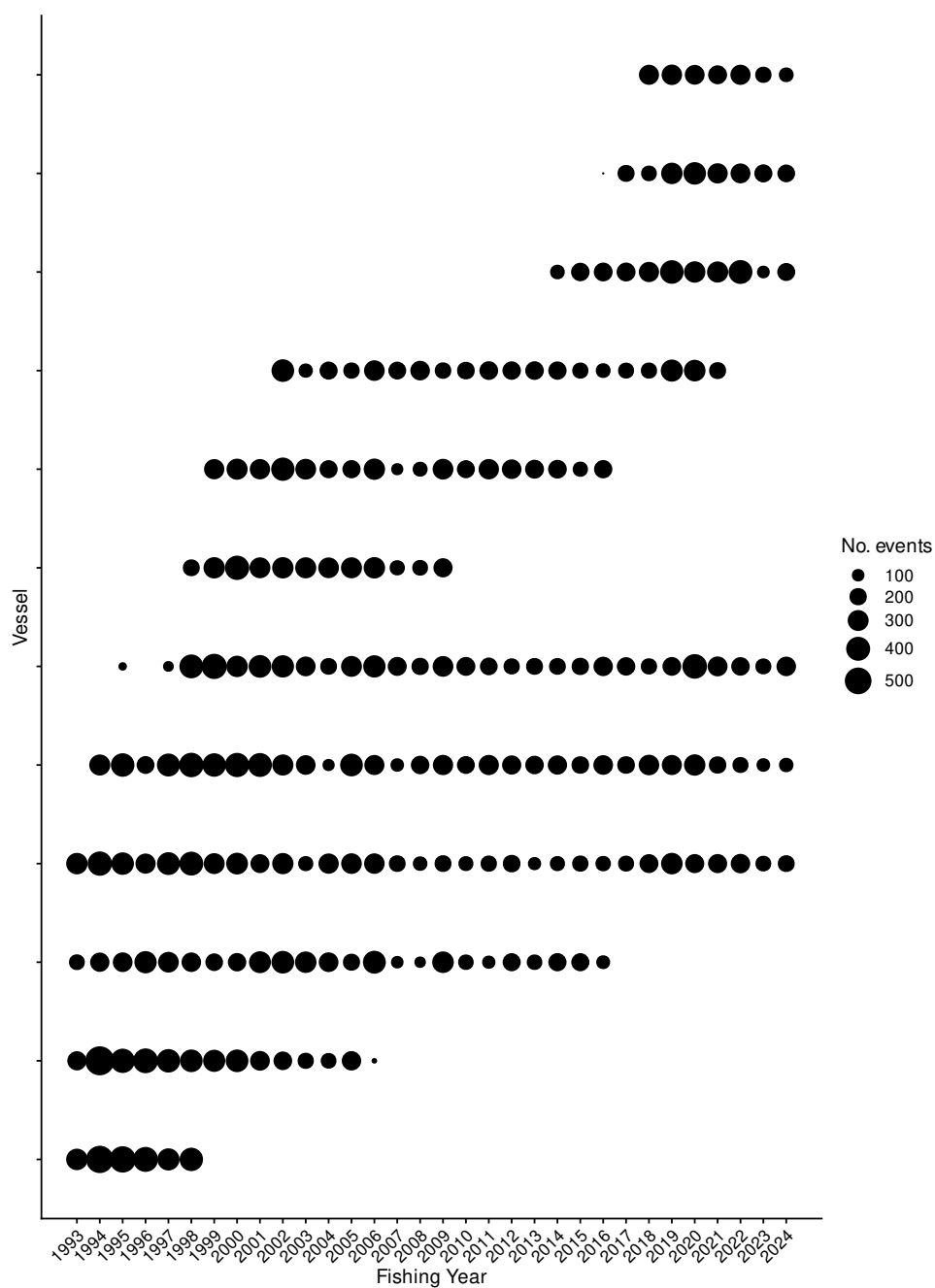


Figure D.244: Number of events by fishing year for core vessels in the JMA3 MW pred JMD event draws10 series. The area of the circles is proportional to the number of events undertaken by a vessel in a fishing year.

Table D.59: Summary of the JMA3 MW pred JMD event draws10 dataset total catch (tonnes) and number of records (n), by fishing year after the application of various filters. The first row gives the catch and number of records before filters were applied (ungroomed data). Subsequent rows display the remaining catch (and percent of catch), and the number of records, after the specified filter was applied. (Continued on next 5 pages)

Filter	1993	1994	1995	1996	1997	1998	1999	2000	2001
Ungroomed data	4500 (100%) n: 7113	2302 (100%) n: 6413	3146 (100%) n: 7617	4600 (100%) n: 7993	2630 (100%) n: 5763	4610 (100%) n: 5648	10631 (100%) n: 5256	4679 (100%) n: 3758	1045 (100%) n: 3011
Fishing speed not null	4500 (100%) n: 7113	2302 (100%) n: 6413	3111 (99%) n: 7615	4600 (100%) n: 7985	2622 (100%) n: 5757	4610 (100%) n: 5644	10629 (100%) n: 5252	4679 (100%) n: 3758	1045 (100%) n: 3010
Fishing speed lt 10kts	4500 (100%) n: 7113	2302 (100%) n: 6413	3111 (99%) n: 7615	4579 (100%) n: 7953	2621 (100%) n: 5745	4610 (100%) n: 5639	10629 (100%) n: 5251	4679 (100%) n: 3758	1045 (100%) n: 3010
Start date not null	4500 (100%) n: 7113	2302 (100%) n: 6413	3111 (99%) n: 7615	4579 (100%) n: 7953	2621 (100%) n: 5745	4610 (100%) n: 5639	10629 (100%) n: 5251	4679 (100%) n: 3758	1045 (100%) n: 3010
End date not null	4500 (100%) n: 7113	2302 (100%) n: 6413	3111 (99%) n: 7615	4579 (100%) n: 7953	2621 (100%) n: 5745	4610 (100%) n: 5639	10629 (100%) n: 5251	4679 (100%) n: 3758	1045 (100%) n: 3010
Start depth not null	4500 (100%) n: 7113	2302 (100%) n: 6413	3111 (99%) n: 7615	4579 (100%) n: 7946	2621 (100%) n: 5729	4489 (97%) n: 5626	10621 (100%) n: 5240	4678 (100%) n: 3755	1042 (100%) n: 3000
Headline height not null	4500 (100%) n: 7113	2302 (100%) n: 6413	3111 (99%) n: 7615	4577 (99%) n: 7797	2621 (100%) n: 5721	4487 (97%) n: 5615	10605 (100%) n: 5233	4676 (100%) n: 3751	1042 (100%) n: 2999
Fishing speed >3.5kn	4217 (94%) n: 6832	2279 (99%) n: 6125	3101 (99%) n: 7473	4569 (99%) n: 7506	2602 (99%) n: 5470	4480 (97%) n: 5391	10521 (99%) n: 5118	4645 (99%) n: 3698	1033 (99%) n: 2985
Headline height >15m	4212 (94%) n: 6811	2266 (98%) n: 6075	3098 (98%) n: 7430	4469 (97%) n: 7400	2596 (99%) n: 5384	4470 (97%) n: 5366	10495 (99%) n: 5022	4642 (99%) n: 3688	1033 (99%) n: 2978
Headline height <90m	3667 (81%) n: 6659	2264 (98%) n: 6073	3098 (98%) n: 7430	4468 (97%) n: 7389	2440 (93%) n: 5181	4225 (92%) n: 4978	10482 (99%) n: 5008	4635 (99%) n: 3678	1033 (99%) n: 2977
Fishing duration >15mins	3574 (79%) n: 6627	2262 (98%) n: 6056	3098 (98%) n: 7413	4386 (95%) n: 7360	2439 (93%) n: 5165	4225 (92%) n: 4964	10476 (99%) n: 4997	4635 (99%) n: 3675	1033 (99%) n: 2970
Fishing duration <15h	3564 (79%) n: 6609	2261 (98%) n: 6040	3082 (98%) n: 7404	4359 (95%) n: 7342	2358 (90%) n: 5134	4218 (91%) n: 4949	10440 (98%) n: 4988	4608 (98%) n: 3656	1033 (99%) n: 2970
Seabed depth >50m	3564 (79%) n: 6609	2261 (98%) n: 6040	3082 (98%) n: 7403	4359 (95%) n: 7342	2358 (90%) n: 5134	4216 (91%) n: 4946	10440 (98%) n: 4987	4608 (98%) n: 3655	1033 (99%) n: 2970
Seabed depth <350m	3560 (79%) n: 6570	2260 (98%) n: 6000	3079 (98%) n: 7227	4355 (95%) n: 7313	2358 (90%) n: 5121	4216 (91%) n: 4942	10423 (98%) n: 4964	4608 (98%) n: 3645	1031 (99%) n: 2967
Start time >0	3427 (76%) n: 6508	2195 (95%) n: 5958	3060 (97%) n: 7156	4159 (90%) n: 7221	2278 (87%) n: 5067	4118 (89%) n: 4901	10079 (95%) n: 4916	4553 (97%) n: 3623	1010 (97%) n: 2956
SA subset	3427 (76%) n: 6508	2195 (95%) n: 5958	3060 (97%) n: 7156	4159 (90%) n: 7221	2278 (87%) n: 5067	4118 (89%) n: 4901	10079 (95%) n: 4916	4553 (97%) n: 3623	1010 (97%) n: 2956
No effort allocation	3426 (76%) n: 6462	2171 (94%) n: 5829	3060 (97%) n: 7023	4159 (90%) n: 7221	2278 (87%) n: 5066	4118 (89%) n: 4901	10079 (95%) n: 4916	4553 (97%) n: 3619	1010 (97%) n: 2956
Core fleet selection	2013 (45%) n: 1050	1219 (53%) n: 2090	2318 (74%) n: 1937	2410 (52%) n: 1698	1445 (55%) n: 1813	2992 (65%) n: 2393	6666 (63%) n: 2269	3702 (79%) n: 2351	876 (84%) n: 2174

Filter	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ungroomed data	1948 (100%) n: 3311	579 (100%) n: 3108	229 (100%) n: 3281	269 (100%) n: 3639	1666 (100%) n: 2834	1041 (100%) n: 2416	943 (100%) n: 2250	1077 (100%) n: 2187	1080 (100%) n: 1313
Fishing speed not null	1948 (100%) n: 3311	579 (100%) n: 3108	229 (100%) n: 3281	269 (100%) n: 3639	1666 (100%) n: 2834	1041 (100%) n: 2416	943 (100%) n: 2250	1077 (100%) n: 2187	1080 (100%) n: 1313
Fishing speed lt 10kts	1948 (100%) n: 3311	579 (100%) n: 3108	229 (100%) n: 3281	269 (100%) n: 3639	1666 (100%) n: 2834	1041 (100%) n: 2416	943 (100%) n: 2250	1077 (100%) n: 2187	1080 (100%) n: 1313
Start date not null	1948 (100%) n: 3311	579 (100%) n: 3108	229 (100%) n: 3281	269 (100%) n: 3639	1666 (100%) n: 2834	1041 (100%) n: 2416	943 (100%) n: 2250	1077 (100%) n: 2187	1080 (100%) n: 1313
End date not null	1948 (100%) n: 3311	579 (100%) n: 3108	229 (100%) n: 3281	269 (100%) n: 3639	1666 (100%) n: 2834	1041 (100%) n: 2416	943 (100%) n: 2250	1077 (100%) n: 2187	1080 (100%) n: 1313
Start depth not null	1947 (100%) n: 3306	579 (100%) n: 3106	229 (100%) n: 3278	269 (100%) n: 3635	1666 (100%) n: 2831	1040 (100%) n: 2412	943 (100%) n: 2246	1077 (100%) n: 2187	1080 (100%) n: 1313
Headline height not null	1947 (100%) n: 3306	579 (100%) n: 3106	229 (100%) n: 3278	269 (100%) n: 3635	1666 (100%) n: 2831	1040 (100%) n: 2412	943 (100%) n: 2246	1077 (100%) n: 2187	1080 (100%) n: 1313
Fishing speed >3.5kn	1946 (100%) n: 3266	577 (100%) n: 3061	229 (100%) n: 3167	269 (100%) n: 3520	1665 (100%) n: 2794	1040 (100%) n: 2380	930 (99%) n: 2222	1028 (95%) n: 2132	1080 (100%) n: 1300
Headline height >15m	1940 (100%) n: 3243	577 (100%) n: 3043	229 (100%) n: 3150	269 (100%) n: 3512	1665 (100%) n: 2790	1040 (100%) n: 2359	930 (99%) n: 2205	1028 (95%) n: 2128	1080 (100%) n: 1297
Headline height <90m	1940 (100%) n: 3243	577 (100%) n: 3043	229 (100%) n: 3149	269 (100%) n: 3512	1665 (100%) n: 2789	1040 (100%) n: 2359	930 (99%) n: 2204	1028 (95%) n: 2128	1080 (100%) n: 1297
Fishing duration >15mins	1937 (99%) n: 3229	577 (100%) n: 3038	229 (100%) n: 3140	269 (100%) n: 3501	1662 (100%) n: 2782	1039 (100%) n: 2354	930 (99%) n: 2198	1028 (95%) n: 2126	1080 (100%) n: 1295
Fishing duration <15h	1937 (99%) n: 3226	577 (100%) n: 3037	229 (100%) n: 3138	269 (100%) n: 3501	1662 (100%) n: 2780	1039 (100%) n: 2353	930 (99%) n: 2195	1028 (95%) n: 2122	1080 (100%) n: 1294
Seabed depth >50m	1935 (99%) n: 3224	577 (100%) n: 3037	229 (100%) n: 3138	269 (100%) n: 3501	1662 (100%) n: 2780	1039 (100%) n: 2353	930 (99%) n: 2195	1028 (95%) n: 2122	1080 (100%) n: 1294
Seabed depth <350m	1930 (99%) n: 3222	577 (100%) n: 3033	229 (100%) n: 3134	269 (100%) n: 3500	1662 (100%) n: 2779	1039 (100%) n: 2351	930 (99%) n: 2193	1028 (95%) n: 2120	1080 (100%) n: 1293
Start time >0	1882 (97%) n: 3198	576 (100%) n: 3025	229 (100%) n: 3119	268 (100%) n: 3458	1632 (98%) n: 2766	1022 (98%) n: 2334	924 (98%) n: 2182	978 (91%) n: 2108	1073 (99%) n: 1280
SA subset	1882 (97%) n: 3198	576 (100%) n: 3025	229 (100%) n: 3119	268 (100%) n: 3458	1632 (98%) n: 2766	1022 (98%) n: 2334	924 (98%) n: 2182	978 (91%) n: 2108	1073 (99%) n: 1280
No effort allocation	1882 (97%) n: 3196	576 (99%) n: 2486	229 (100%) n: 2363	268 (100%) n: 2581	1632 (98%) n: 2593	1020 (98%) n: 1705	921 (98%) n: 1587	977 (91%) n: 1990	1073 (99%) n: 1260
Core fleet selection	1742 (89%) n: 2598	507 (88%) n: 1904	223 (97%) n: 1725	267 (99%) n: 2103	1624 (97%) n: 2204	919 (88%) n: 1109	829 (88%) n: 1223	623 (58%) n: 1809	1045 (97%) n: 1191

Filter	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ungroomed data	1803 (100%) n: 1434	2040 (100%) n: 1486	2438 (100%) n: 1247	2817 (100%) n: 1484	1508 (100%) n: 1445	1455 (100%) n: 1549	3420 (100%) n: 1368	3595 (100%) n: 1678	1727 (100%) n: 2307
Fishing speed not null	1803 (100%) n: 1434	2040 (100%) n: 1486	2438 (100%) n: 1247	2817 (100%) n: 1484	1508 (100%) n: 1445	1455 (100%) n: 1549	3420 (100%) n: 1368	3595 (100%) n: 1678	1727 (100%) n: 2307
Fishing speed lt 10kts	1803 (100%) n: 1434	2040 (100%) n: 1486	2438 (100%) n: 1247	2817 (100%) n: 1484	1508 (100%) n: 1445	1455 (100%) n: 1549	3420 (100%) n: 1368	3586 (100%) n: 1675	1727 (100%) n: 2303
Start date not null	1803 (100%) n: 1434	2040 (100%) n: 1486	2438 (100%) n: 1247	2817 (100%) n: 1484	1508 (100%) n: 1445	1455 (100%) n: 1549	3420 (100%) n: 1368	3586 (100%) n: 1675	1727 (100%) n: 2303
End date not null	1803 (100%) n: 1434	2040 (100%) n: 1486	2438 (100%) n: 1247	2817 (100%) n: 1484	1508 (100%) n: 1445	1455 (100%) n: 1549	3420 (100%) n: 1368	3586 (100%) n: 1675	1727 (100%) n: 2303
Start depth not null	1803 (100%) n: 1434	2040 (100%) n: 1486	2438 (100%) n: 1247	2817 (100%) n: 1484	1508 (100%) n: 1445	1455 (100%) n: 1549	3420 (100%) n: 1368	3586 (100%) n: 1675	1727 (100%) n: 2303
Headline height not null	1803 (100%) n: 1434	2040 (100%) n: 1486	2438 (100%) n: 1247	2817 (100%) n: 1484	1508 (100%) n: 1445	1455 (100%) n: 1549	3420 (100%) n: 1368	3586 (100%) n: 1675	1727 (100%) n: 2303
Fishing speed >3.5kn	1801 (100%) n: 1412	2040 (100%) n: 1465	2437 (100%) n: 1229	2816 (100%) n: 1454	1503 (100%) n: 1381	1451 (100%) n: 1503	3419 (100%) n: 1357	3574 (99%) n: 1625	1723 (100%) n: 2269
Headline height >15m	1790 (99%) n: 1395	2040 (100%) n: 1464	2437 (100%) n: 1229	2816 (100%) n: 1454	1502 (100%) n: 1379	1451 (100%) n: 1503	3380 (99%) n: 1354	3574 (99%) n: 1625	1723 (100%) n: 2263
Headline height <90m	1790 (99%) n: 1395	2040 (100%) n: 1463	2437 (100%) n: 1229	2816 (100%) n: 1454	1502 (100%) n: 1379	1451 (100%) n: 1503	3380 (99%) n: 1354	3574 (99%) n: 1624	1723 (100%) n: 2263
Fishing duration >15mins	1790 (99%) n: 1394	2040 (100%) n: 1459	2432 (100%) n: 1224	2816 (100%) n: 1449	1502 (100%) n: 1378	1451 (100%) n: 1498	3380 (99%) n: 1352	3574 (99%) n: 1624	1723 (100%) n: 2260
Fishing duration <15h	1790 (99%) n: 1392	2039 (100%) n: 1457	2432 (100%) n: 1224	2816 (100%) n: 1448	1502 (100%) n: 1378	1451 (100%) n: 1497	3380 (99%) n: 1352	3574 (99%) n: 1624	1721 (100%) n: 2257
Seabed depth >50m	1790 (99%) n: 1392	2039 (100%) n: 1457	2432 (100%) n: 1224	2816 (100%) n: 1448	1502 (100%) n: 1378	1451 (100%) n: 1497	3380 (99%) n: 1352	3574 (99%) n: 1624	1721 (100%) n: 2257
Seabed depth <350m	1790 (99%) n: 1390	2039 (100%) n: 1457	2432 (100%) n: 1224	2816 (100%) n: 1448	1502 (100%) n: 1378	1450 (100%) n: 1491	3380 (99%) n: 1352	3574 (99%) n: 1623	1721 (100%) n: 2256
Start time >0	1773 (98%) n: 1382	2031 (100%) n: 1453	2419 (99%) n: 1217	2756 (98%) n: 1438	1496 (99%) n: 1370	1398 (96%) n: 1483	3377 (99%) n: 1349	3569 (99%) n: 1617	1721 (100%) n: 2252
SA subset	1773 (98%) n: 1382	2031 (100%) n: 1453	2419 (99%) n: 1217	2756 (98%) n: 1438	1496 (99%) n: 1370	1398 (96%) n: 1483	3377 (99%) n: 1349	3569 (99%) n: 1617	1721 (100%) n: 2252
No effort allocation	1773 (98%) n: 1382	2031 (100%) n: 1390	2419 (99%) n: 1216	2756 (98%) n: 1436	1496 (99%) n: 1370	1388 (95%) n: 1447	3377 (99%) n: 1336	3569 (99%) n: 1616	1721 (100%) n: 2252
Core fleet selection	1759 (98%) n: 1301	2028 (99%) n: 1344	2387 (98%) n: 1169	2748 (98%) n: 1420	1489 (99%) n: 1362	1374 (94%) n: 1409	3343 (98%) n: 1212	3559 (99%) n: 1599	1626 (94%) n: 2156

Filter	2020	2021	2022	2023	2024
Ungroomed data	1709 (100%) n: 2542	4059 (100%) n: 1919	2823 (100%) n: 1800	4002 (100%) n: 1038	1570 (100%) n: 1343
Fishing speed not null	1709 (100%) n: 2542	4059 (100%) n: 1919	2823 (100%) n: 1800	4002 (100%) n: 1038	1570 (100%) n: 1343
Fishing speed lt 10kts	1709 (100%) n: 2542	4059 (100%) n: 1919	2823 (100%) n: 1800	4002 (100%) n: 1038	1570 (100%) n: 1343
Start date not null	1709 (100%) n: 2542	4059 (100%) n: 1919	2823 (100%) n: 1800	4002 (100%) n: 1038	1570 (100%) n: 1343
End date not null	1709 (100%) n: 2542	4059 (100%) n: 1919	2823 (100%) n: 1800	4002 (100%) n: 1038	1554 (99%) n: 1342
Start depth not null	1709 (100%) n: 2542	4059 (100%) n: 1919	2823 (100%) n: 1800	4002 (100%) n: 1038	1554 (99%) n: 1342
Headline height not null	1709 (100%) n: 2542	4059 (100%) n: 1919	2823 (100%) n: 1800	4002 (100%) n: 1038	1554 (99%) n: 1342
Fishing speed >3.5kn	1705 (100%) n: 2430	4059 (100%) n: 1919	2823 (100%) n: 1794	4000 (100%) n: 1037	1554 (99%) n: 1342
Headline height >15m	1705 (100%) n: 2426	4059 (100%) n: 1917	2823 (100%) n: 1792	4000 (100%) n: 1035	1544 (98%) n: 1336
Headline height <90m	1705 (100%) n: 2426	4059 (100%) n: 1917	2823 (100%) n: 1792	4000 (100%) n: 1035	1544 (98%) n: 1336
Fishing duration >15mins	1705 (100%) n: 2421	4058 (100%) n: 1912	2823 (100%) n: 1785	3999 (100%) n: 1032	1544 (98%) n: 1331
Fishing duration <15h	1705 (100%) n: 2421	4054 (100%) n: 1910	2823 (100%) n: 1785	3996 (100%) n: 1031	1544 (98%) n: 1330
Seabed depth >50m	1705 (100%) n: 2421	4054 (100%) n: 1910	2823 (100%) n: 1784	3996 (100%) n: 1031	1544 (98%) n: 1330
Seabed depth <350m	1705 (100%) n: 2419	4054 (100%) n: 1910	2823 (100%) n: 1783	3996 (100%) n: 1030	1544 (98%) n: 1329
Start time >0	1704 (100%) n: 2415	3954 (97%) n: 1902	2806 (99%) n: 1781	3985 (100%) n: 1029	1543 (98%) n: 1326
SA subset	1704 (100%) n: 2415	3954 (97%) n: 1902	2806 (99%) n: 1781	3985 (100%) n: 1029	1543 (98%) n: 1326
No effort allocation	1704 (100%) n: 2414	3954 (97%) n: 1898	2806 (99%) n: 1775	3985 (100%) n: 1029	1543 (98%) n: 1306
Core fleet selection	1322 (77%) n: 2235	3801 (94%) n: 1744	2480 (88%) n: 1603	3909 (98%) n: 953	1397 (89%) n: 1157

Table D.60: Summary of the JMA3 MW pred JMD event draws10 dataset after core fleet selection. 'Records' indicates the number of rows (events) in the dataset, and 'Records caught' indicates the percentage of events with catches of jack mackerels.

Fishing year	Vessels	Trips	Records	Hours	Catch (t)	Records caught
1993	4	54	1 050	2 466.57	2 013.28	27.90
1994	5	40	2 090	5 313.80	1 218.83	24.45
1995	6	38	1 937	5 281.88	2 318.30	25.35
1996	5	31	1 698	4 946.23	2 410.13	41.58
1997	6	23	1 813	5 486.45	1 445.05	32.71
1998	7	36	2 393	6 500.45	2 992.34	34.60
1999	7	29	2 269	6 680.20	6 665.63	55.80
2000	7	34	2 351	7 026.89	3 702.16	55.17
2001	7	29	2 174	7 230.32	875.70	22.72
2002	8	32	2 598	8 281.02	1 742.43	30.02
2003	8	33	1 904	6 719.12	507.06	17.28
2004	8	23	1 725	6 488.50	223.10	6.78
2005	8	28	2 103	7 303.95	267.00	7.51
2006	8	33	2 204	8 642.28	1 623.80	27.77
2007	7	27	1 109	4 762.03	919.08	24.17
2008	7	27	1 223	5 763.20	828.85	14.72
2009	7	37	1 809	8 957.70	623.32	9.40
2010	6	25	1 191	5 181.56	1 044.55	33.17
2011	6	21	1 301	5 811.68	1 759.43	29.98
2012	6	27	1 344	5 844.70	2 028.02	31.03
2013	6	25	1 169	4 960.32	2 386.80	39.35
2014	7	36	1 420	6 220.82	2 748.03	41.55
2015	7	37	1 362	6 240.75	1 489.06	35.61
2016	8	48	1 409	6 312.63	1 374.36	24.98
2017	6	29	1 212	6 426.48	3 343.13	47.03
2018	7	33	1 599	7 557.02	3 558.50	50.34
2019	7	36	2 156	9 997.48	1 625.53	30.47
2020	7	44	2 235	10 344.52	1 321.57	25.10
2021	7	32	1 744	7 955.15	3 801.03	62.16
2022	6	35	1 603	7 543.75	2 480.10	55.90
2023	6	25	953	4 692.92	3 909.37	85.31
2024	6	34	1 157	5 419.63	1 397.22	80.21

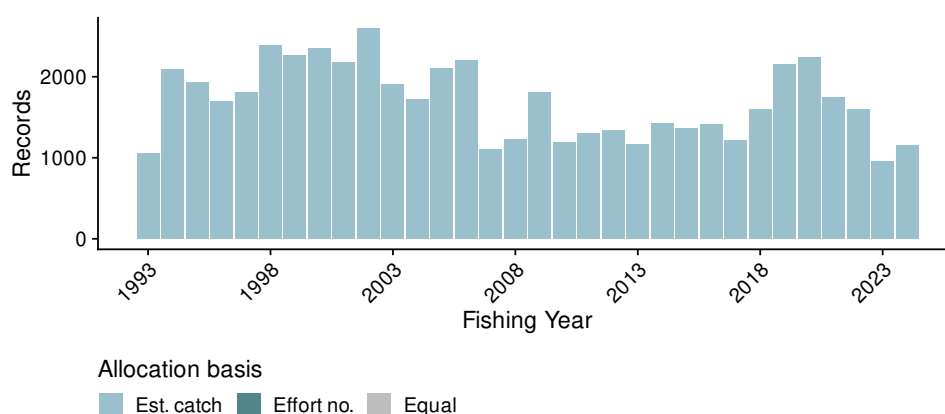


Figure D.245: The allocation approach used for attributing catches to records in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset. Catches were allocated in proportion to the estimated catch for each record (Est. catch allocation), in proportion to the number of fishing events per record (Effort no. allocation), or equally across fishing effort records (Equal allocation).

Table D.61: Summary table for occurrence of positive catch in the JMA3 MW pred JMD event draws10 series. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	29 929.16	0.00	0.00	*
fyear	31	24 556.35	15.94	15.94	*
vessel_key	11	24 469.29	16.29	0.35	*
target_species	2	21 528.34	28.30	12.00	*
month	11	21 332.28	29.16	0.87	*
start_obs_fma	3	20 366.78	32.34	3.17	*
ns(log(fishing_duration), 3)	3	20 360.61	32.39	0.06	*
ns(log(start_time), 3)	3	20 276.16	32.68	0.28	*
ns(log(bottom_depth), 3)	3	20 196.14	32.96	0.28	*
ns(log(effort_height), 3)	3	20 155.70	33.10	0.14	*
ns(effort_speed, 3)	3	20 038.13	33.56	0.46	*

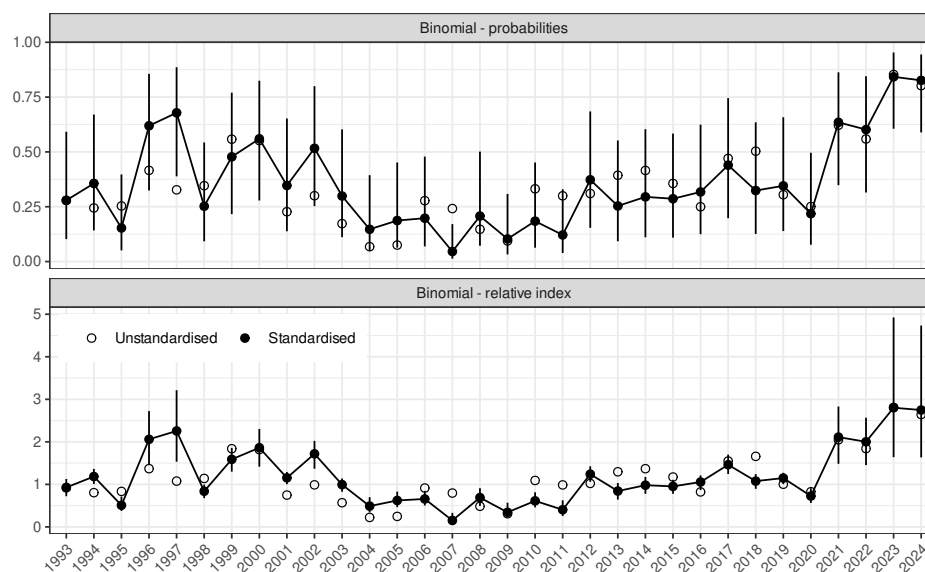


Figure D.246: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for occurrence of catch in the JMA3 MW pred JMD event draws10 dataset, plotted as both probability of occurrence and as a relative index standardised to the geometric mean.

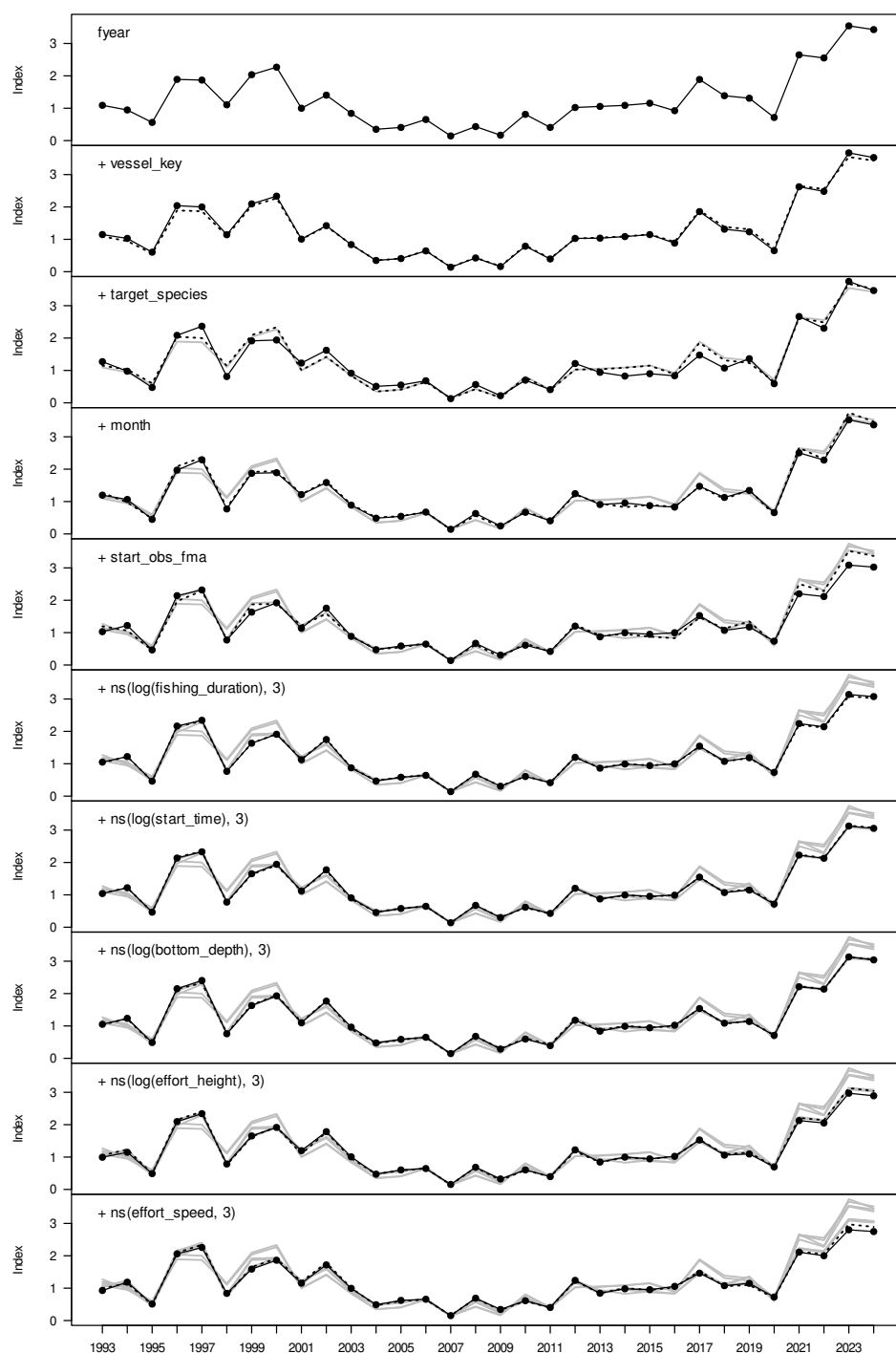


Figure D.247: Step plot for occurrence of catch in the JMA3 MW pred JMD event draws10 dataset.

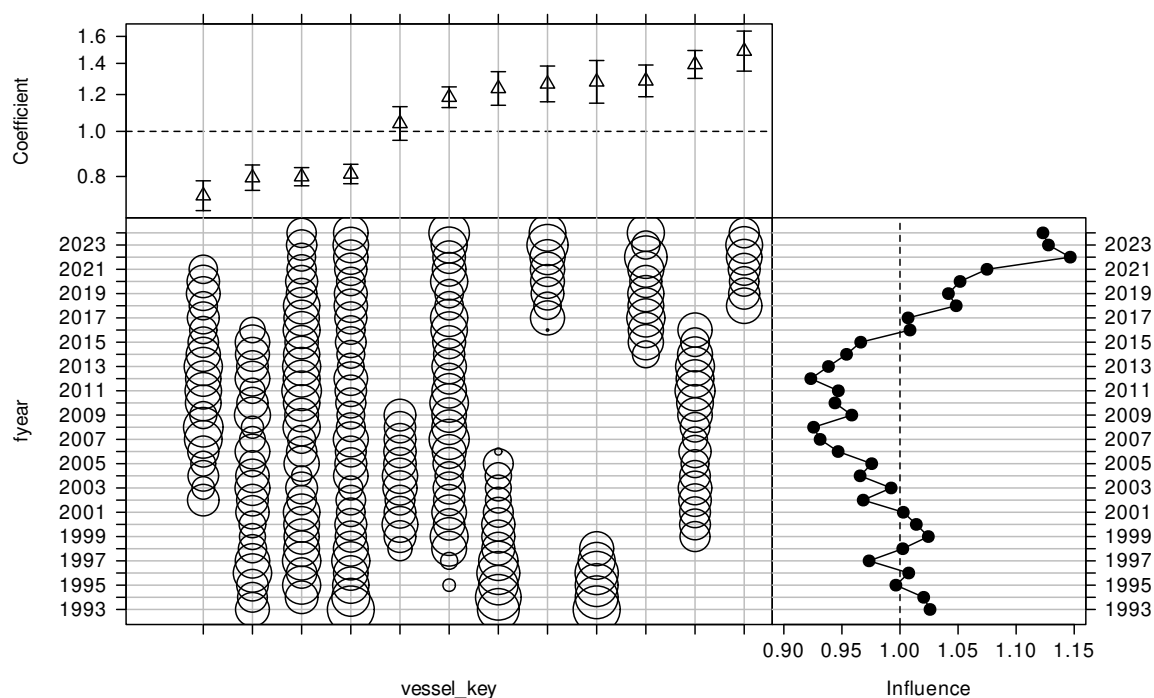


Figure D.248: CDI plot for vessel key for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

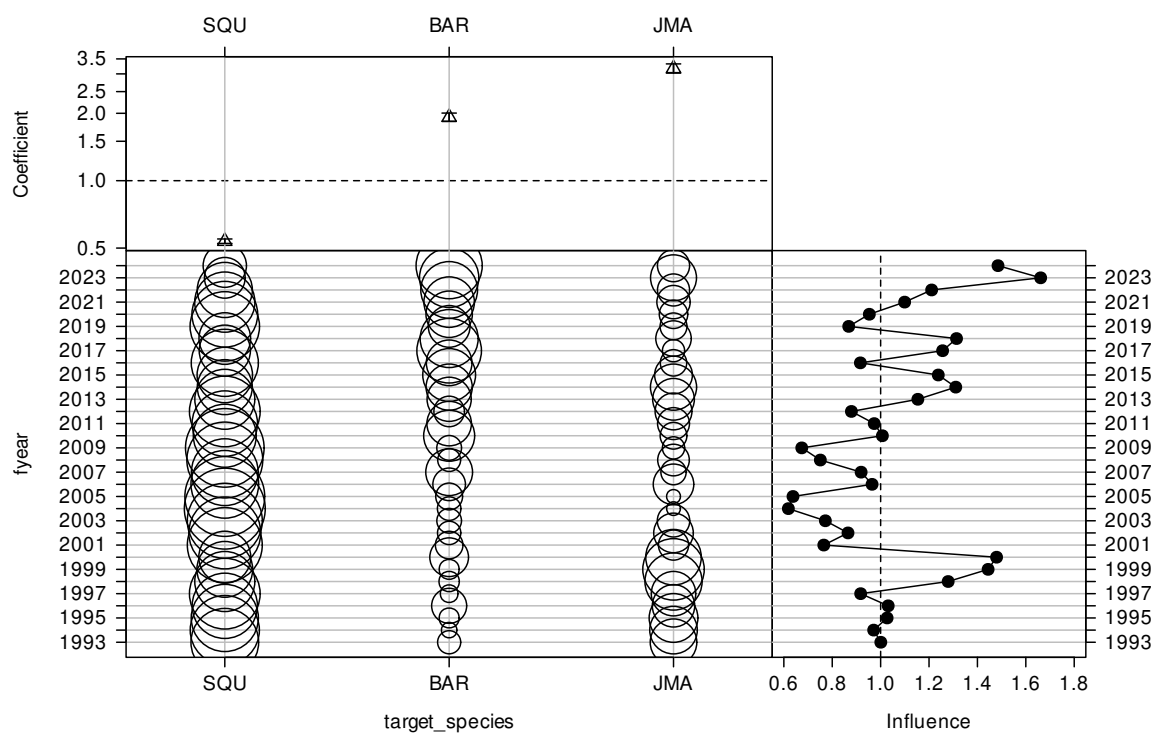


Figure D.249: CDI plot for target species for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

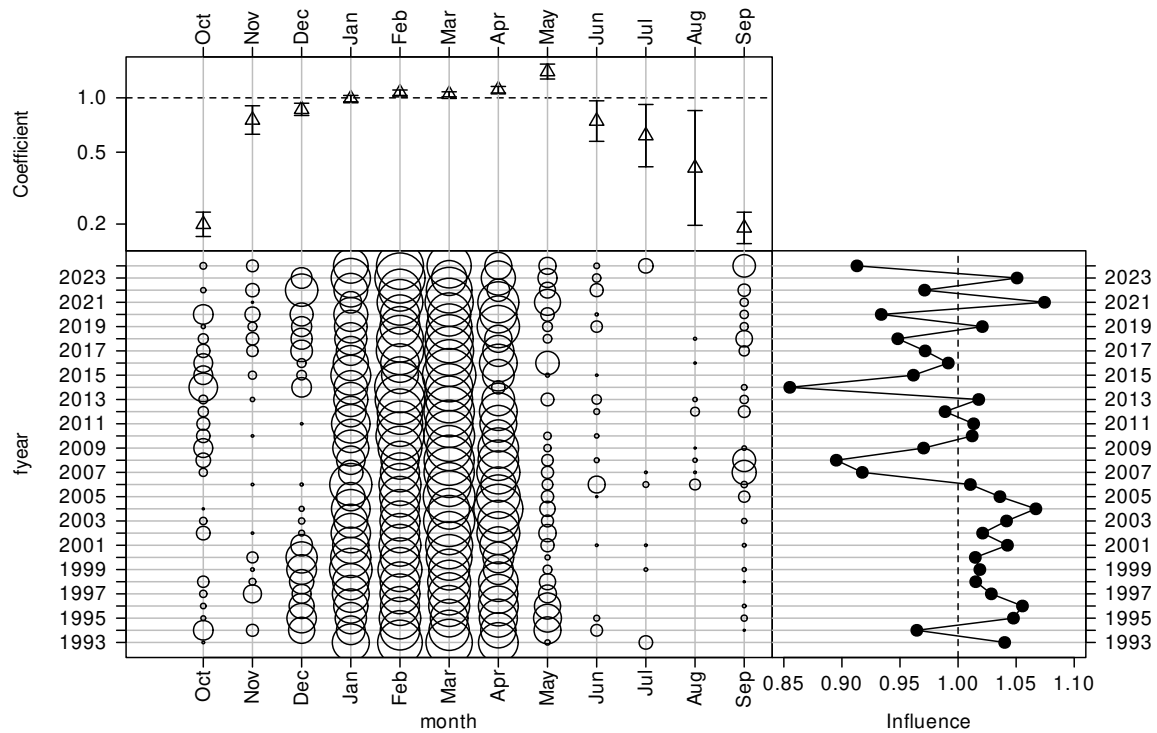


Figure D.250: CDI plot for month for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

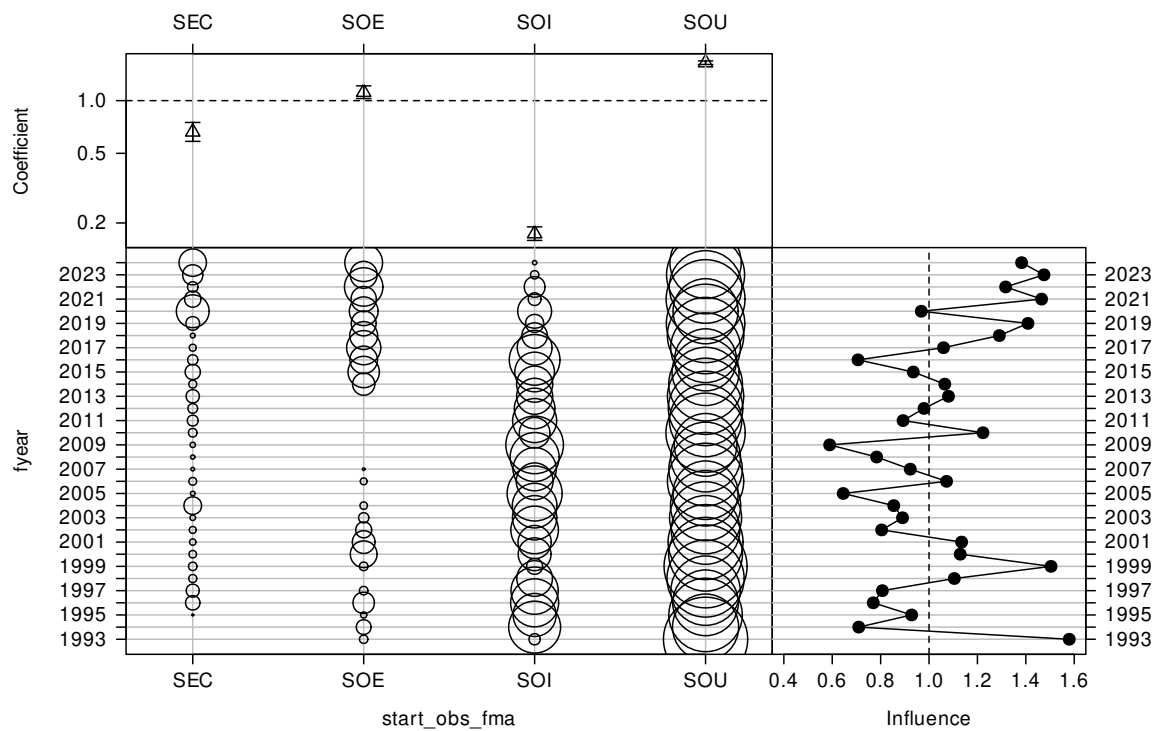


Figure D.251: CDI plot for start obs fma for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

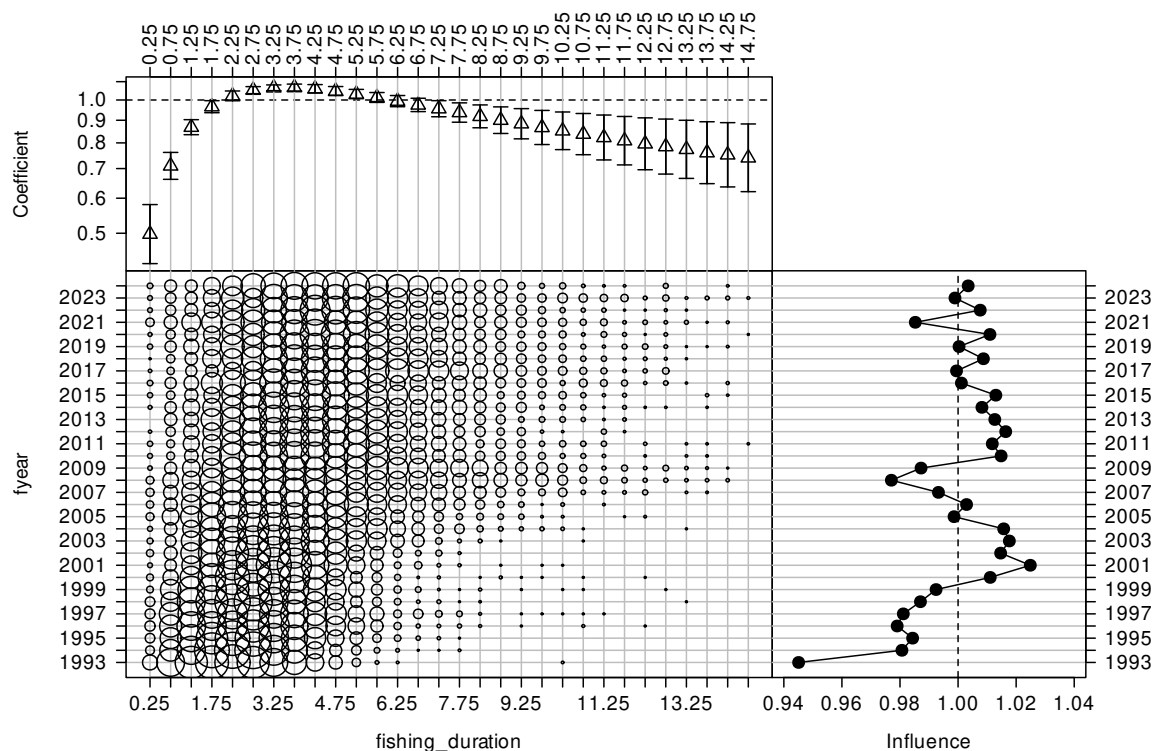


Figure D.252: CDI plot for fishing duration (h) for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

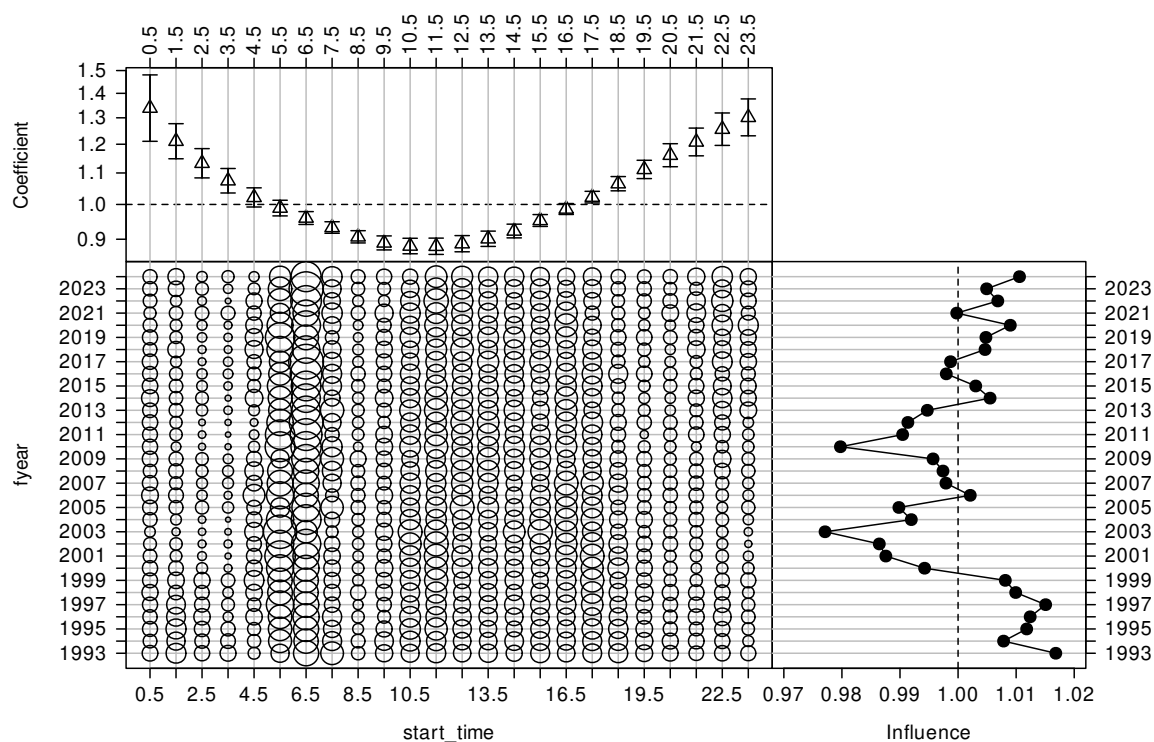


Figure D.253: CDI plot for start time for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

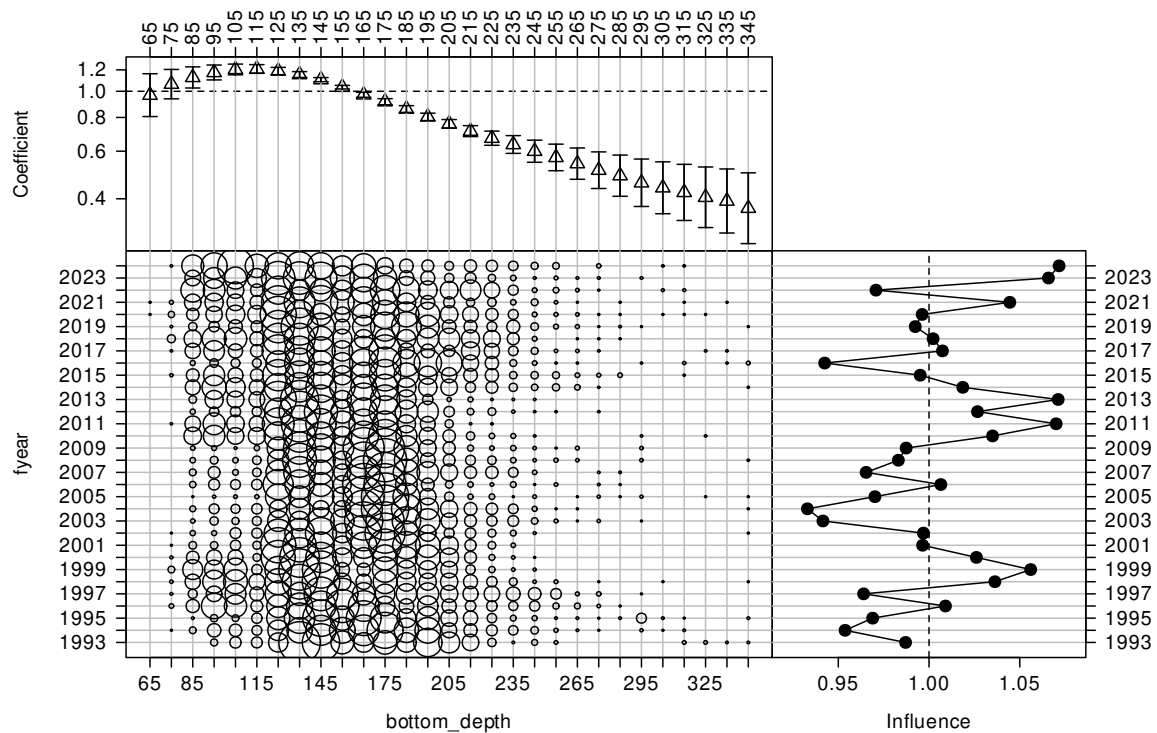


Figure D.254: CDI plot for bottom depth (m) for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

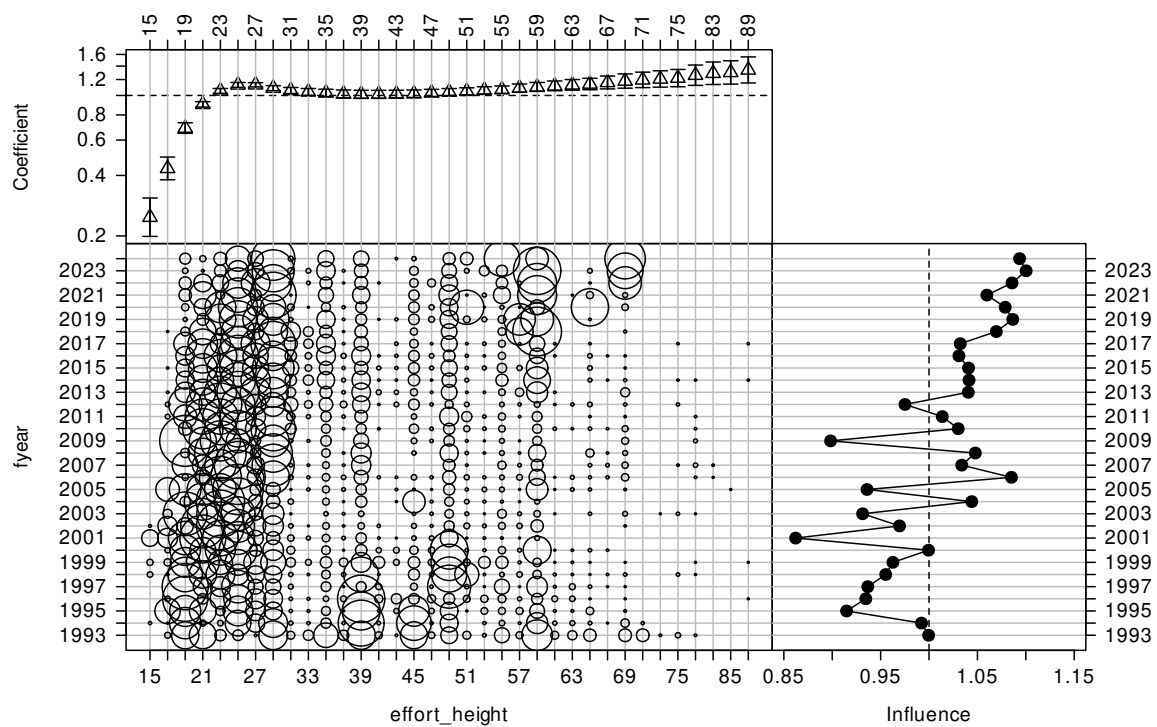


Figure D.255: CDI plot for effort height (m) for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

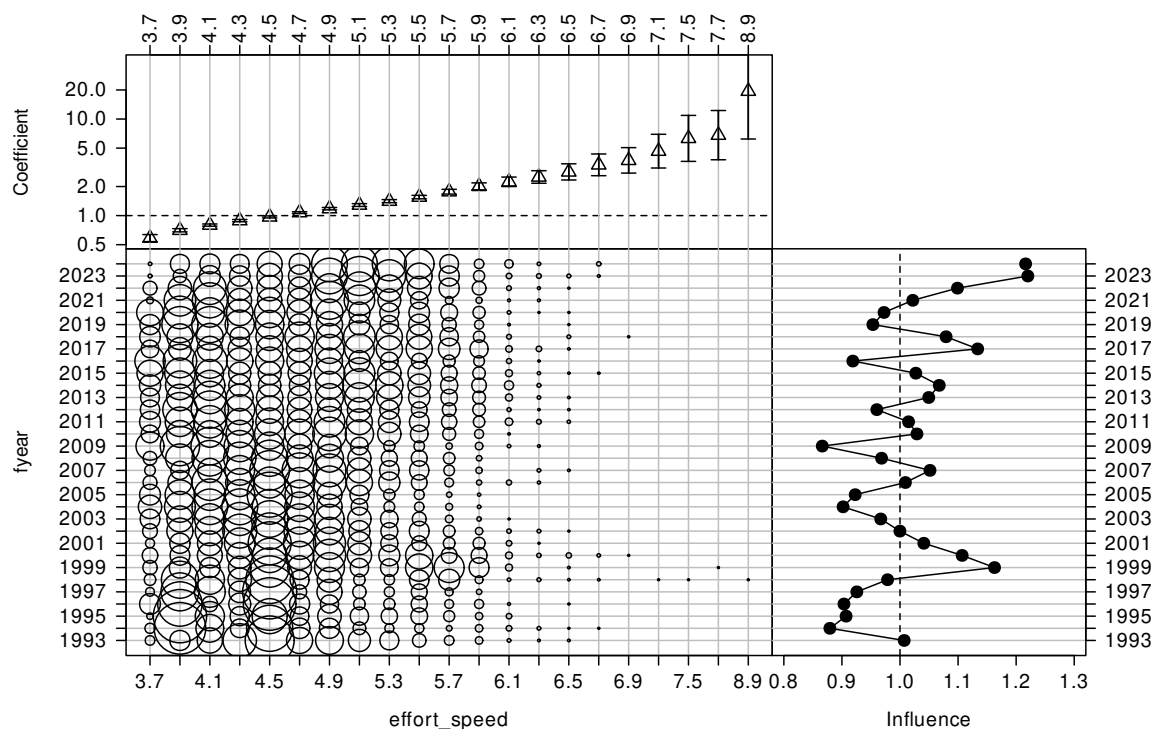


Figure D.256: CDI plot for effort speed for the occurrence of positive catch in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

Table D.62: Summary table for the Weibull model. Model terms are listed in the order offered to the model. AIC: Akaike Information Criterion; *: Term included in final model.

Predictor	df	AIC	% deviance	addl. % deviance	Included
intercept	1	86 834.87	0.00	0.00	*
fyear	31	86 587.39	8.02	8.02	*
vessel_key	11	86 528.82	10.11	2.09	*
target_species	2	86 104.64	21.20	11.10	*
month	11	86 072.12	22.62	1.41	*
start_obs_fma	3	86 033.24	23.78	1.16	*
ns(log(fishing_duration), 3)	3	86 030.40	24.01	0.23	*
ns(log(start_time), 3)	3	86 012.89	24.62	0.61	*
ns(log(bottom_depth), 3)	3	85 994.01	25.26	0.64	*
ns(log(effort_height), 3)	3	85 989.62	25.53	0.27	*
ns(effort_speed, 3)	3	85 984.99	25.81	0.28	*

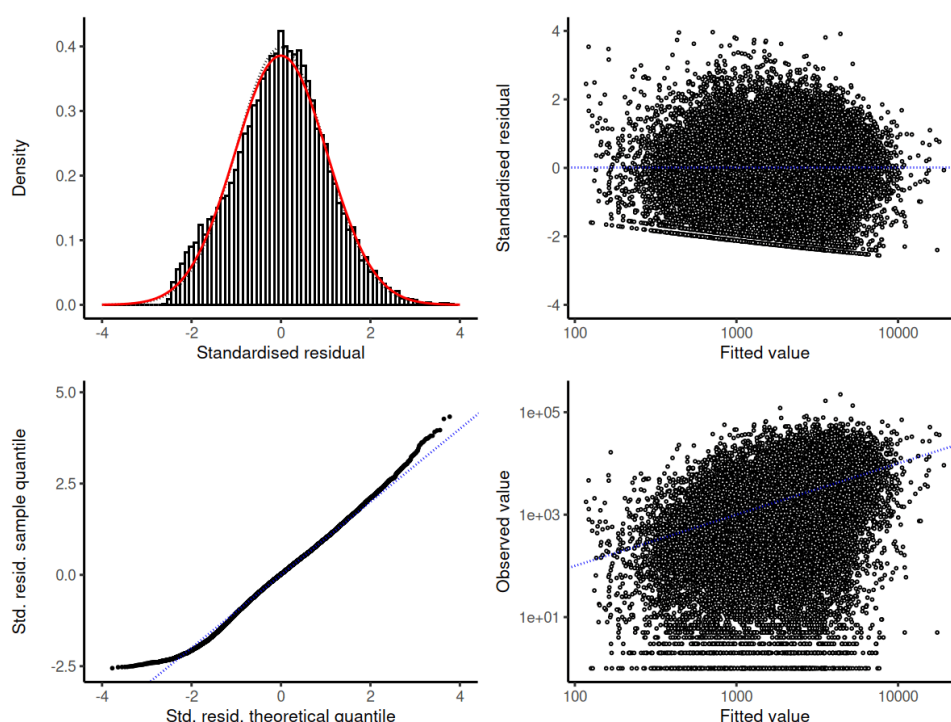


Figure D.257: Diagnostic plots for the selected Weibull model for positive catches in the JMA3 MW pred JMD event draws10 dataset.

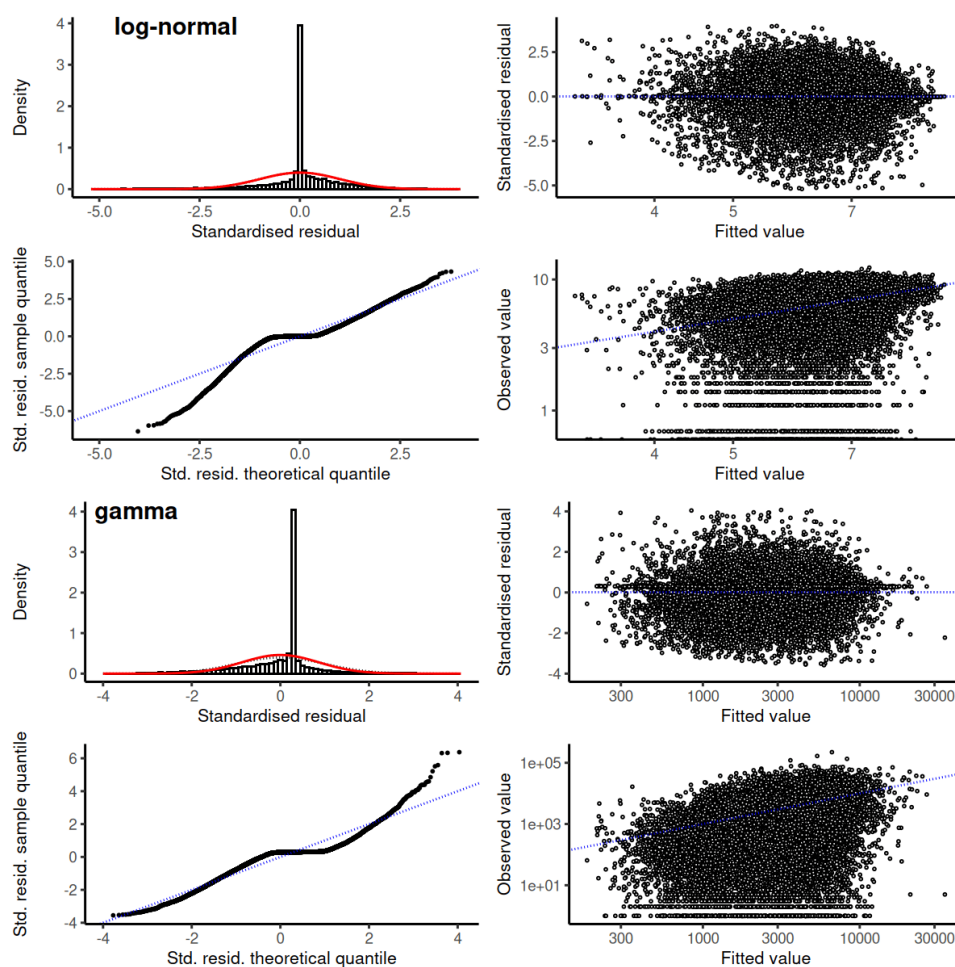


Figure D.258: Diagnostic plots for the alternative log-normal and gamma models considered for positive catches in the JMA3 MW pred JMD event draws10 dataset.

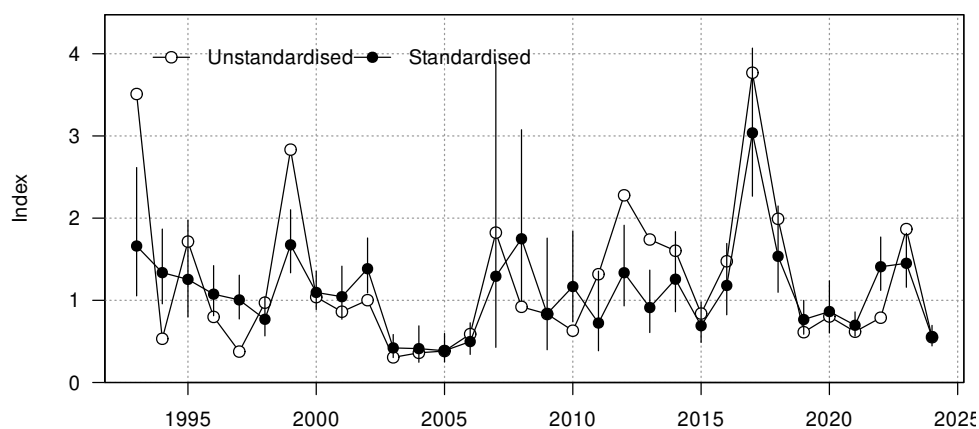


Figure D.259: Unstandardised (geometric mean; open circles) and standardised indices (black circles) for positive catch using the Weibull model for the JMA3 MW pred JMD event draws10 dataset.

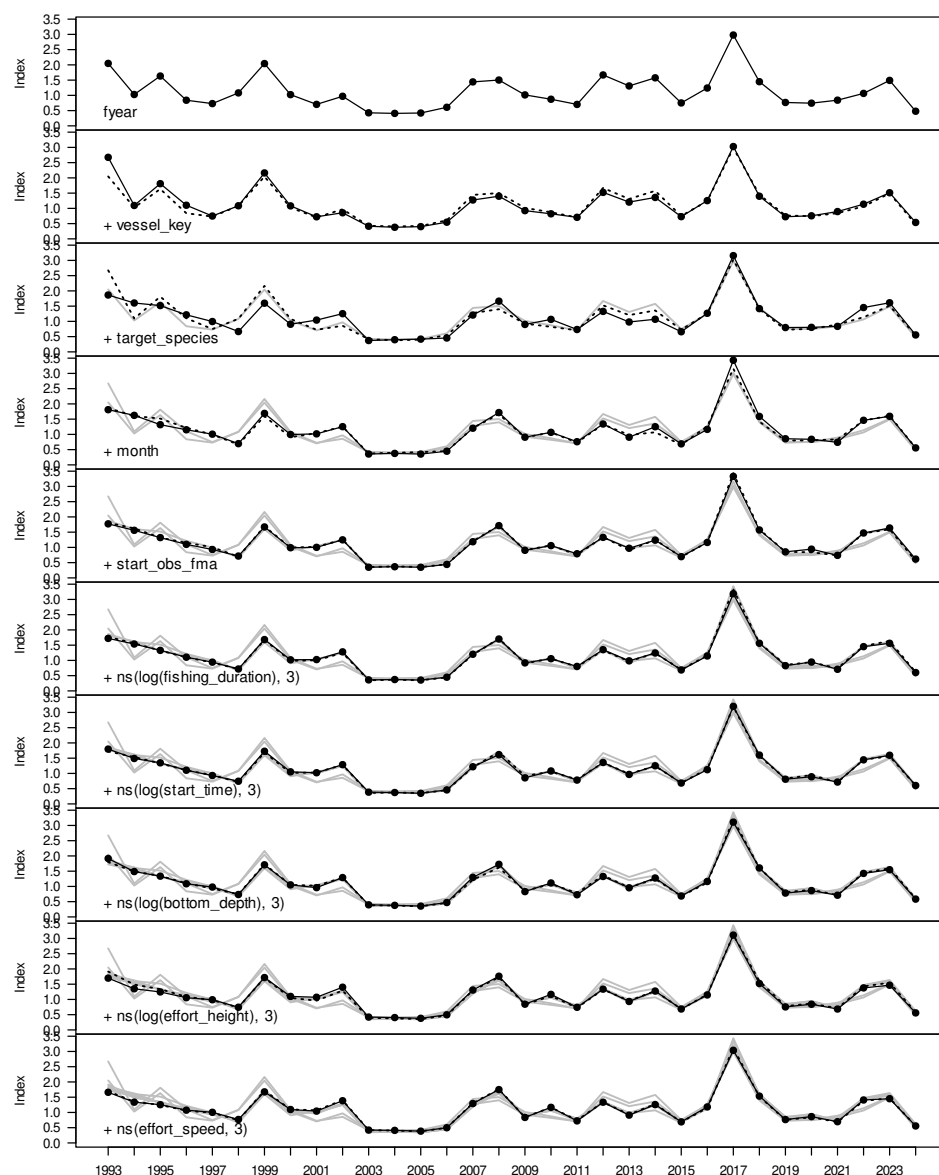


Figure D.260: Changes to the JMA3 MW pred JMD event draws10 positive catch index as terms are successively entered into the Weibull model.

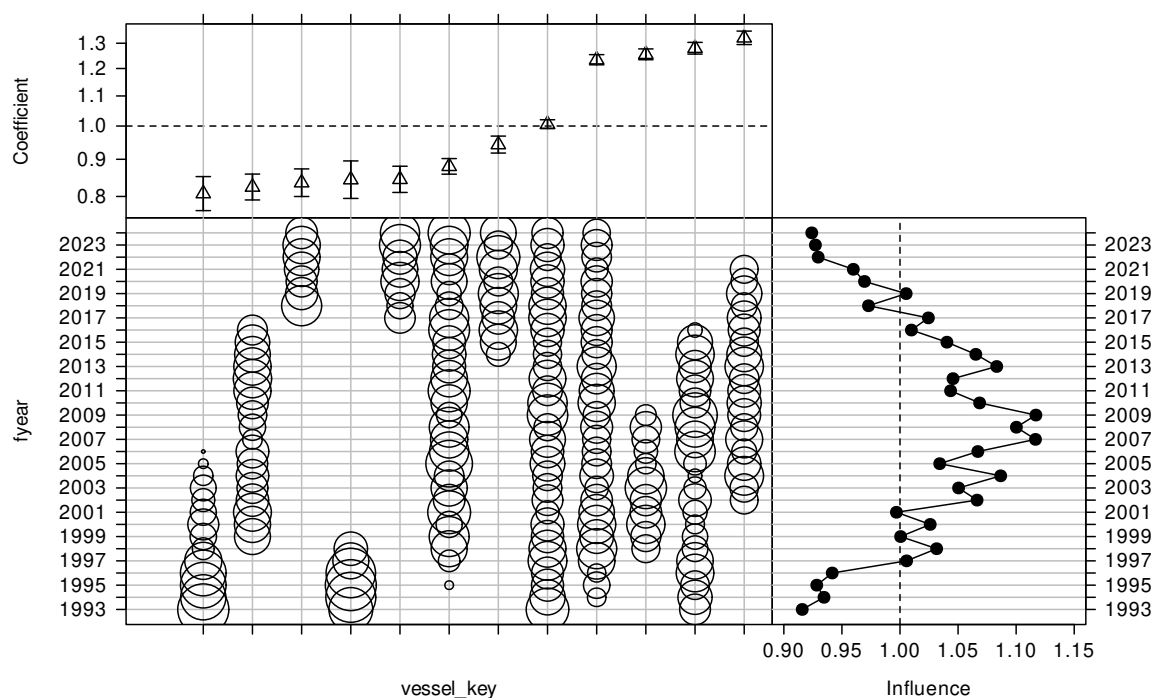


Figure D.261: CDI plot for vessel key for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

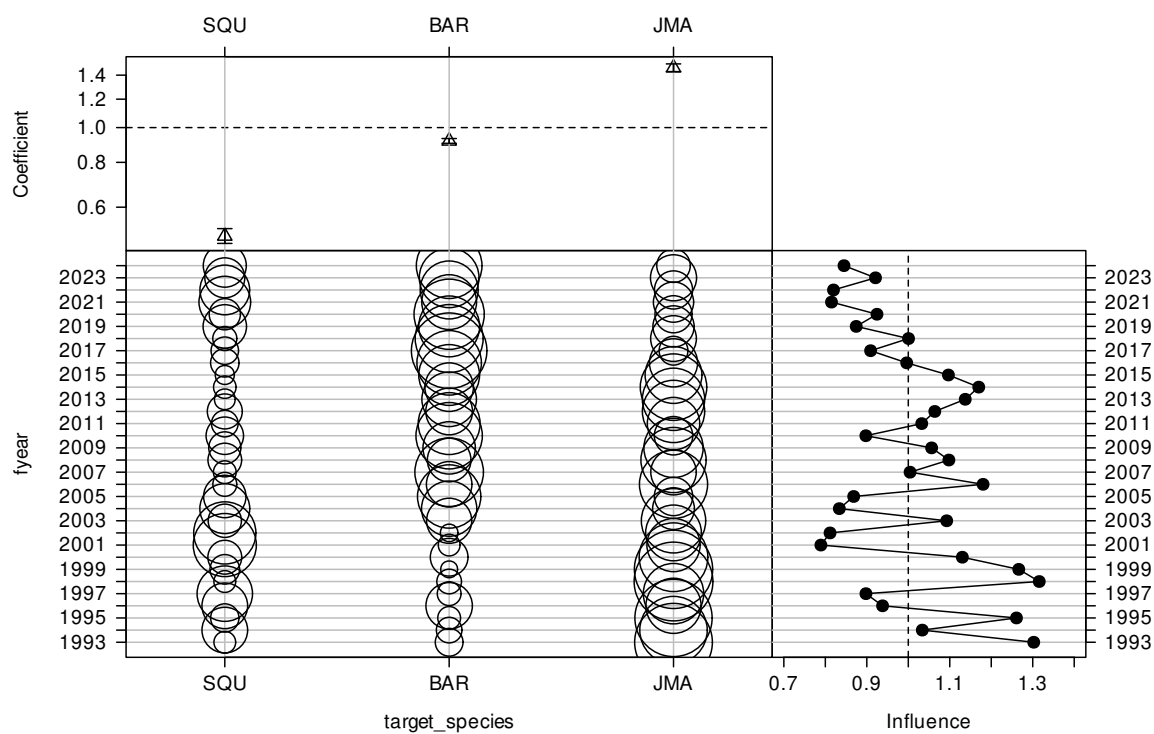


Figure D.262: CDI plot for target species for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

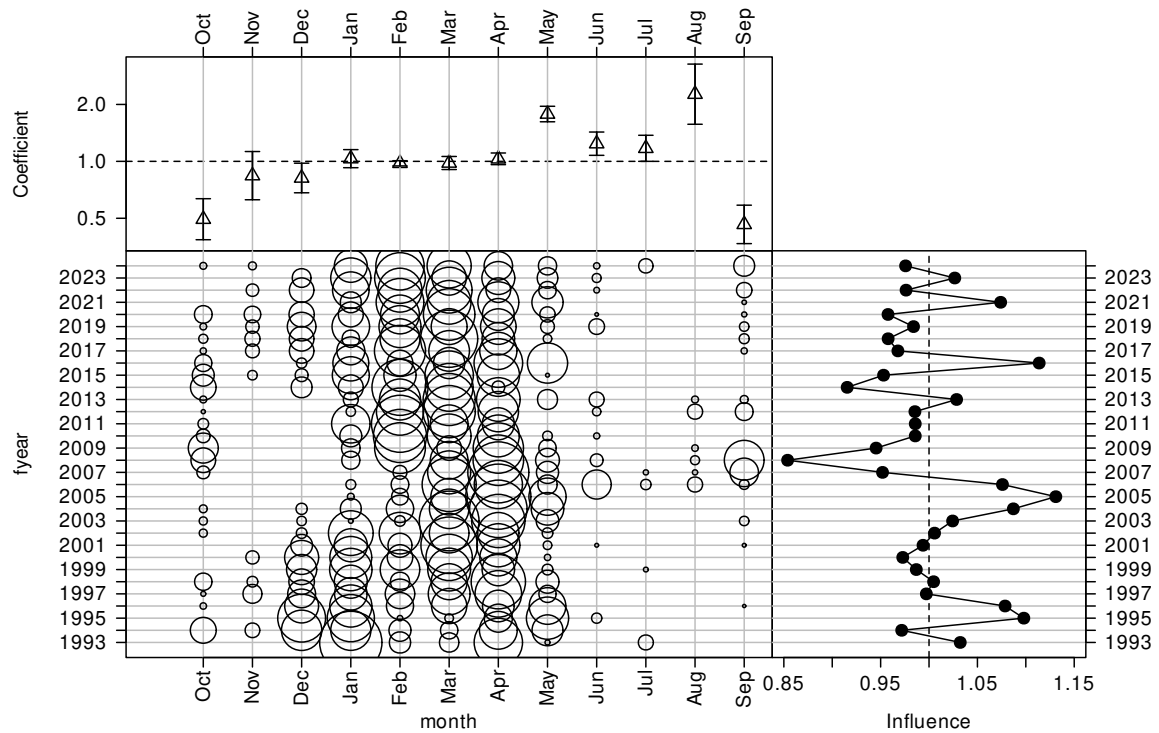


Figure D.263: CDI plot for month for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

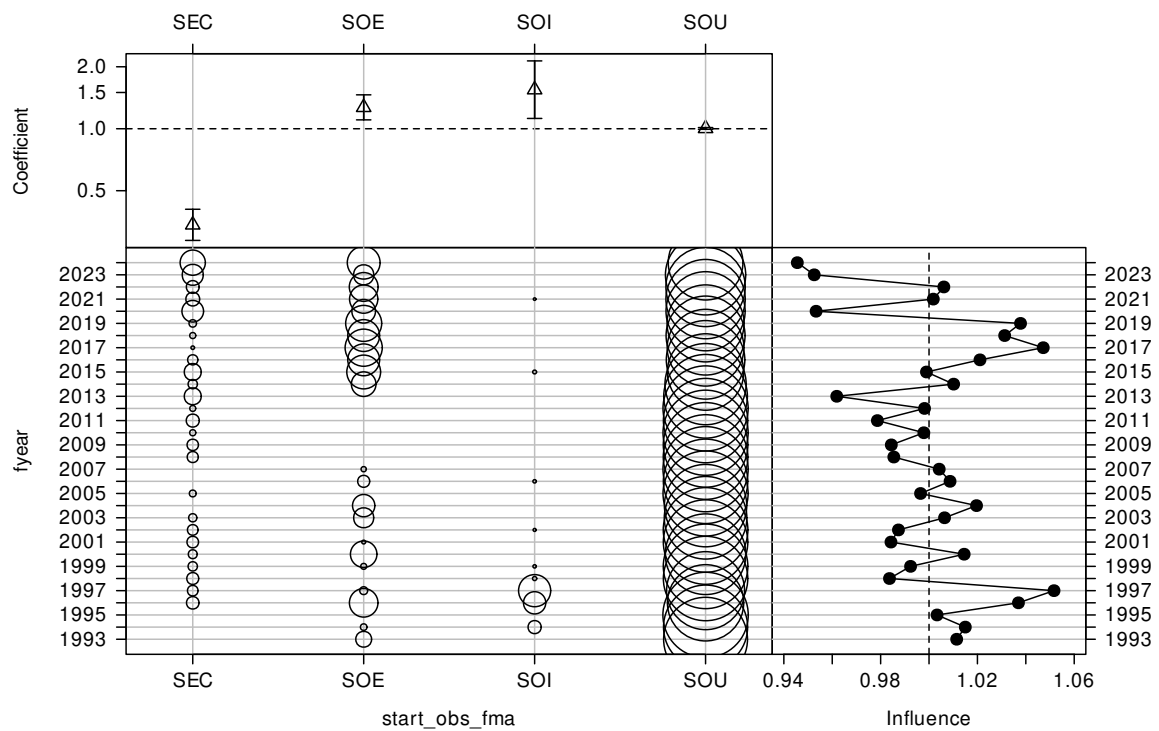


Figure D.264: CDI plot for start obs fma for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

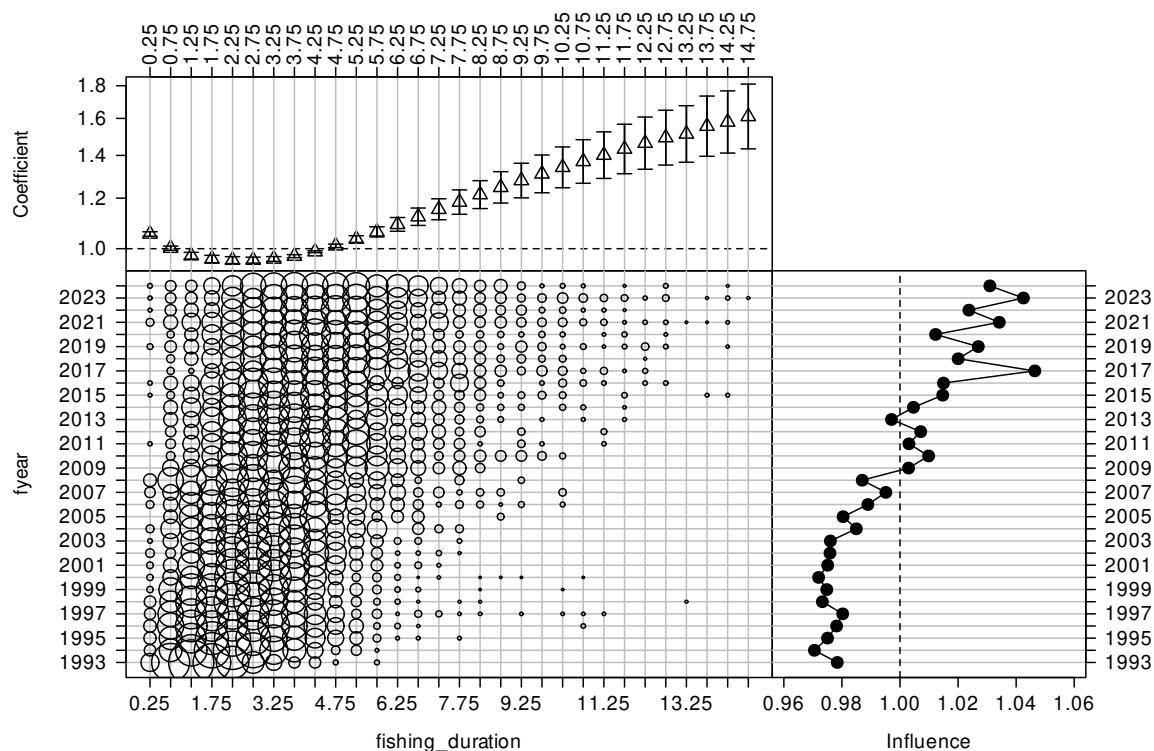


Figure D.265: CDI plot for fishing duration (h) for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

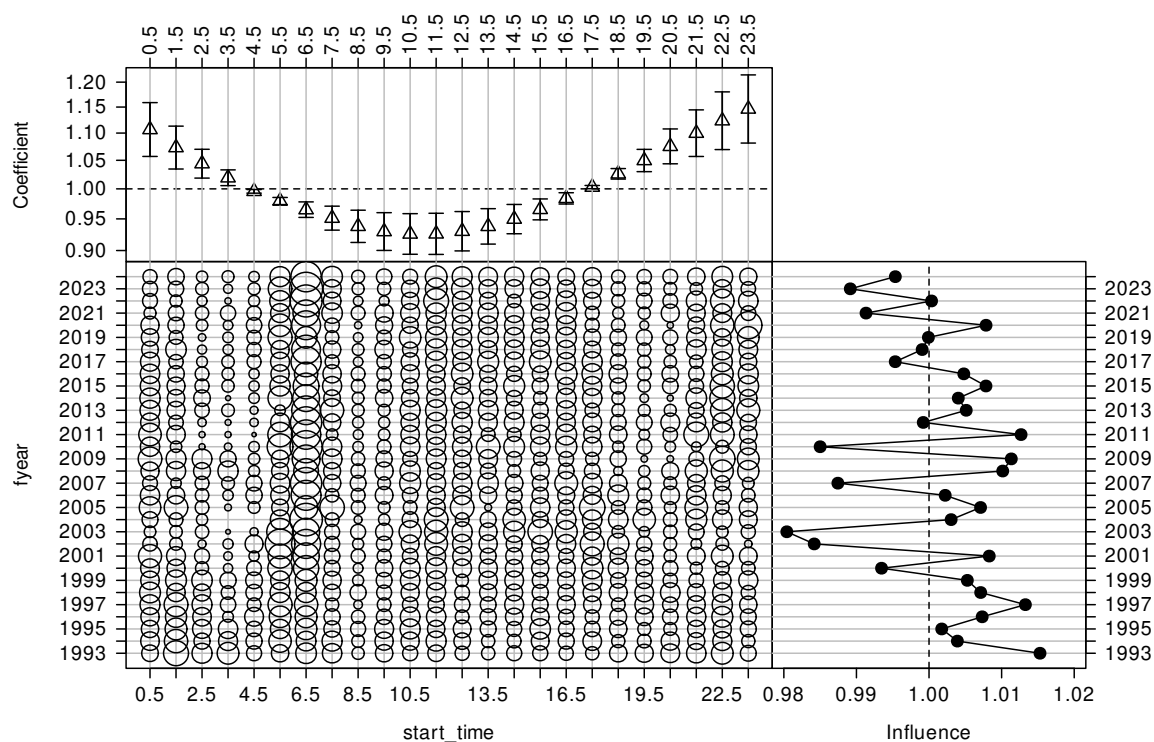


Figure D.266: CDI plot for start time for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

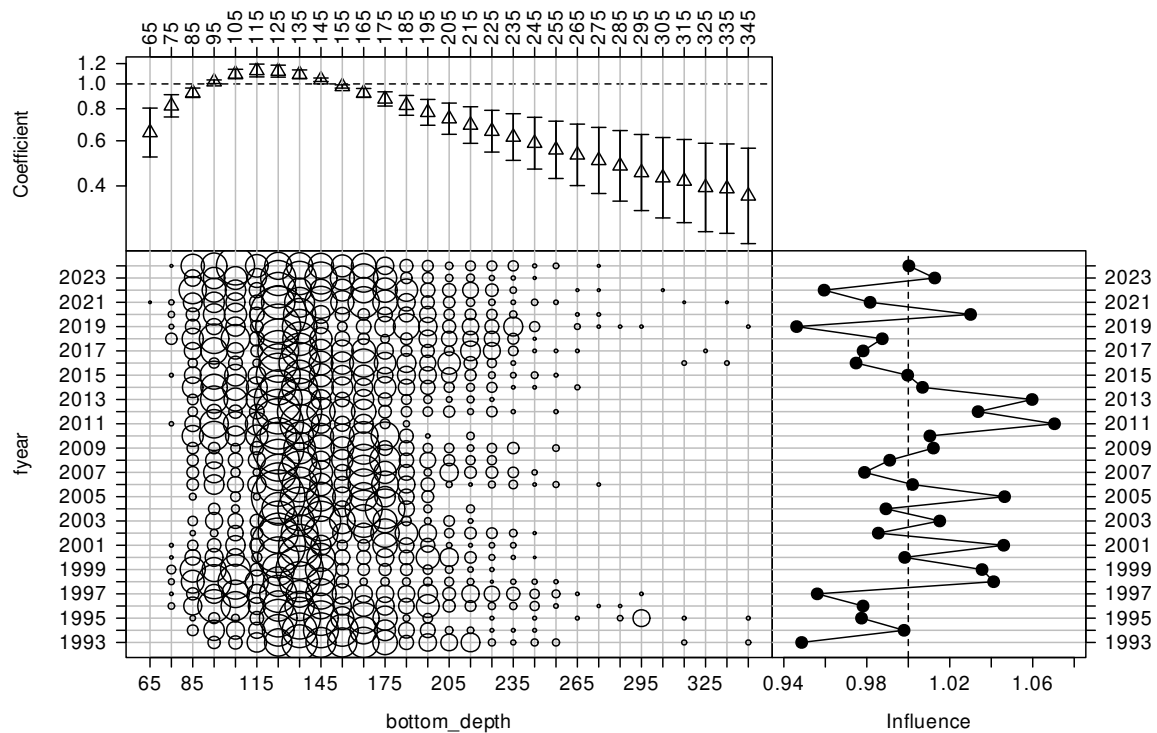


Figure D.267: CDI plot for bottom depth (m) for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

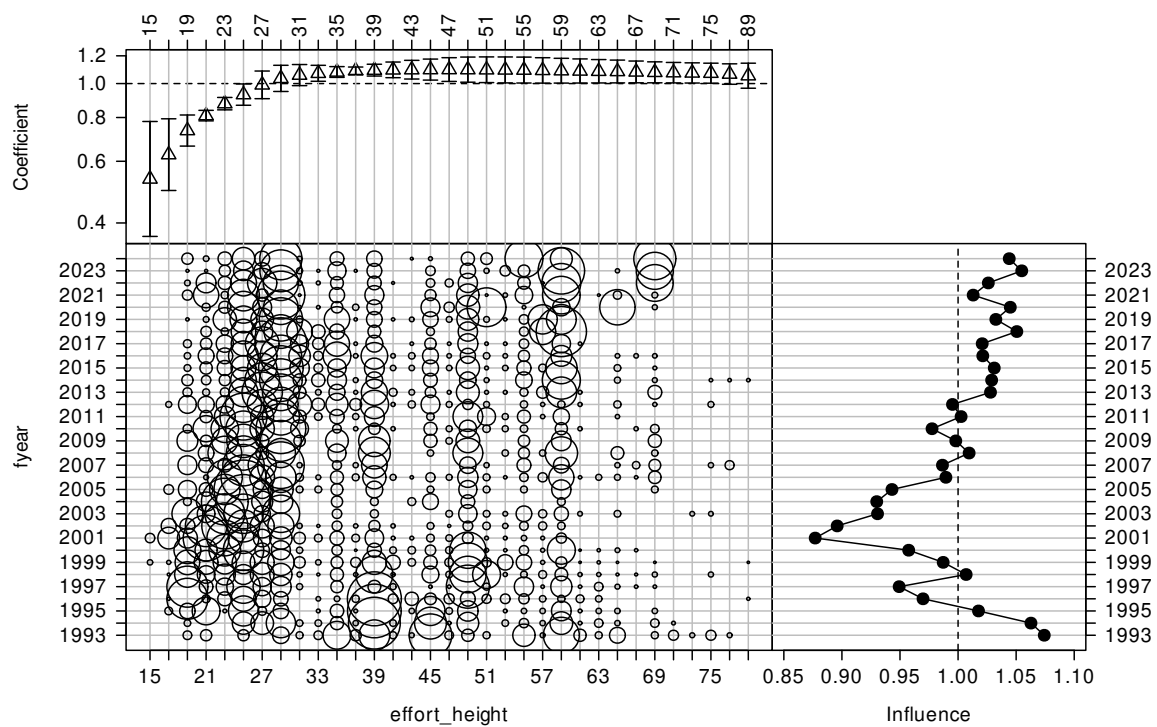


Figure D.268: CDI plot for effort height (m) for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

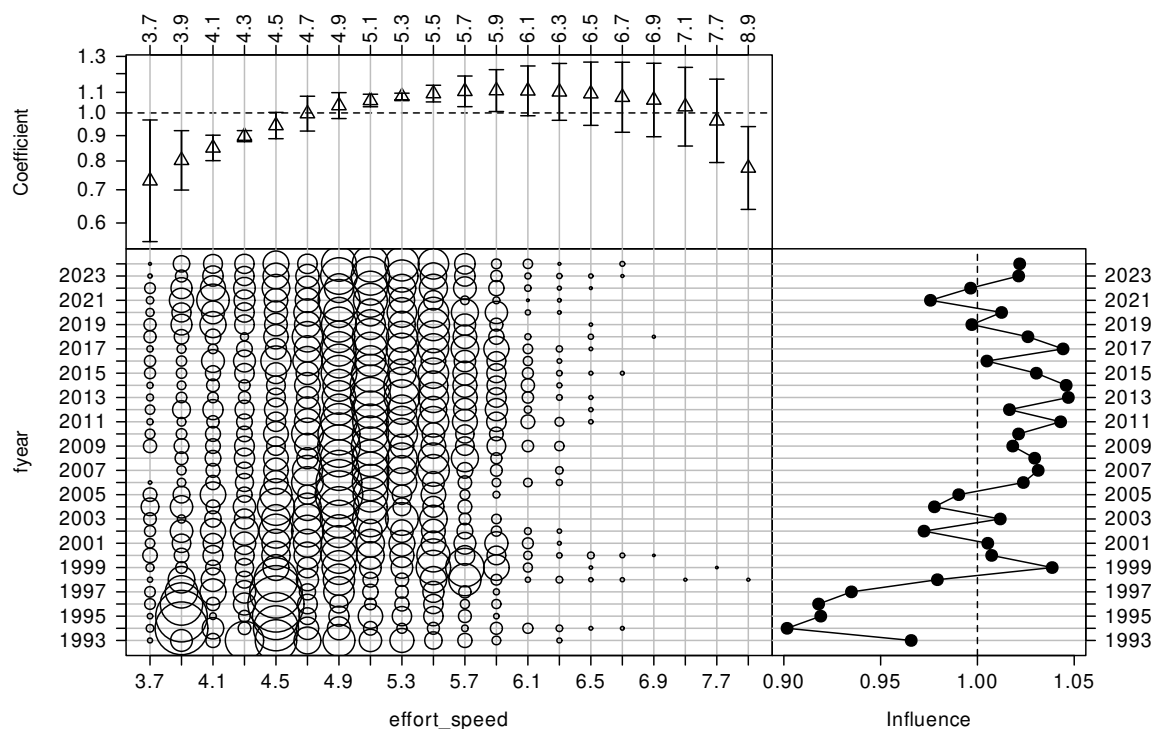


Figure D.269: CDI plot for effort speed for the Weibull model of positive catches in the JMA3 MW pred JMD event draws10 catch-per-unit-effort dataset.

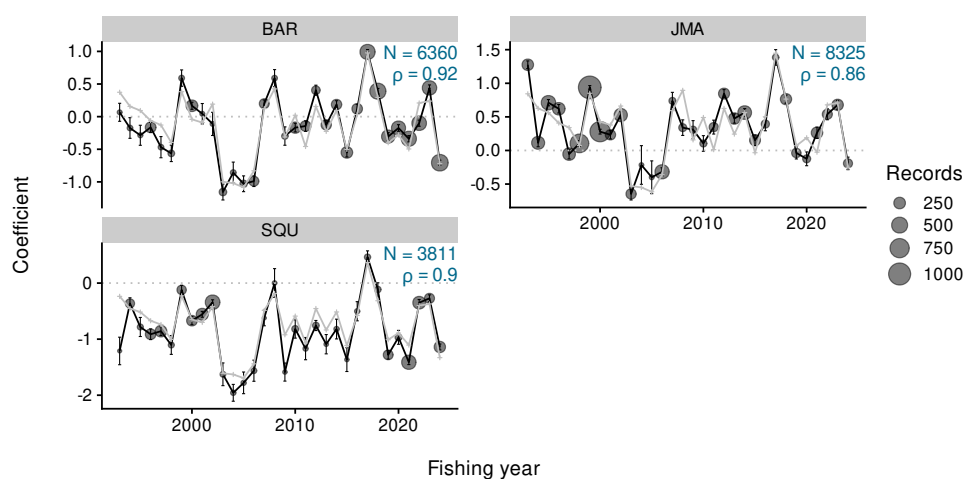


Figure D.270: Residual implied coefficients for target-year in the Weibull positive catch model for the JMA3 MW pred JMD event draws10 dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in a target-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

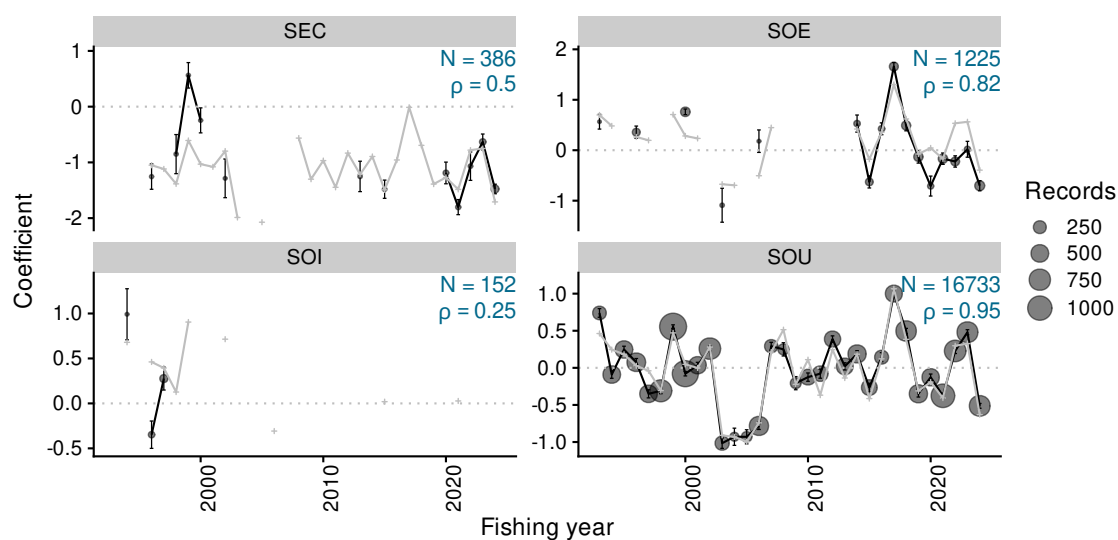


Figure D.271: Residual implied coefficients for area-year in the Weibull positive catch model for the JMA3 MW pred JMD event draws10 dataset (black points, mean +/- one standard error). The dark grey circles indicate the number of data points. Implied coefficients are only plotted when there are at least 10 data points in an area-year stratum. The light grey line and points indicate the overall year indices; these are only plotted where there are data in a stratum.

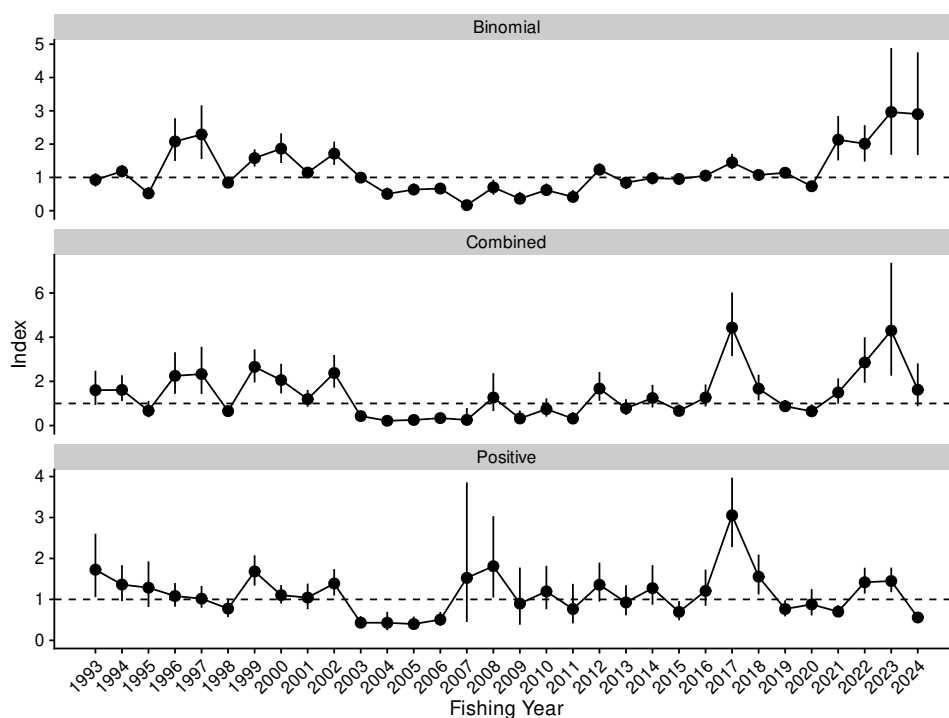


Figure D.272: Standardised indices and 95% confidence intervals for the JMA3 MW pred JMD event draws10 dataset.

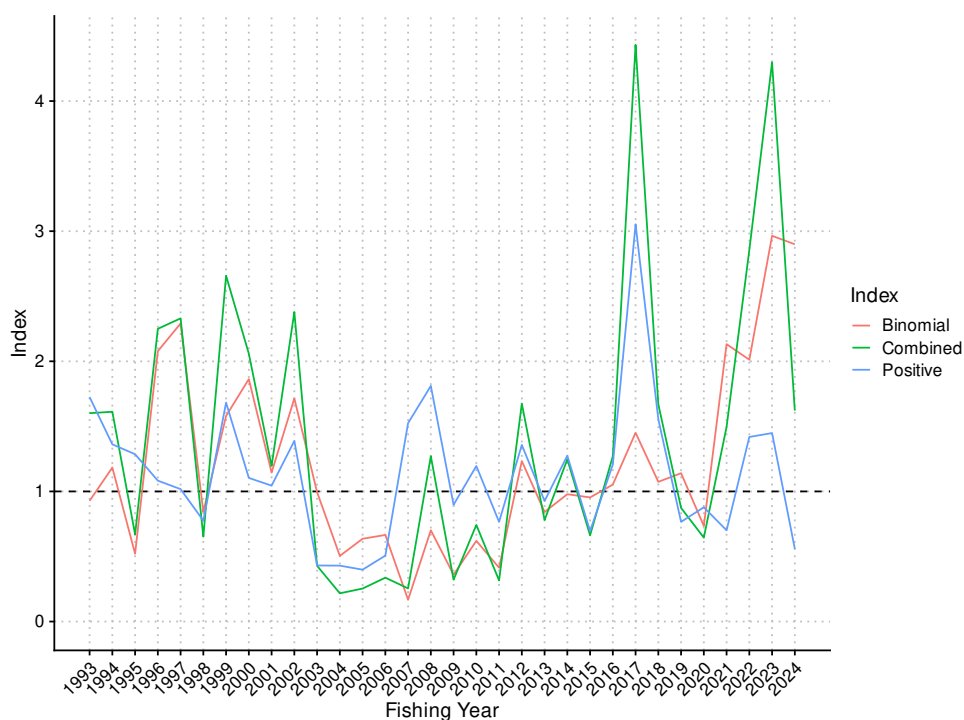


Figure D.273: Standardised indices for the JMA3 MW pred JMD event draws10 dataset.

Table D.63: Annual indices and standard errors, with upper and lower bounds (LCI: 2.5%, UCI: 97.5%) for each model in the JMA3 MW pred JMD event draws10 series.

Fishing year	Binomial				Combined				Positive			
	index	SE	LCI	UCI	index	SE	LCI	UCI	index	SE	LCI	UCI
1993	0.928	0.102	0.727	1.126	1.601	0.394	0.934	2.479	1.725	0.395	1.054	2.604
1994	1.183	0.095	1.003	1.373	1.612	0.298	1.109	2.276	1.362	0.224	0.958	1.836
1995	0.521	0.086	0.368	0.703	0.670	0.189	0.373	1.115	1.286	0.285	0.813	1.930
1996	2.078	0.326	1.496	2.776	2.250	0.480	1.436	3.319	1.083	0.147	0.823	1.399
1997	2.291	0.410	1.555	3.163	2.330	0.545	1.426	3.563	1.018	0.136	0.796	1.328
1998	0.842	0.081	0.679	0.996	0.653	0.115	0.452	0.902	0.775	0.116	0.568	1.022
1999	1.580	0.132	1.326	1.842	2.658	0.383	1.951	3.451	1.682	0.189	1.336	2.077
2000	1.863	0.227	1.433	2.322	2.058	0.341	1.457	2.794	1.104	0.115	0.899	1.351
2001	1.145	0.069	1.012	1.283	1.196	0.195	0.848	1.614	1.044	0.159	0.762	1.386
2002	1.715	0.178	1.377	2.077	2.378	0.376	1.717	3.192	1.388	0.165	1.093	1.739
2003	0.994	0.075	0.839	1.131	0.428	0.079	0.295	0.604	0.431	0.072	0.311	0.591
2004	0.504	0.088	0.353	0.697	0.217	0.070	0.109	0.383	0.430	0.115	0.248	0.697
2005	0.636	0.089	0.470	0.817	0.253	0.065	0.145	0.400	0.399	0.084	0.255	0.583
2006	0.666	0.086	0.502	0.840	0.337	0.075	0.208	0.501	0.507	0.087	0.355	0.696
2007	0.168	0.062	0.078	0.320	0.255	0.188	0.056	0.792	1.525	0.869	0.450	3.857
2008	0.702	0.114	0.480	0.928	1.271	0.437	0.659	2.372	1.811	0.506	1.047	3.032
2009	0.360	0.090	0.213	0.567	0.322	0.144	0.119	0.682	0.898	0.356	0.381	1.778
2010	0.620	0.095	0.448	0.819	0.743	0.211	0.402	1.231	1.195	0.270	0.760	1.820
2011	0.414	0.092	0.264	0.624	0.316	0.120	0.144	0.614	0.766	0.246	0.414	1.380
2012	1.233	0.091	1.066	1.423	1.674	0.332	1.121	2.422	1.357	0.243	0.946	1.898
2013	0.842	0.094	0.652	1.021	0.780	0.181	0.483	1.194	0.926	0.187	0.611	1.345
2014	0.979	0.092	0.789	1.150	1.247	0.262	0.817	1.843	1.274	0.247	0.869	1.838
2015	0.954	0.082	0.785	1.106	0.663	0.131	0.442	0.956	0.695	0.120	0.489	0.958
2016	1.053	0.089	0.880	1.227	1.271	0.254	0.863	1.860	1.207	0.226	0.843	1.728
2017	1.451	0.118	1.249	1.710	4.432	0.735	3.143	6.023	3.053	0.432	2.278	3.973
2018	1.074	0.085	0.901	1.235	1.669	0.296	1.139	2.300	1.554	0.248	1.121	2.094
2019	1.140	0.068	1.005	1.272	0.873	0.132	0.640	1.158	0.766	0.100	0.585	0.978
2020	0.735	0.083	0.574	0.901	0.645	0.138	0.419	0.962	0.878	0.164	0.608	1.253
2021	2.132	0.340	1.511	2.844	1.496	0.290	0.993	2.131	0.701	0.073	0.573	0.860
2022	2.012	0.279	1.475	2.568	2.855	0.525	1.937	3.996	1.419	0.162	1.141	1.775
2023	2.964	0.818	1.679	4.884	4.297	1.304	2.255	7.366	1.449	0.153	1.176	1.776
2024	2.900	0.787	1.671	4.756	1.621	0.496	0.871	2.815	0.559	0.063	0.447	0.696

APPENDIX E: GLOSSARY

Table E.1: Product state codes used in this report.

Code	Description
DRE	Dressed
FIL	Fillets: skin-on
GRE	Green (or whole)
GUT	Gutted
HDS	Heads
HGT	Headed, gutted, and tailed
HGU	Headed and gutted
MEA	Fish meal
SKF	Fillets: skin-off

Table E.2: Form type codes used in this report.

Code	Description
CEL	Catch, Effort and Landing Return (CELR)
ERS - Lining	Electronic Reporting System - Lining
ERS - Netting	Electronic Reporting System - Netting
ERS - Potting	Electronic Reporting System - Potting
ERS - Seining	Electronic Reporting System - Seining
ERS - Trawl	Electronic Reporting System - Trawl
HTC	High Seas Trawl Catch Effort Return (HS TCER)
LCE	Lining Catch Effort Return (LCER)
LTC	Lining Trip Catch Effort Return (LTCER)
NCE	Netting Catch, Effort and Landing Return (NCELR)
SJC	Squid Jigging Catch and Effort Return (SJCER)
TCE	Trawl Catch Effort Return (TCER)
TCP	Trawl Catch, Effort and Processing Return (TCEPR)

Table E.3: Fishing method codes used in this report.

Code	Description
BT	Bottom trawl
MW	Midwater trawl
PRB	Precision bottom trawl
PRM	Precision midwater trawl
PS	Purse seine
SJ	Squid jig

Table E.4: Species codes used in this report.

Code	Common name	Scientific name
BAR	Barracouta	<i>Thyrsites atun</i>
HOK	Hoki	<i>Macruronus novaezelandiae</i>
JMA	Jack mackerel	<i>Trachurus declivis</i> , <i>Trachurus murphyi</i> , <i>Trachurus novaezelandiae</i>
KAH	Kahawai	<i>Arripis trutta</i> , <i>Arripis xylabion</i>
RCO	Red cod	<i>Pseudophycis bachus</i>
SQU	Arrow squid	<i>Nototodarus sloanii</i> , <i>Nototodarus gouldi</i>
SWA	Silver warehou	<i>Seriolella punctata</i>
WAR	Common warehou	<i>Seriolella brama</i>

Table E.5: Area codes for Observer data used in this report.

Code	Description
SEC	South-East (Coast) (FMA 3)
SOE	South-East (Chatham Rise) (FMA 4)
SOI	Southern Ocean Islands (Auckland Islands and Campbell Island)
SOU	Southland (FMA 5)