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Resource Assessment Report No.6: Western Rock Lobster Resource - 2025 update assessment

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Western Rock Lobster Resource

2025 Update Assessment

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Aquatic Resource Assessment Report No. 6

Western Rock Lobster Resource
2025 Assessment

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Executive Summary

The western rock lobster (WRL) fishery is considered sustainable with catches being slightly below those associated with the maximum economic yield (MEY) proxy (39% harvest rate), which ensures the large lobster biomass and economical catch rates are maintained. The marine environment continues to be the biggest driver in stock dynamics with post larval recruitment (puerulus) and adult behaviour, including catchability, strongly influenced by oceanic conditions. Recent seasons have seen strong Leeuwin Currents and warm ocean conditions. Over the past few seasons, puerulus settlement levels have been below average at numerous locations and it has been almost 10 years since there was a coast wide above average "spike" in puerulus settlement (2016). The spatial distribution of fishing suggests a possible southward concentration of the lobster stock with the northern end of Zone B potentially showing some signs of reduced productivity. This may be a short-term anomaly or part of a longer-term climate driven progression.

For the 2024/25 fishing season multiple lines of evidence indicate that the WRL resource is at an acceptable level of depletion (LOW risk of unacceptable stock depletion). This assessment is based on empirical data from the commercial and recreational fisheries, fishery independent surveys and stock assessment models.

In summary:

- Catch and effort data do not indicate a high level of lobster depletion in any region of the fishery.
- Catch rates remain well above historical levels throughout the fishery.
- The size composition of lobster measured through multiple surveys does not indicate a high level of lobster depletion in any region.
- Fishery independent recruitment surveys do indicate a recent period of below average recruitment, but this is most likely associated with unfavourable environmental conditions.
- Fishery independent surveys indicate that breeding biomass is well above historic levels throughout the fishery.
- A data moderate (Level 4) fishery wide model estimates that the resource is not over-fished and over-fishing is not occurring.
- The fine spatial and temporal scale (Level 5) integrated model estimates legal biomass and egg production are well above historic levels and harvest rates are below that used as a proxy for MEY (39%).
- A continuation of the current TACC (6800 t) will maintain high biomass levels throughout the fishery over the following five fishing seasons.

Assessment Overview

Target Stocks

Stock / Species	Stock Risk	Fishing Mortality	Relative Biomass	Status
Western Rock Lobster	Low	$F<F_{target}$	$B>B_{threshold}$	Sustainable-Adequate

Application of Control Rules:

Breeding stock levels are above thresholds and forecast to remain there over the subsequent five projected fishing seasons with a confidence level greater than 75%. Harvest rates are below but tracking towards their target. No change to TAC is required for the 2026 season.

Ecological Components

Feature	Risk	Comments
Other Retained Species: Octopus Champagne Crab Southern Rock Lobster Tropical Rock Lobster	 Low Low Low Low	All caught in relatively low numbers (kg) 13902 962 5 2
Bycatch	Acceptable	Lobster pots are not efficient at trapping bycatch species (e.g. finfish) and most are returned alive.
ETP Species Whales Sealions Turtles	 Acceptable Acceptable Acceptable	Management requires the uses of SLEDs and whale mitigation gear to reduce interactions. Bait bands are banned from vessels.
Habitats	Acceptable	Fishing gear causes minimal impacts to the habitat.
Ecosystem	Acceptable	Assessed using 5 yearly risk assessments

Application of Control Rules:

The interaction between the fishery and ecological components are all acceptable, with the fishery being a low risk to the sustainability of byproduct species. No reduction in fishing effort or gear modifications are required.

Socio-Economic Components and External Drivers

Feature	Level	Comments
Economic	High	2024/25 GVP AUD$373 million. GVP will increase with resumption of Chinese imports.
Social	High	Largest recreational fishery and largest commercial fishing fleet in Western Australia

External Drivers (climate)	Medium	A strong Leeuwin current continues to move the mean latitude of puerulus settlement southward.
External Drivers (others)	Medium	Expansion of areas closed to fishing (sanctuary areas / wind farms) could increase over the next decade.

Application of Control Rules:

Harvest rates are below those associated with maximum economic yield but are approaching this target over projected five fishing seasons. The recreational sector is obtaining good catch rates and is close to obtaining their allocation (TARC: Smallwood et al., 2023). In 2024 there were no reported impacts on the accessible stock by climate variation (e.g. heat waves) and no spatial reductions to fishing grounds. No change to TAC is required for the 2026 season.

1 Background

1.1 Resource Description

The Western Rock Lobster resource (WRL) is accessed primarily by the West Coast Rock Lobster Managed Fishery (WCRLMF) located off the West Coast of Western Australia, with far smaller catches coming from the South Coast Crustacean Managed Fishery (SCCMF) which is located off the South Coast of Western Australia (Figure 1.1). The WCRLMF was certified under the Marine Stewardship Council (MSC) standard in 2000 and was the first fishery in the world to be MSC certified. Since then, it was successfully reaccredited in 2006, 2012, 2017 and 2022.

The stock structure of WRL has been examined genetically through allozyme electrophoresis (Johnson and Wernham, 1999; Thompson et al., 1996). Both studies concluded that WRL is a single panmictic population (both on the west and south coasts), with ephemeral genetic patchiness between cohorts. A more recent study examined microsatellite and mitochondrial sequences of WRL to examine possible changes in genetic variation over time (Kennington et al., 2013). This again confirmed the previous assertions of a single panmictic population.

The WCRLMF is regulated by the *West Coast Rock Lobster Management Plan 2012*, the *Western Australian Fish Resources Management Act 1994*, and *Fish Resources Management Regulations 1995*. A formal Harvest Strategy has been developed to support the ecological, social, and economic management objectives of this fishery (DPIRD, 2024).

The SCCMF is regulated by the *South Coast Crustacean Management Plan 2012*, the *Western Australian Fish Resources Management Act 1994*, and *Fish Resources Management Regulations 1995*. A formal Harvest Strategy has been developed to support the ecological, social and economic management objectives of this fishery (DPIRD, 2023).

This document provides (i) an update on changes to the fishery for annual audits by the MSC certification body and (ii) the annual stock assessment update for quota setting of the WRL resource. A weight of evidence assessment of the resource is provided that includes information on other ecological components which may be impacted by the resource in the 2024 fishing season (represents the 2024/25 financial year). This document also provides information required to inform the setting of TACs for the future seasons.

Unless otherwise stated, data summarised in this report include up to the 2024/25 financial year. The datasets discussed are a synopsis of more comprehensive data which can be found in de Lestang et al. (2016) and Bellchambers (2017).

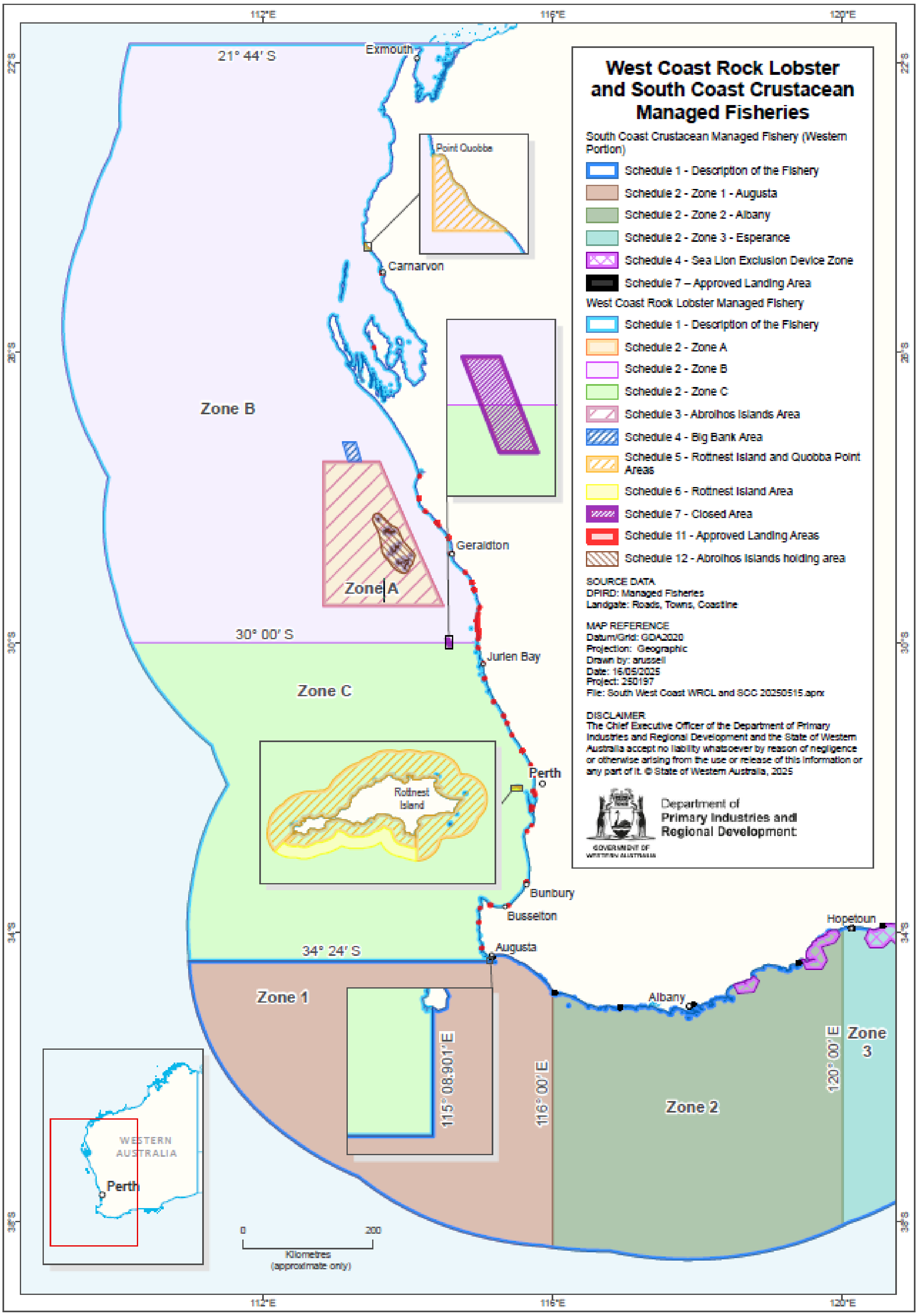

Figure 1.1. Location and boundaries of the WRL Resource accessed by two managed fisheries (WCRLMF and SCCMF) and their specified management zones.

1.2 Assessment Approach

The different methods used by the Department of Primary Industries and Regional Development to assess the status of aquatic resources in WA have been categorised into five broad levels, ranging from relatively simple analysis of catch and effort information, through to the application of more sophisticated analyses and models that incorporate biological data (e.g., de Lestang et al., 2016). The relevance and applicability of each assessment level varies among stocks and is determined based on the level of ecological risk, the biology and population dynamics of the relevant species, the characteristics of the fisheries exploiting the species, and data availability.

Irrespective of the types of assessment methods used, all stock assessments undertaken by the department apply a risk based, weight of evidence approach. This requires the consideration of each available line of evidence, including outputs from quantitative (empirical and/or model based) analyses, as well as qualitative lines of evidence such as biological and fishery information that describe the inherent vulnerability of the species to fishing. For each stock, all the lines of evidence are considered, both individually and collectively, within the department's ISO 31000 based risk assessment framework to derive an overall risk status from the combinations of consequence and likelihood scores (Fletcher, 2015).

1.3 Scope

This report provides an update assessment for the WRLR, following the principles of ecosystem based fisheries management (EBFM; Fletcher 2015). The document provides information relevant to monitoring of the broader resource (Section 4), as well as more detailed stock assessment outputs for the target species (Section 5). Additional information relevant to assessing the risk to other ecological components affected by fishing activities targeting the WRLR are also presented in Section 6. As the main fishery accessing the resource (WCRLMF) has a fishing season aligned with financial year (Table 1.1), this assessment will be conducted on the 2024/25 financial year.

Table 1.1. Fishery's season dates accessing the WRLR.

Fishery	Season dates
WCRLMF	1st July – 30th June
SCCMF	1st July – 30th June

2 Resource Level

2.1 Catch

Catches are determined through a combination of compulsory catch logs (WCRLMF commercial, WCRLMF charter and SCCMF) and voluntary surveys (WCRLMF recreational). In 2023/24, a total of 7910 t of the WRL resource was retained by the three WCRLMF sectors who collectively landed over 99% of all WRL catch (Figure 2.1).

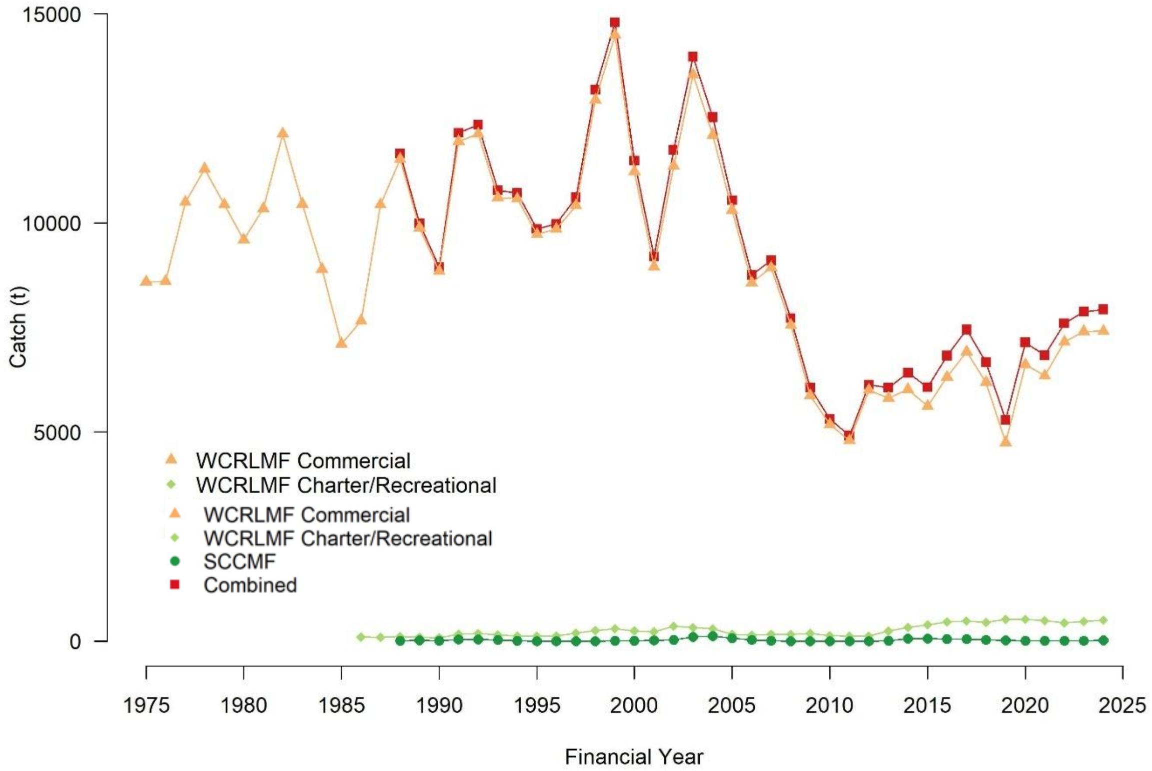

Figure 2.1. Retained catch (t; whole weight) by fishery (WCRLMF; South Coast Crustacean Managed Fishery, SCCMF) accessing the West Coast Rock Lobster Resource in 2024/25.

2.2 Effort

Nominal fishing effort is determined on a sector (e.g. commercial, recreational, charter) / fishery specific (WCRLMF or SCCMF) basis. Due to unclear species targeting in the SCCMF until 2020 and a change in seasonal structure within the recreational WCRLMF sector, effort by financial year has only been plotted from the WCRLMF commercial sector. As more data become available for the other sectors/fisheries it will be added to future reports.

For the commercial WCRLMF sector, effort levels progressively increased from ~10 million pot lifts in 1975 to ~ 13 million in 1991 (Figure 2.2). The introduction of pot reductions in 1993 caused effort to drop back to ~ 10 million. Additional effort reductions introduced in 2005 – 2008, and a change in management regime in 2010 from effort to quota, cumulatively dropped effort to historic lows of ~2.5 million pot lifts between 2010 and 2021. Over recent seasons, as the commercial TAC has progressively increased from 5.5 million kg to 7.3 million kg, pot lifts have also increased slightly, although a slight decline occurred in 2024 (Figure 2.2). Recreational participation in the WCRLMF is monitored through surveys, which require various adjustments to account for reporting bias and the impact of the recreational season changing from November to June to year round (Smallwood et al., 2023). Analysis to develop a timeseries of recreational effort (both pot lifts and diver days) is currently underway.

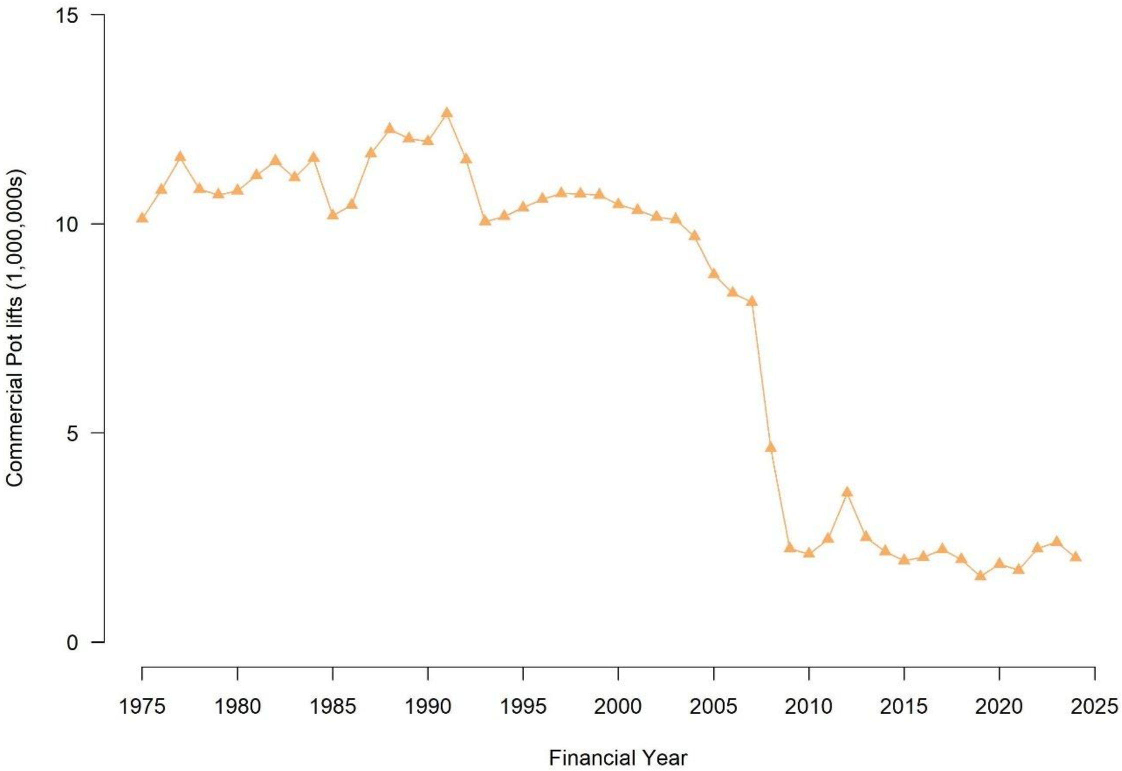

Figure 2.2. Annual fishing effort: number of pot lifts by the WCRLMF commercial sector.

2.3 Social and Economic

Based on the most recent available beach prices (for the 2024/25 financial year), the value of the WRLR was $375 million for the 2024/25 season (Table 2.1), with the WCRLMF comprising the majority of this. The main market for the resource is live export. The WCRLMF is considered to have a high social amenity value as it is the biggest recreational fishery in the state (31,156 participants in 2023/24 season) while also having the greatest number of commercial vessels of any fishing fleet (196 vessels). Both recreational participation and commercial vessels declined slightly from their previous seasons (35,236 and 207, respectively) (Figure 2.3). Based on an average of two – three crew per vessel, approximately 490 commercial fishers were directly involved in the fishery in 2024/25. Most commercial product is landed live at ports between Kalbarri and Fremantle, generating additional economic activity and benefits. In the SCCMF WRL are mainly caught in zone 1 by two commercial vessels and landed in Augusta.

Recreational participation progressively increased from the 1980s to early 2000s in concert with the Western Australia population growing, combined with three pulses of good puerulus settlement (1984, 1989 and 1995) which increased recreational lobster catch rates. Participation then declined as catch rates reduced (Melville-Smith et al., 2004) before increasing markedly in 2010 as management changes increased lobster biomass (and thus catch rates) followed by a relaxation of recreational regulations (Appendix 1), thus making obtaining a recreational bag limit easier and potentially increasing recreational amenity. The cause of the recent decline in recreational participation (2022 and 2023) is unknown but may represent a spike during the Covid 19 pandemic with participation now returning to a more "normal" level (Figure 2.3).

Table 2.1. Estimated value (beach price) of WRL by fishery which comprise the resource, for the financial year 2024/25. Catches reported in tonnes as per Figure 2.1. and (*) SCCMF catch records have not been finalised for the 2024/25 fishing season due to delays in the submission of catch records.

Species	Fishery	Catch (t)	Beach price ($/kg)	Value
Western Rock Lobster	WCRLMF	7410	$50.20	$371,998,767
Western Rock Lobster	SCCMF	20*	$50.20	~$1,000,000

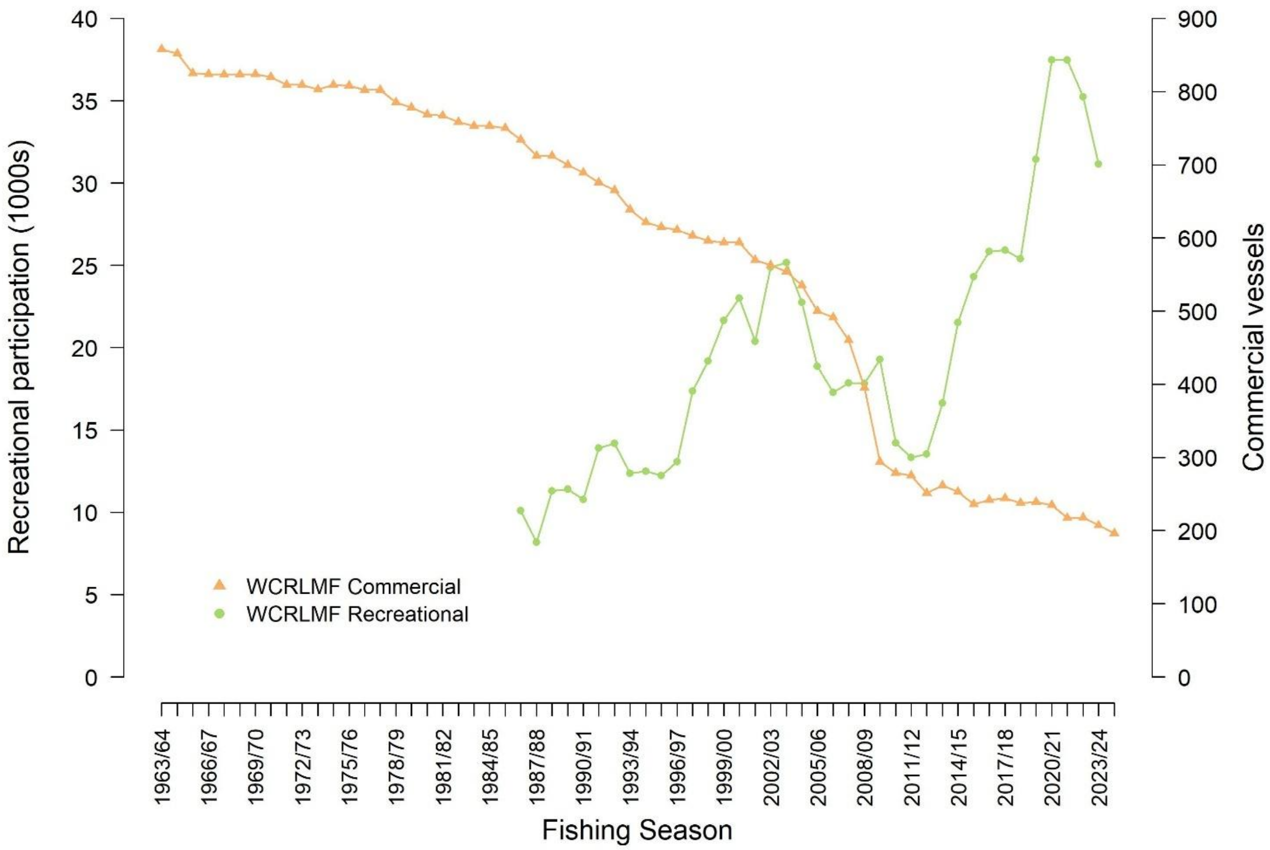

Figure 2.3. Commercial (orange triangles) and recreational (green filled circle) participation in the WCRLMF.

3 Species Assessment

3.1 Western Rock Lobster

3.1.1 Catch

Each fishing season, four year old WRL undergo a migration during which they become very catchable (they also develop a white coloured shell and are referred to as “whites”). This migration spans November to February and due to their increased catchability, they dominate the commercial and recreational catches during this period. Historically the annual commercial catch was equally spread between whites (November to February) and reds (March – October) periods of the year, however this has progressively changed, with far more lobsters now being landed during the reds period (Figure 5-1). This change has occurred even after the “opening up” of A zone to whites fishing following the move to quota management in 2010 and a corresponding expansion of the fishing season (prior to 2010 A zone was closed to fishing July – 15th March) (Appendix 1). The proportion of the catch landed within each management zone between the two periods since 2010 has continued to change, with the magnitude of the catch landed as whites beginning to increase over the past few years (Figure 3.1).

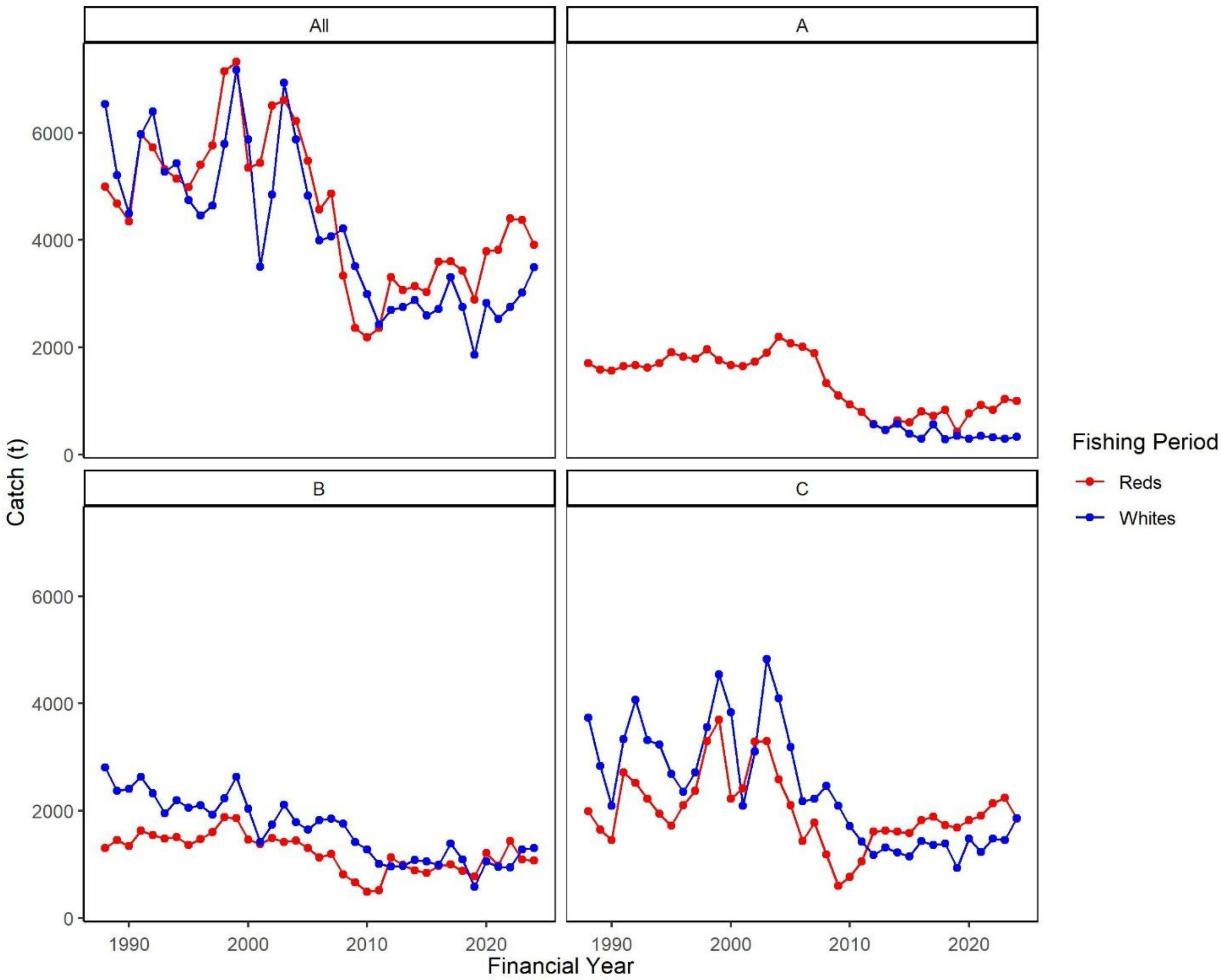

Figure 3.1. Commercial WCRLMF catch during the whites (A: Nov – Feb) and reds (B: Mar – Oct) periods during each financial year since 1988 for the whole fishery (All) and in each management zone (A, B and C).

The relative contribution of each management zone in each month to that financial year's total catch changed markedly with the move to quota in 2010 and year round fishing (Figure 3.2). This was especially the case in zones B and C in December, which had historically contributed 30% of the entire season's catch, whereas in recent years this has declined to ~ 15% as a greater proportion of the catch is now landed in July – October (Figure 3.2). There has also been a decrease in the contribution in March and April since 2010.

Figure 3.2. Proportion of commercial WCRLMF catch landed in zones A (coral), B (green) and C (blue) and month during each financial year since 1988.

The proportion of catch landed within each latitude of the northern and southern halves of the fishery has progressively changed over time, especially in the northern half of the fishery (Figure 3.3). Prior to 1990 latitude 29° contributed less than half of all catch landed in zones A and B, with latitude 28° being the most productive. Around 1990, latitude 27° started to contribute more to the northern catch, while 28° declined to ~20% and latitude 29° increased to ~50%. Since 1990 there has been a progressive move southward in zones A and B, with latitude 27° producing a smaller proportion and latitude 29° a greater proportion (Figure 3.3). In the southern half of the fishery, Zone C, the contributions from each latitude have remained relatively stable across the timeseries, albeit with a cyclic signal being present as catches in the most southern latitudes (32 ° and 33°)

increase/decrease following pulses in puerulus settlement. Like the north, there is also a very slight southward trend, with C zones most northern latitude (30°) decreasing slightly and the more southern (32°) increasing slightly over the timeseries. The progressive southward trends in the north and south may reflect a slow change in lobster biomass distribution in response to drivers such as increasing water temperatures (see section 3.1.8), or it may reflect a movement of fishers away from regional areas to the major ports of Geraldton (north) and Fremantle (south) for lifestyle reasons.

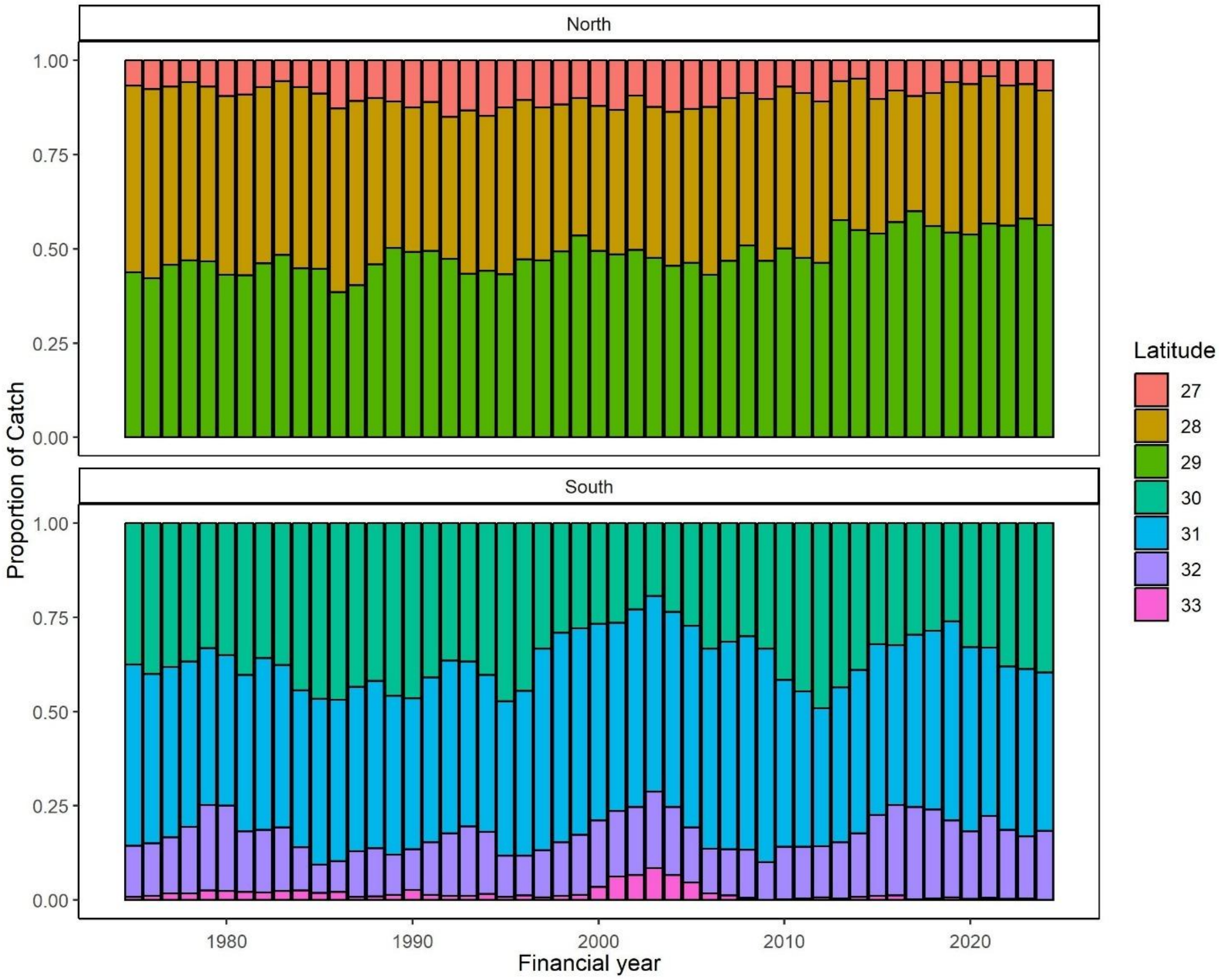

Figure 3.3. Relative proportion of commercial WCRLMF catch landed in the north (Zones A and B) and south (Zone C) of the fishery each financial year since 1975 across the various latitudes in each zone.

A finer spatial spread of catches can be examined only since the introduction of catch disposal records in 2010, which changed commercial fishing reporting from 1° blocks to 10x10' blocks (Appendix 1). The catch anomalies represent the difference in the proportion of the current season's catch landed in a block relative to the long term (2010 – most recent season) average proportion landed within that block. A decrease (red block) indicates that less than 50% of the average landings were reported in the current season in that block and an increase (green block) indicates that there was a 50% increase from the long-term average.

During 2024/25 in the whites fishing season there were large areas where the relative catch declined, mainly in deepwater areas throughout zone C and much of A zone (Figure

3.4, left). A greater proportion of the whites catch was landed around latitude 30° in deepwater and off Cervantes and through a region that emanated from the coast at ~29°S. In the reds period of fishing (March – October) there has been a marked reduction in catches being landed in the northern end of the fishery above Latitude 27°S and an increase at the southern end of B zone (Figure 3.4, right). A and C zone have seen catches move further inshore.

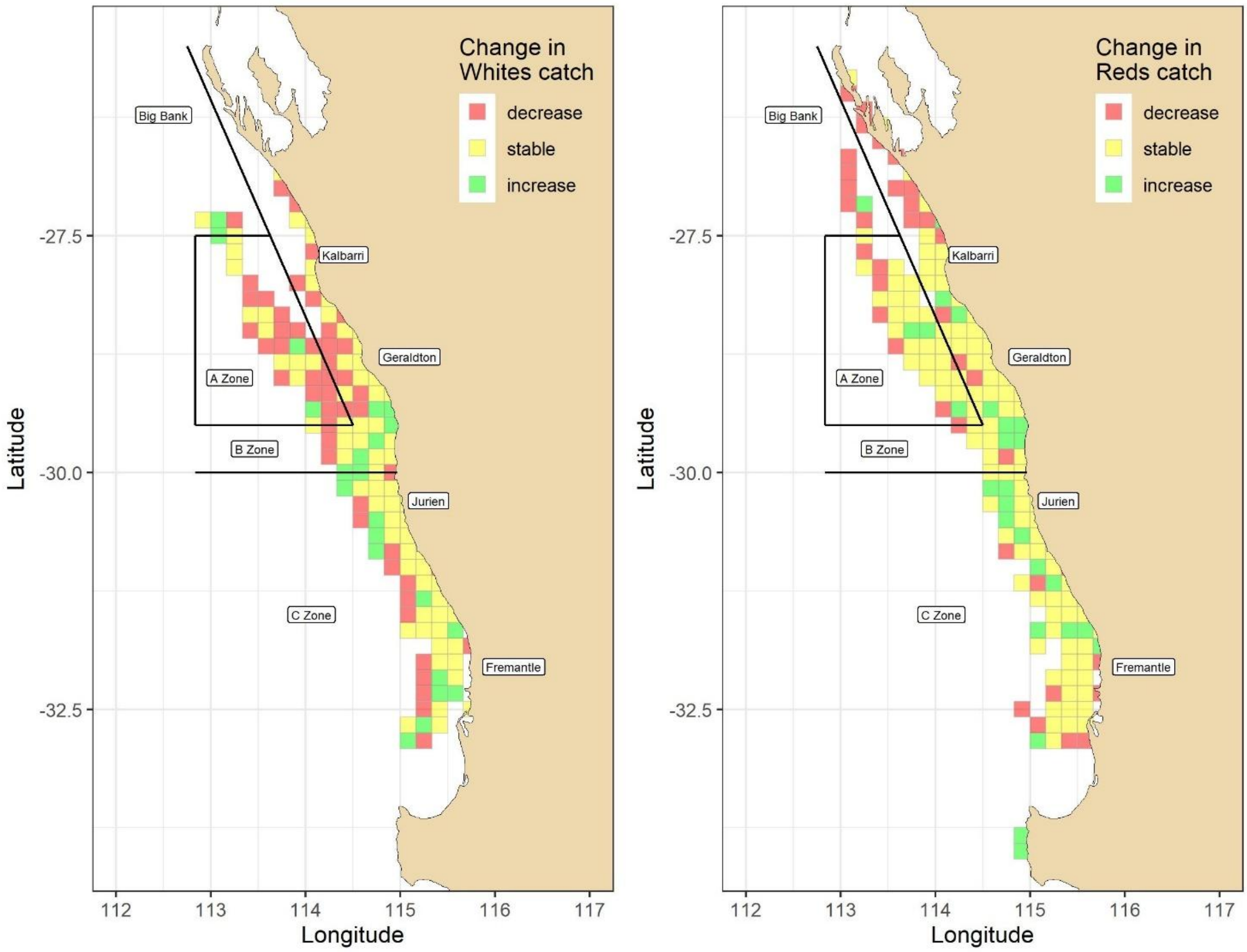

Figure 3.4. Spatial distribution of commercial WCRLMF catch anomalies (from 2010 – 2024 average) during the whites (A: Nov – Feb) and reds (B: Mar – Oct) periods of the 2024/25 fishing season.

Catch data do not indicate a high level of lobster depletion in any region of the fishery, indicating the stock is at a low risk of being over-fished.

3.1.2 Effort

The proportion of effort (pot lifts) each financial year progressively changed over time in a very similar fashion to that of the catch (Figure 3.3, Figure 3.5). Essentially the more northern latitudes in each area of the fishery have shown a progressive decline over time, while the more southern latitudes a progressive increase, especially in the northern half of the fishery (Figure 3.5). As with the catch distribution, these trends in the north and south may reflect fishers behaviour as they track the lobster biomass distribution which could be moving south in response to a driver such as increasing water temperatures (see section 5.1.8), or it may reflect a movement of fishers away from regional areas to the major ports of Geraldton (north) and Fremantle (south) for lifestyle reasons.

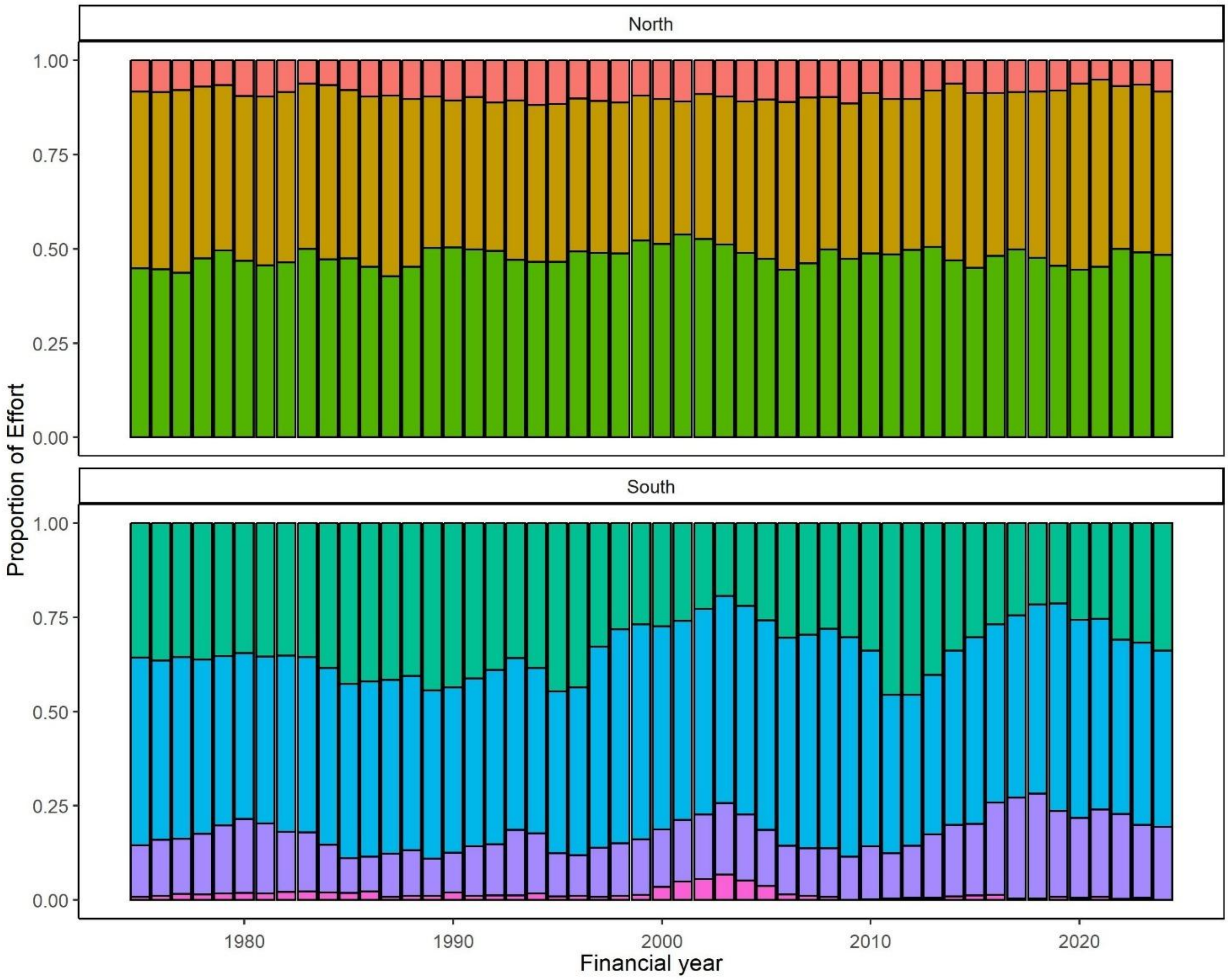

Figure 3.5. Relative proportion of commercial WCRLMF effort in the north (Zones A and B) and south (Zone C) of the fishery each financial year since 1975 across the various latitudes of each zone (coral, brown, green, aqua, blue, purple and pink represent latitudes 27° to 33°S, respectively).

The finer spatial spread of effort (pot lifts) was also examined using 10x10' blocks CDR data. The effort anomalies represent the difference in the proportion of the season's total effort (pot lifts) in a block relative to the long-term (2010 – current) average proportion of pots fished within that block. A decrease (red) indicates that less than 50% of the average effort was reported in the target year in that block and an increase (green) that there was a 50% increase from the long-term average.

In 2024, there was an overall move in effort from the whites to reds fishing period, as shown by the greater number of areas of increase during the reds (Figure 3.6). During the whites fishing period in 2024 there was a relative increase in effort towards the northern end of A zone, and inshore at the southern end of B zone (Figure 3.6). Relative reductions in effort occurred in deepwater B zone and around the border between A and B zone, while in C zone relative effort declined through much of the deepwater fishing grounds.

During the reds fishing period, effort was noticeably reduced in the northern end of B zone and in an area south of Fremantle.

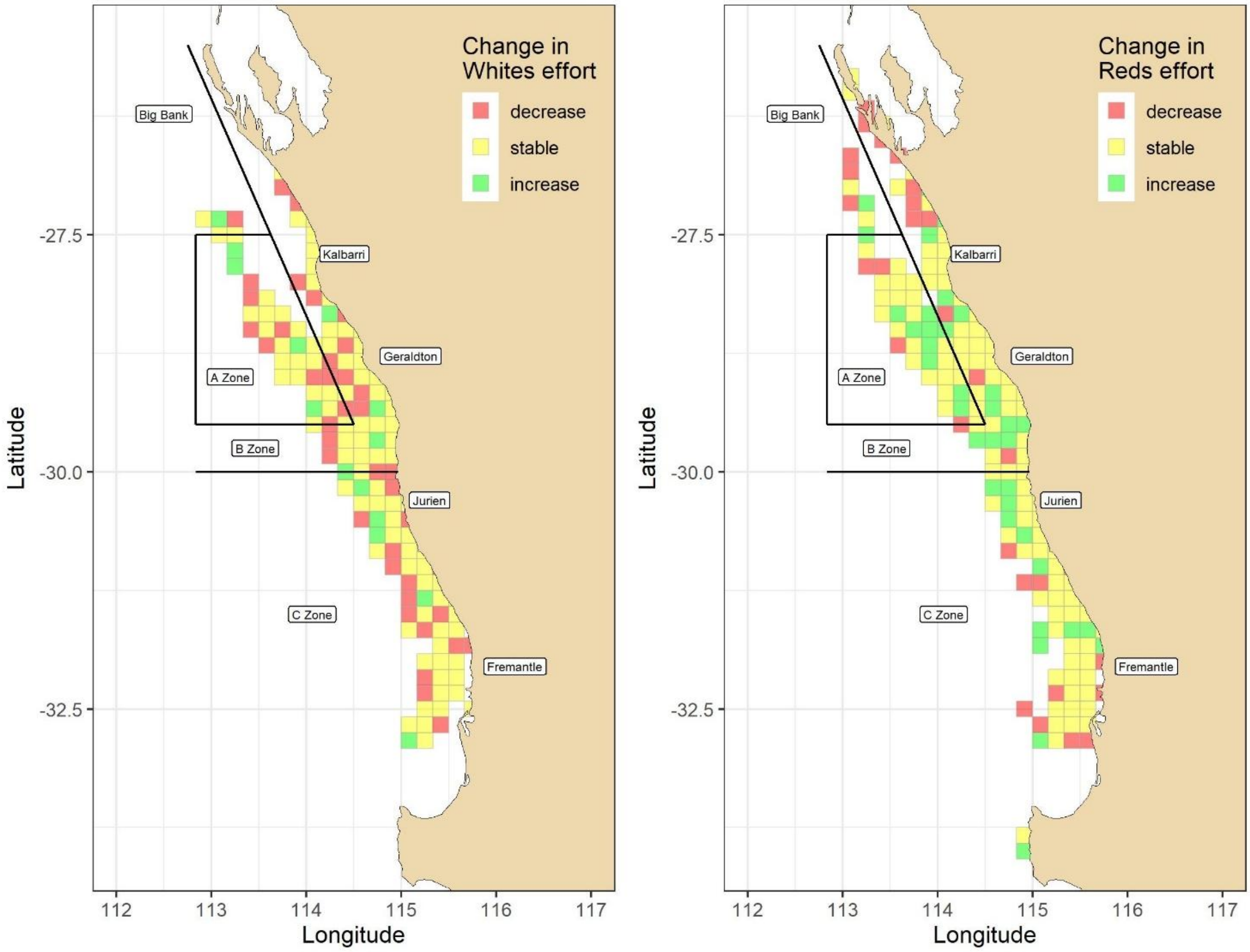

Figure 3.6. Spatial distribution of commercial WCRLMF effort anomalies (from 2010-2024 average) during the whites (A: Nov – Feb) and reds (B: Mar – Oct) periods of the 2024/25 fishing season.

Effort data does not indicate a high level of lobster depletion in any region of the fishery, indicating the stock is at a low risk of being over-fished.

3.1.3 Catch Rate

Commercial catch rates of lobster are based on compulsory catch and effort returns (CER; which have changed their reporting requirements over time; (de Lestang et al., 2016)) and from data collected during commercial monitoring trips (CMT). The data from CER encompass the entire fishery since 1975, whereas CMT, which started in 1971, only samples <5% of all fishing trips. Both data sources are strongly influenced by fishers' behaviour (increasing fishing efficiency, variable targeting due to quota and differential lobster pricing, different pot shapes/sizes) as well as the area/depth/timing of fishing. Log-normal generalise additive mixed models (GAMM) are used to standardise for as many of these influencing factors as possible. For CER data, catch rates are determined by latitude and management zone and standardised for fishing vessel (random effects) and month (cubic spline). The effects of targeted fishing behaviour and increases in fishing efficiency cannot be corrected for, while that of high grading is accounted for prior to standardisation. Since management changed to quotas in 2010, some fishers started to return lower value legal lobsters to maximise the economic yield of their catches. This behaviour can change daily due to changes in the split pricing of lobster between grade categories. Fishers report high grading levels in their CDRs, and rates of high grading are recorded during commercial monitoring. This information is used to scale commercial landings back to commercial legal catches. As management arrangements change what components of the stock are available for capture (e.g. changing legal size limits) the relativity of these catch rate indices between years becomes broken; they no longer represent the same catchable stock (note, changing legal definitions are built into the integrated stock assessment model so that these indices remain valuable in the modelling framework).

Standardisation of the CER catch rate timeseries had a marked impact on most areas but especially A zone (A zone latitude 28), where the peak in catch rates was reduced from ~ six kg/pot lift down to less than four (Figure 5-7). This was due primarily to the change in access to fishing in this zone from 3 ½ months prior to 2010 to year round after.

The standardised catch rates showed a similar pattern at all locations, slowly increasing from 1975 until 2009, after which a marked increase occurred. In most locations this increase continued for ~10 years before levelling off to a slow progression (Figure 5-7). In the more southern C zone, an additional ~ five-year cycle also exists, caused by cycles in recruitment strength, as this zone experiences much greater annual variation in puerulus settlement (see section 3.1.5.2).

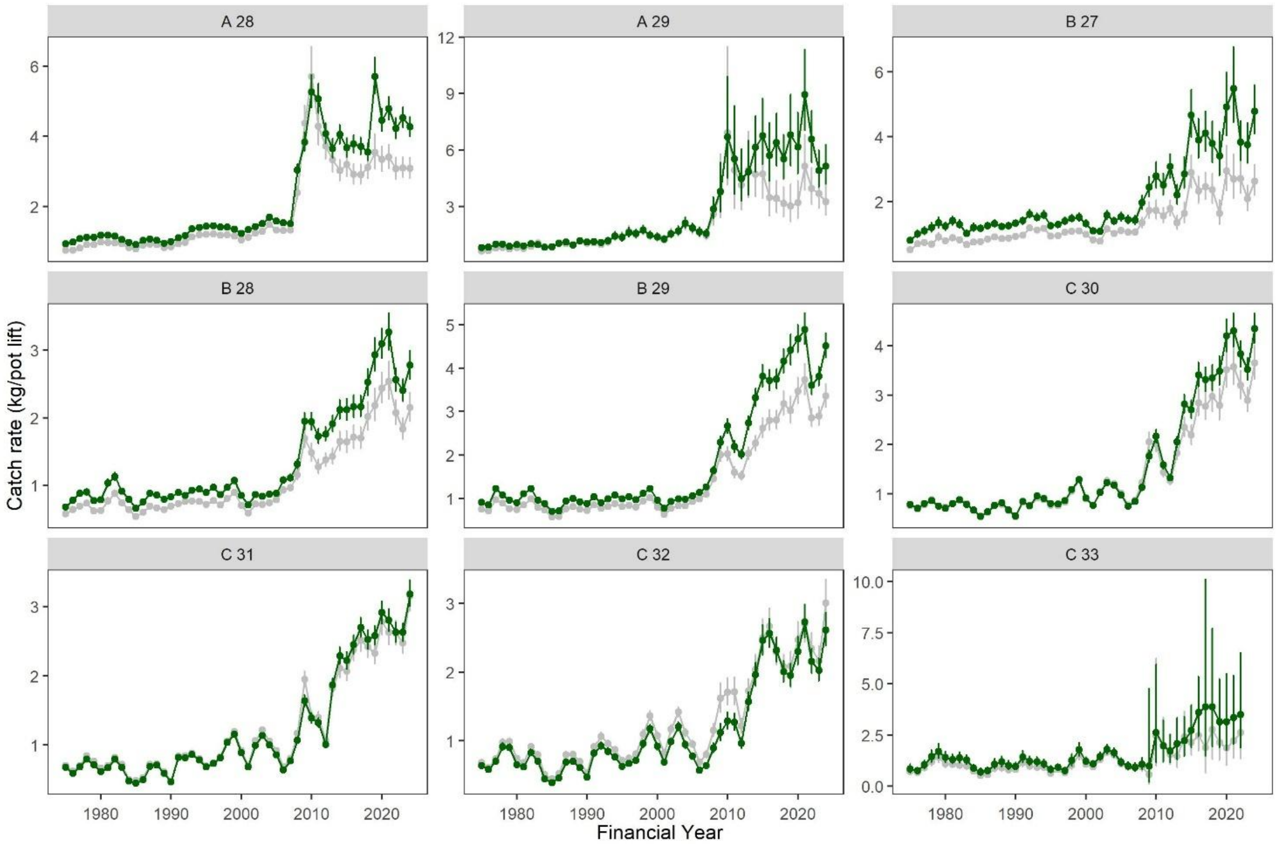

Figure 3.7. Nominal (grey) and standardised (green) commercial catch rates (± 95% CI) of legal lobster from compulsory catch and effort returns in each management zone / latitude combination.

Commercial monitoring catch rates were derived for each sampling location and standardised using a GAMM for fishing vessel (random effects) and month (cubic spline), water depth (factor) and pot soak time (factor), with month and fishing vessel having the greatest impact on the standardisation. As with the CER data, the effects of targeted fishing behaviour and increases in fishing efficiency cannot be corrected for. Unlike the CER derived catch rates, this index (CMT) is not affected by management arrangements as it is based on all lobsters ≥ 76 mm (i.e. the legal status of individual lobsters had no impact as retained catch is not being modelled).

Standardisation of the CER catch rate timeseries had the greatest impact at the northern end of the fishery (Abrolhos, Kalbarri and Geraldton), whereas only a few years were impacted further to the south (Figure 3.8). This was due primarily to the change in access to fishing in zone A (as discussed above) and a change in time of fishing in Kalbarri and Geraldton, to less consistency across the months.

The standardised catch rates again showed a similar pattern at all locations, slowly increasing from 1971 until 2009, after which a marked increase occurred. In most locations this increase continued for ~10 years before levelling off to a slow progression (Figure 3.8). A marked drop in catch rates was observed in 2022 and 2023 in both Dongara and Jurien but was not present in the other locations and appears more likely due to a change in catchability rather than biomass. The most southern two locations (Lancelin and Fremantle) are the only places that have displayed a slight decline in catch rates since their peak around 2015 (Figure 3.8). In the more southern C zone, an additional cycle also exists, caused by cycles in recruitment strength, as this zone experiences much greater annual variation in puerulus settlement (see section 3.1.5.2).

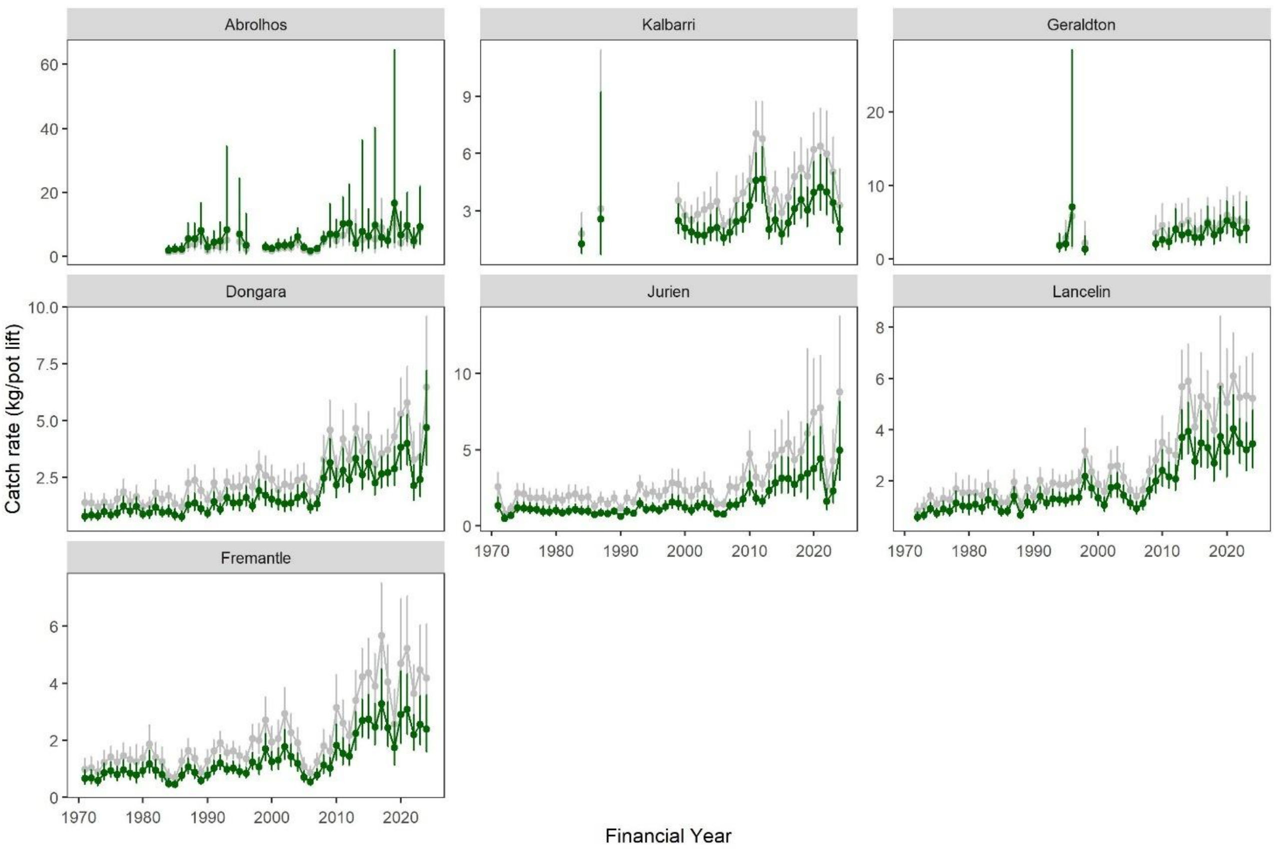

Figure 3.8. Nominal (grey) and standardised (green) commercial monitoring catch rates (± 95% CI) of western rock lobster with carapace length ≥ 76 mm from length monitoring at each monitoring location.

Catch rate indices remain well above historical levels and do not indicate a high level of lobster depletion in any region of the fishery, indicating the stock is at a low risk of being over-fished.

3.1.4 Size Compositions

The size composition of the lobster resource is measured during fishery dependent commercial monitoring, fishery independent surveys (independent breeding stock survey – IBSS and shallow water survey – ISS) and recreational boat ramp surveys.

3.1.4.1 Commercial monitoring

Carapace length data from commercial monitoring (see de Lestang et al. (2016) for further details of monitoring design) is limited to lobsters greater than (or equal to) the minimum legal size of 76 mm CL, and standardised using a linear model to account for unbalanced sampling between month, water depth, and pot soak time. The standardisation process had a marked impact, especially in male lobsters from the southern locations, mainly due to a temporal change in sampling. Prior to 2010 the fishery was active between 15 November to following June, whereas after this the fishery occurred year round.

A progressive pattern is shown by both female and male lobsters and most noticeably in the more northern areas from the Abrolhos to Jurien (Figure 3.9). Mean CL declined from the 1970s to minima around 2010, before increasing rapidly and peaking in ~ 2013, before dropping slightly before showing a continued slow increase. In the more southern areas (Lancelin and Fremantle) mean CL varied in a short cycle between years, decreasing in years with strong juvenile recruitment. A similar peak in CL occurred across most sites after 2010 and recent years have shown a slight decline especially in female lobster CL (Figure 3.9).

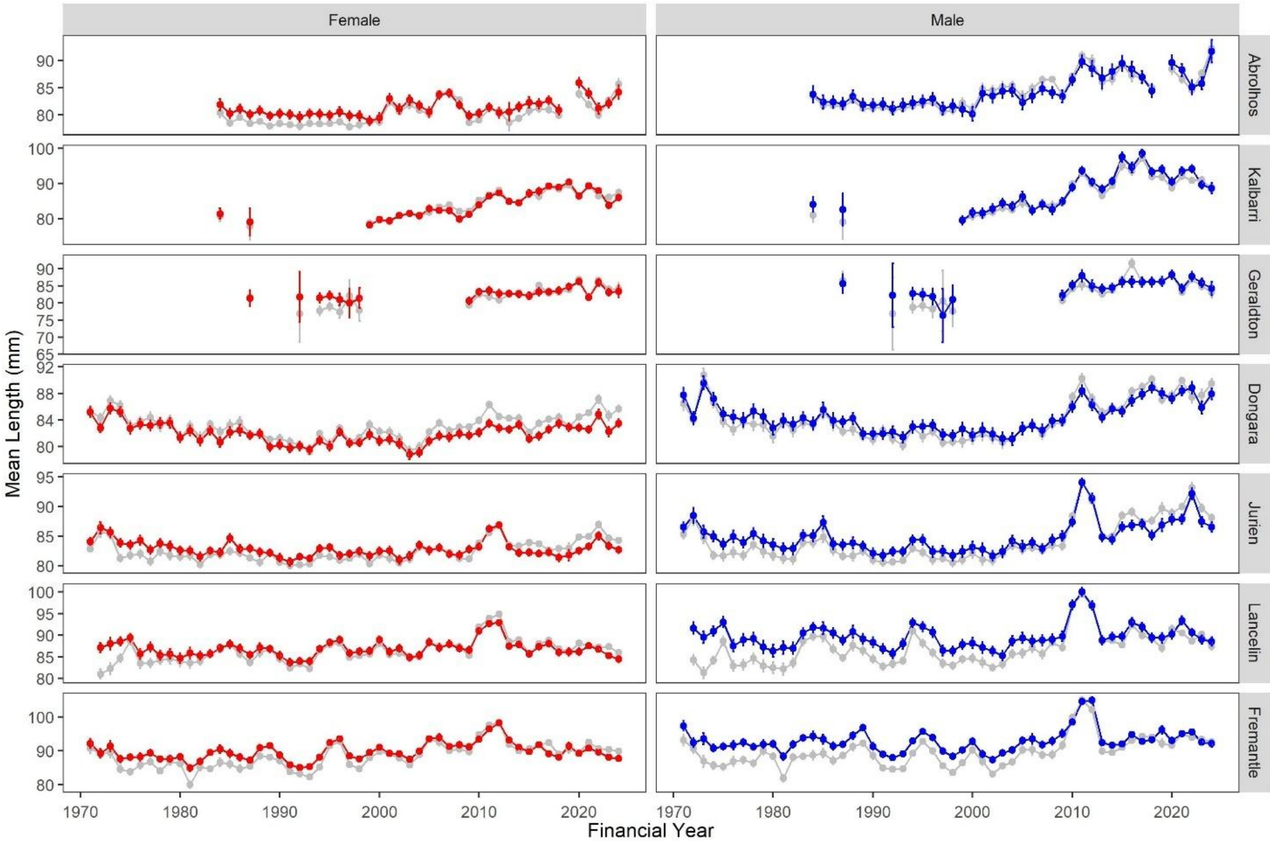

Figure 3.9. Annual fishery-dependent mean (± 95% CI) carapace length of female and male lobster in the three fishing zones before (grey) and after standardisation (red and blue).

3.1.4.2 Independent breeding stock survey

Size composition data from the independent breeding stock survey (IBBS; see de Lestang et al. (2016) for further details of survey design) is collected in a more balanced sampling framework (same locations, timing etc.). A standardisation process is however still applied to account for the infrequent use of different pot types and pot soak times being longer than two days. All pots used during the IBSS have their escape gaps closed, so the data have not been limited to only legal sized lobster as is the case with commercial dependent data. The standardisation process had a small impact to the timeseries, due to the well balanced structure of the survey.

All IBSS locations displayed a marked increase in mean CL around 2010 after which some areas continue to record increased CLs (Abrolhos, Dongara, Kalbarri and Leeman), where in other more southern locations the mean CL declined slightly (**Figure 3.10**).

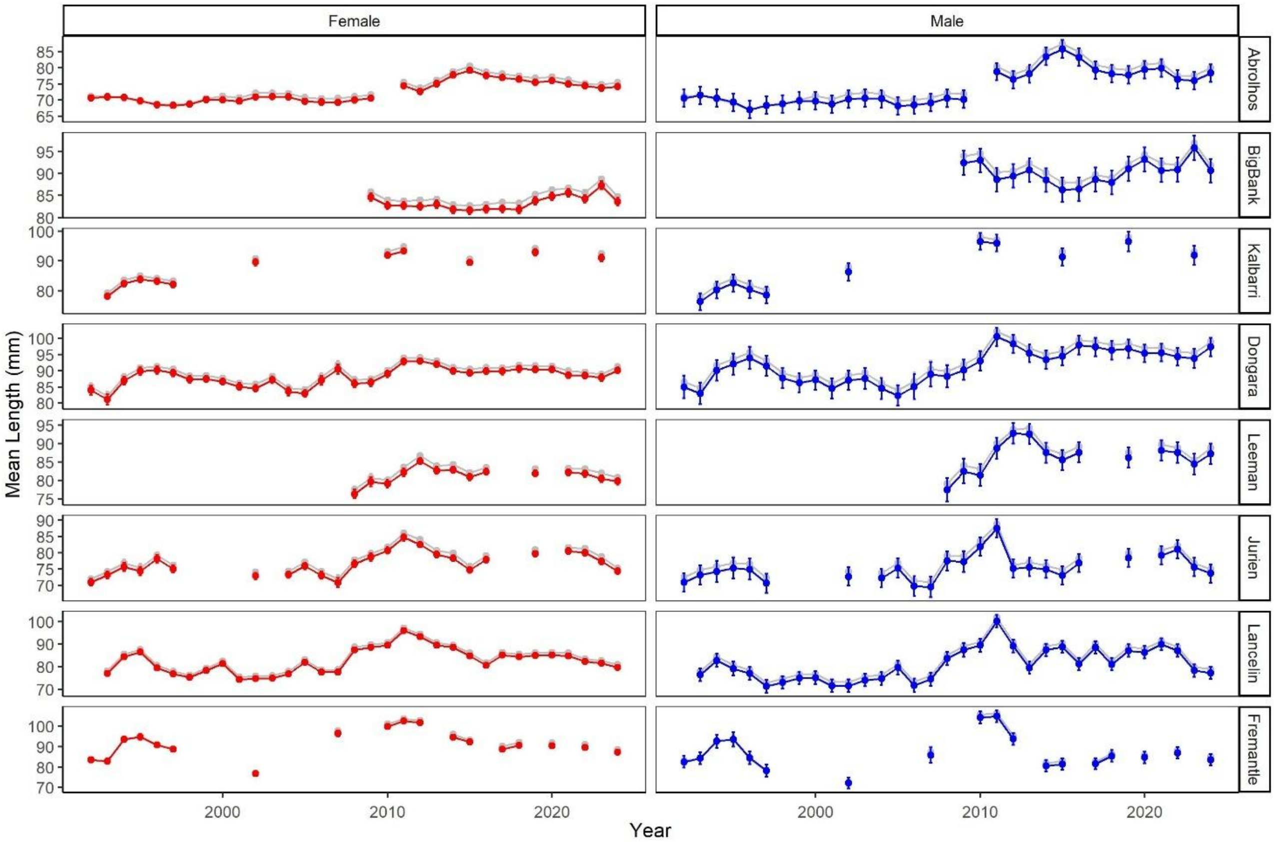

Figure 3.10. Annual fishery independent breeding stock survey (IBSS) mean length (± 95% CI) of female and male lobster as a raw (grey) and standardised index (female = red, male = blue).

3.1.4.3 Independent shallow survey

Size composition data from the independent shallow survey (ISS) is also collected in a balanced sampling framework (same locations, timing, see Appendix 2 for further details of survey design) and is therefore only standardised using a linear model to account for the use of three different pot types. All pots used during the ISS have their escape gaps closed, so the data have not been limited to only legal sized lobster as is the case with commercial dependent data.

Standardisation of mean lengths for pot type had minimal impact for both males and females. The timeseries, however, is short, and as such clear marked trends are not very evident (Figure 3.11**,** Figure 3.12). There does appear to be a progressive decline at the Abrolhos Islands (Wallabi and Rat), a progressive increase at the central locations (Dongara, Freshwater, Jurien, Cervantes) and no trend in the southern locations (Lancelin, Two Rocks, Fremantle, Mandurah) (Figure 3.11**,** Figure 3.12).

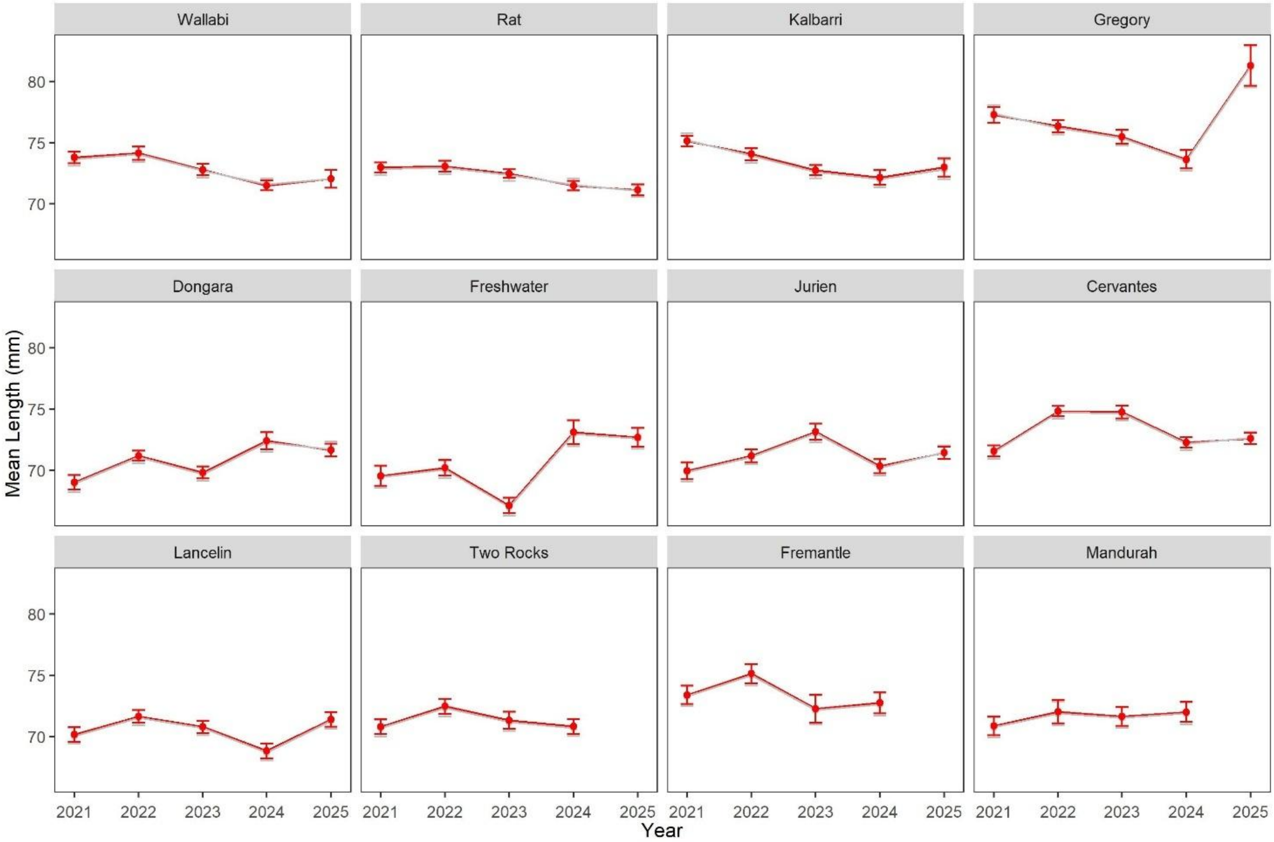

Figure 3.11. Annual fishery independent shallow survey (ISS) mean (± 95% CI) length of female lobster as a raw (grey) and standardised index (red).

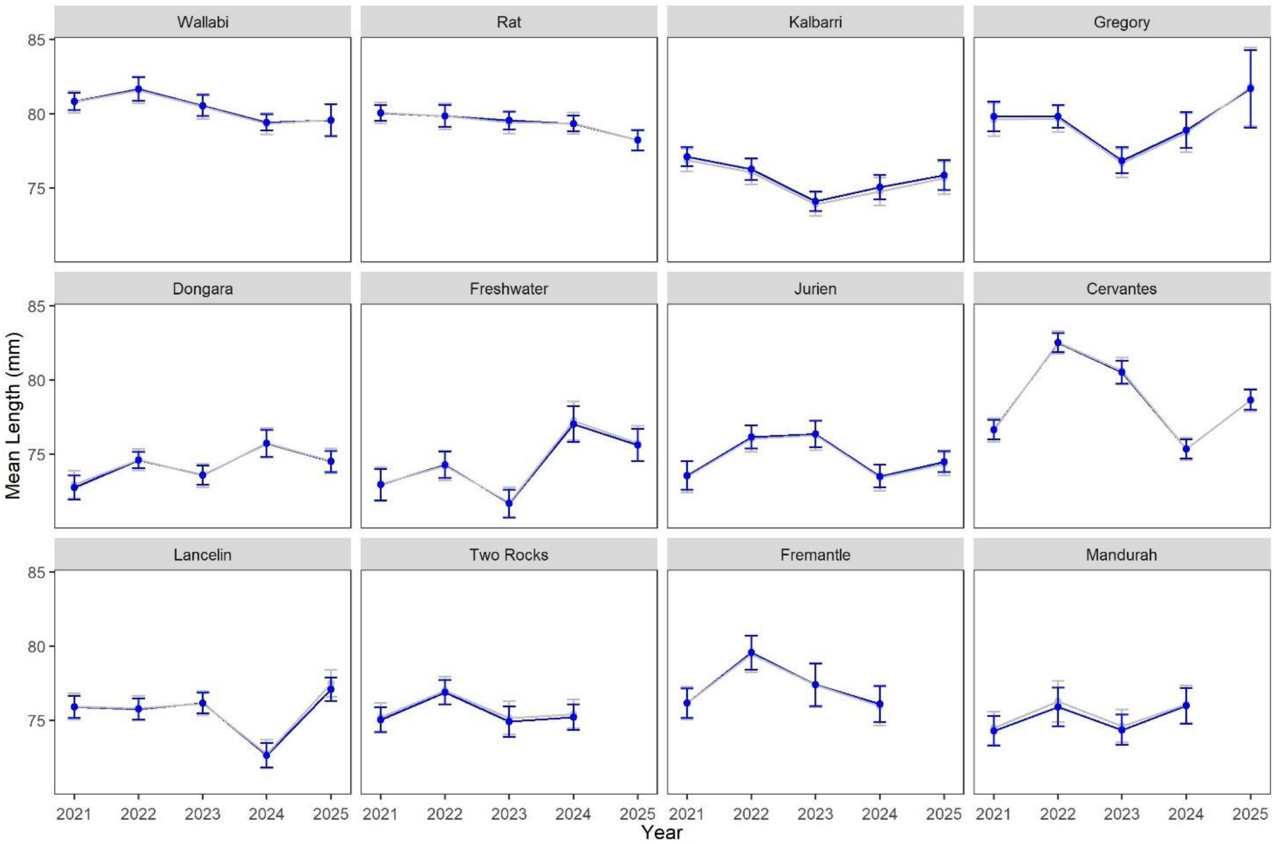

Figure 3.12. Annual fishery independent shallow survey (ISS) mean (± 95% CI) standardised length composition of male lobster as a raw (grey) and standardised index (blue).

Carapace length data collected by the various surveys do not indicate a high level of lobster depletion in any region of the fishery. This carapace length data indicates the stock is at a low risk of being over-fished.

3.1.5 Fishery independent indices

3.1.5.1 Fishery Independent Surveys

There are three fishery independent surveys conducted in the WCRLMF. Sampling the recruitment of post larval lobster (puerulus) first started in 1968 at Seven Mile Beach near Dongara, using “Phillips collectors” which are sampled every new moon. This survey has subsequently been expanded to now encompass eight locations. For more details see de Lestang et al. (2016). The lobster breeding stock is measured annually during a standardised ten-day survey at between three and eight locations that encompasses the offshore breeding grounds of the fishery: Independent Breeding Stock Survey (IBSS). This survey was first started in 1992 and occurs over the last new moon period before the 15 November. Three locations; Abrolhos, Dongara, and Lancelin, are always surveyed, with other locations surveyed based on funding and staff availability. For more details see de Lestang et al. (2016). The shallow water juvenile grounds of the fishery are surveyed each March new moon at 12 locations over two days: the independent shallow water survey (ISS). This survey started in 2021 and is designed to monitor the abundance of juvenile lobster prior to their recruitment into the fishery. For more details see Appendix 2.

3.1.5.2 Recruitment Index

Recruitment is directly measured through monitoring puerulus settlement (post larvae) and through the independent shallow water survey which targets lobster in their first few years post settlement. Recruitment into the fishery is also estimated by the integrated model (see section 5.1.7 and Appendix 5).

Puerulus settlement levels have historically shown marked contrast between adjacent seasons presumably a result of variable environmental conditions during the 9–11 month larval phase (Figure 3.13). Across all locations, two consecutive years of very poor settlement were recorded in 2008 and 2009, with subsequent years showing a return to historical patterns in Port Gregory, Dongara and Jurien. In locations further south, settlement levels appear not to have returned to the same magnitude after 2008 (Figure 3.13). The most recent settlement season (May 2024 – April 2025) was below average at Abrolhos, Port Gregory, Dongara, Alkimos and Warnbro and above average at Jurien, Lancelin and Cape Mentelle (Figure 3.13).

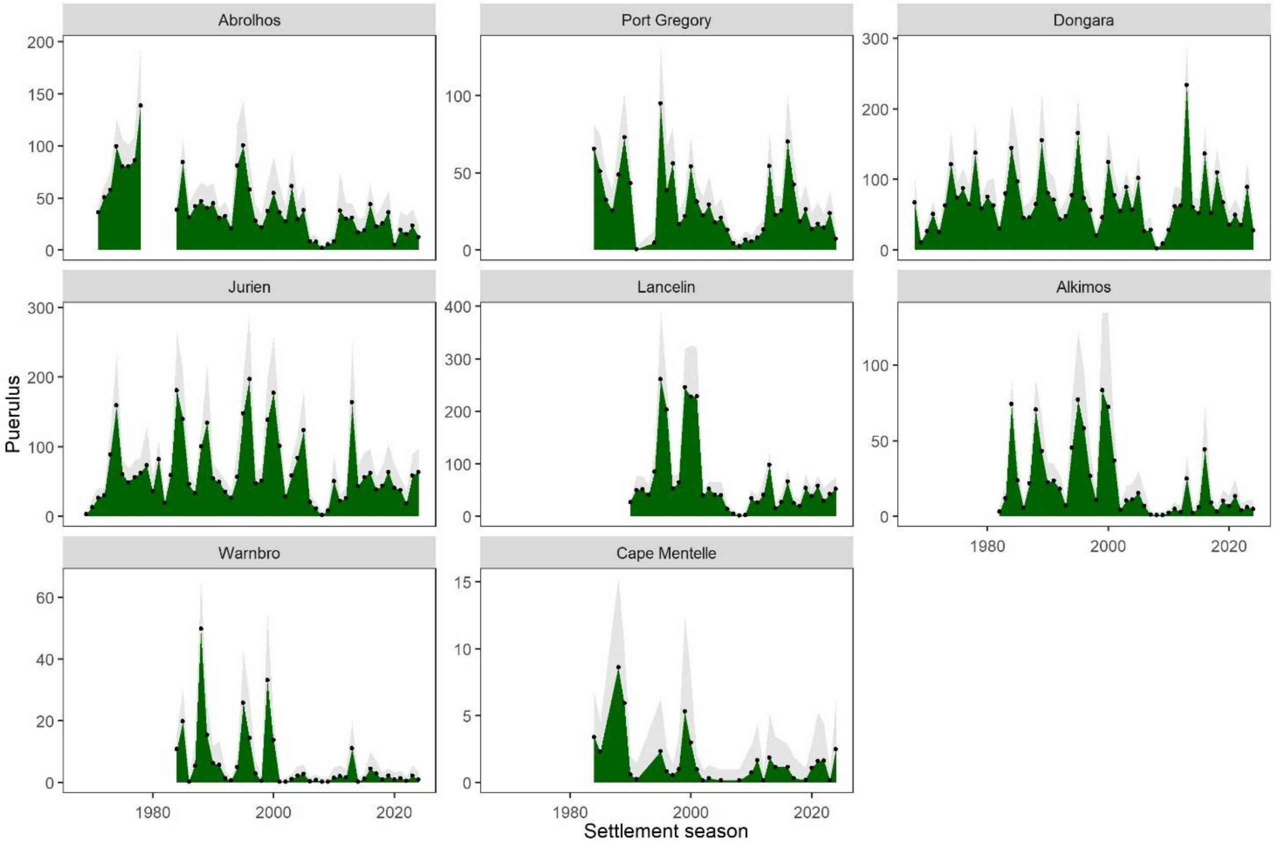

Figure 3.13. Annual fishery independent puerulus settlement index (+ 95% CI in grey) at eight locations throughout the fishery.

The shallow water survey (ISS) was started in 2021 and is therefore limited in its temporal coverage (Figure 3.14). Detailed analysis of data from this survey is currently being undertaken, with findings reported in a research report to be published in early 2026. Preliminary examination of mean catch rates of all undersize lobster (≤ 76 mm CL) in each area show no marked increasing or decreasing trends but do show that adjacent areas generally reported similar patterns (Figure 3.14). Catch rates at Port Gregory were very low in 2025, but this decline was consistent with that at nearby areas Wallabi, Easter and Kalbarri, which suggests it does not indicate an abnormal localised reduction. Note, the survey was not conducted in Two Rocks, Fremantle or Mandurah in 2025.

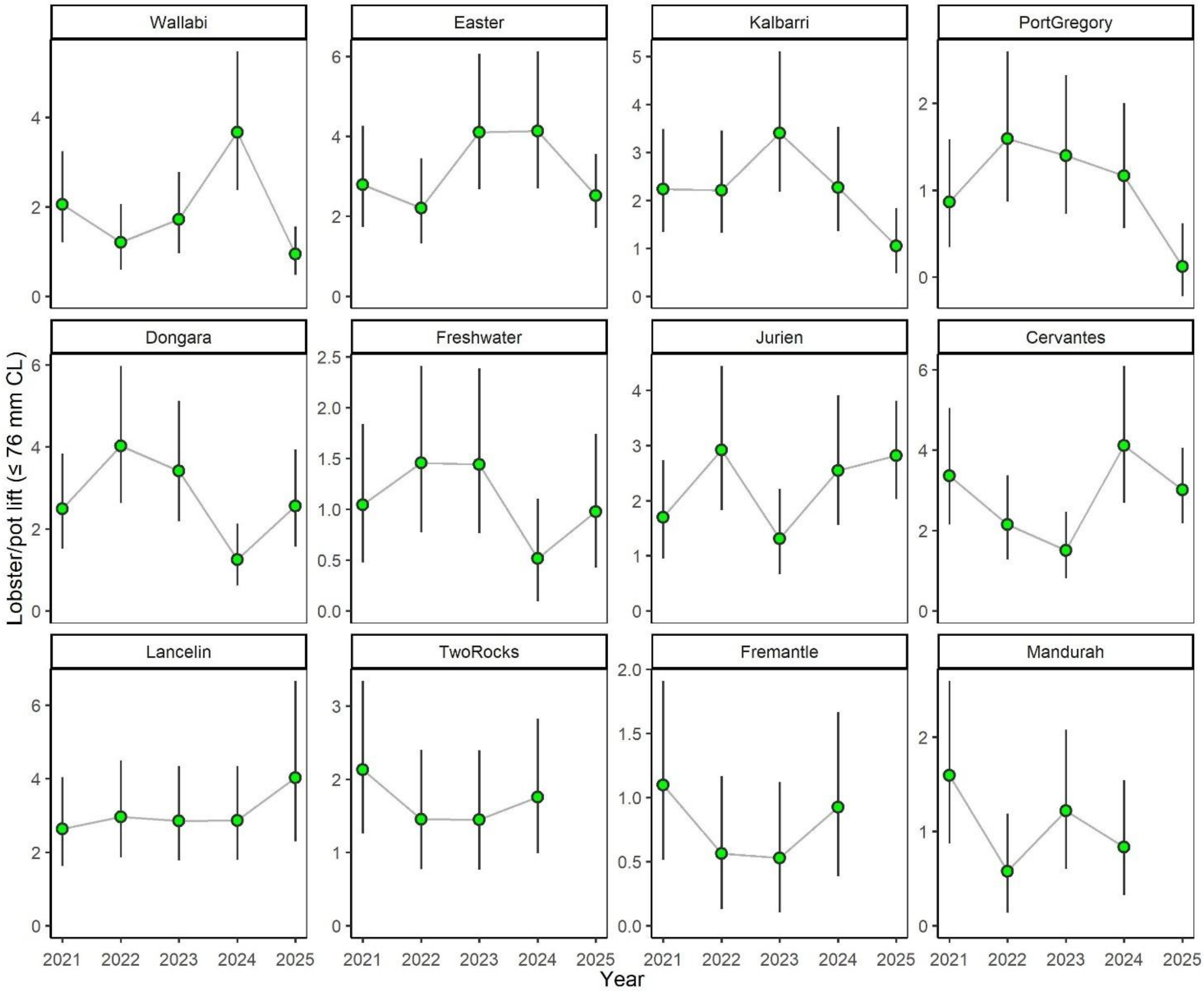

Figure 3.14. Annual fishery independent shallow survey catch rates (+ 95% CI) of lobster ≤ 76 mm CL at 12 locations throughout the fishery.

Fishery independent recruitment surveys do not indicate an unexpected reduction in recruitment levels. This indicates the stock is at a low risk of being over-fished.

3.1.5.3 Biomass Index

Deepwater biomass indices of both female and male lobster are directly measured through the independent breeding stock survey as number of lobster / pot lift. The biomass of all legal lobster (sexes combined) in 11 regions of the fishery is estimated by the integrated model (see section 5.1.7).

The IBSS survey is a standardised survey that keeps many factors that can influence catch rates standard between years: exact pot location, month, lunar phase, bait and where possible soak time and pot type. In some years certain standard pots are not available for all sites and bad weather can result in extended pot soaking times (e.g. three days vs two). Other factors such as swell, water temperature and reproductive phase can also impact catch rates and are therefore corrected for using a linear model.

Model standardisation of female biomass only had an impact at the most southern locations (e.g. Lancelin and Fremantle), and this was mainly a scaling change, with the overall trend remaining relatively similar (Figure 3.15). For males, marked changes occurred at several locations, with biomass increases being far less at the Abrolhos, Leeman, Lancelin and Fremantle (

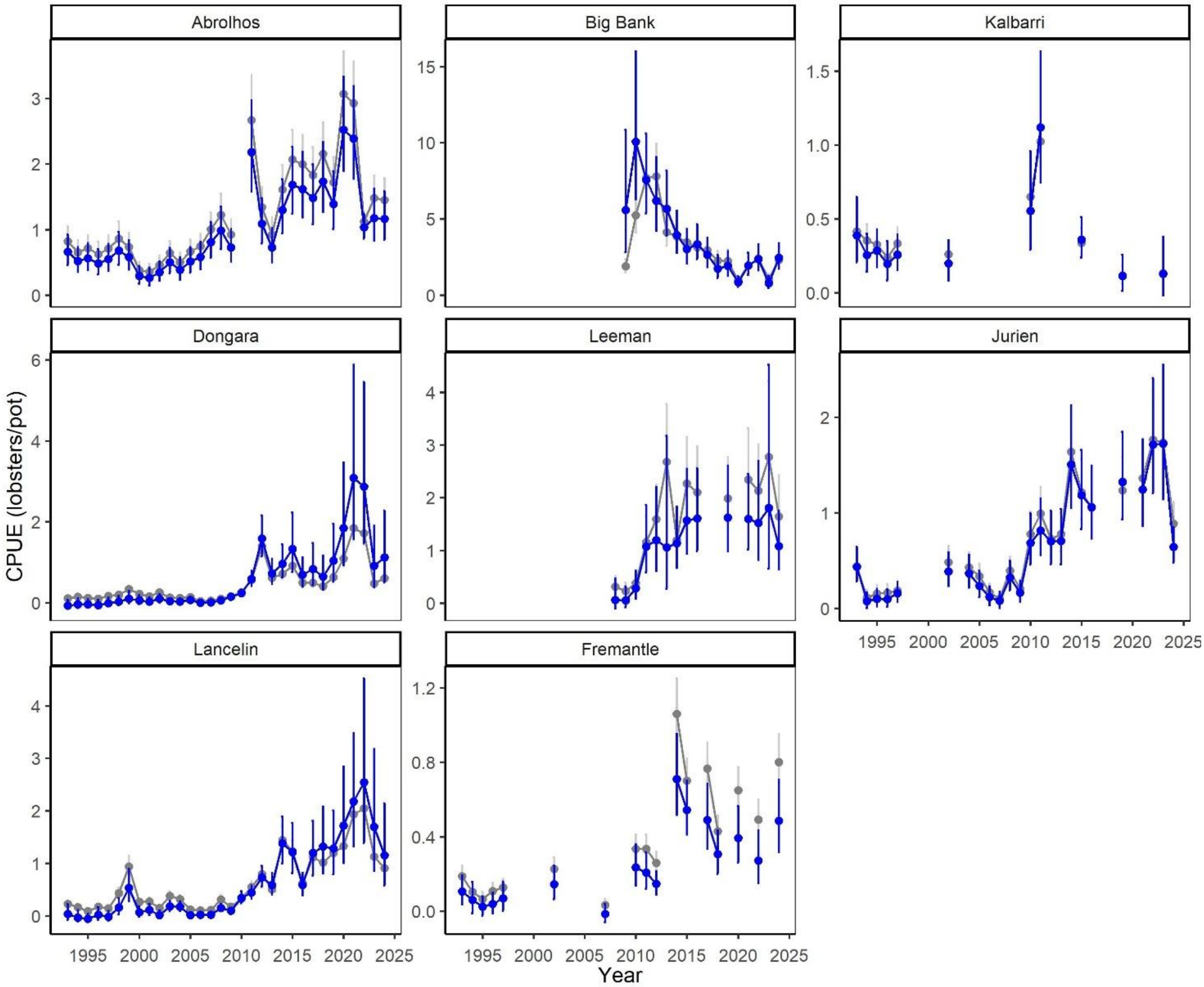

Figure 3.16).

IBSS female and male biomass indices both showed a similar trend, with marked increases occurring around 2010 following a reduction in harvest levels in the two previous fishing seasons (as the fishery changed management arrangements). Biomass levels then dropped in ~2015 as the poor recruitment of 2008 failed to enter the breeding stock grounds (Figure 3.15,

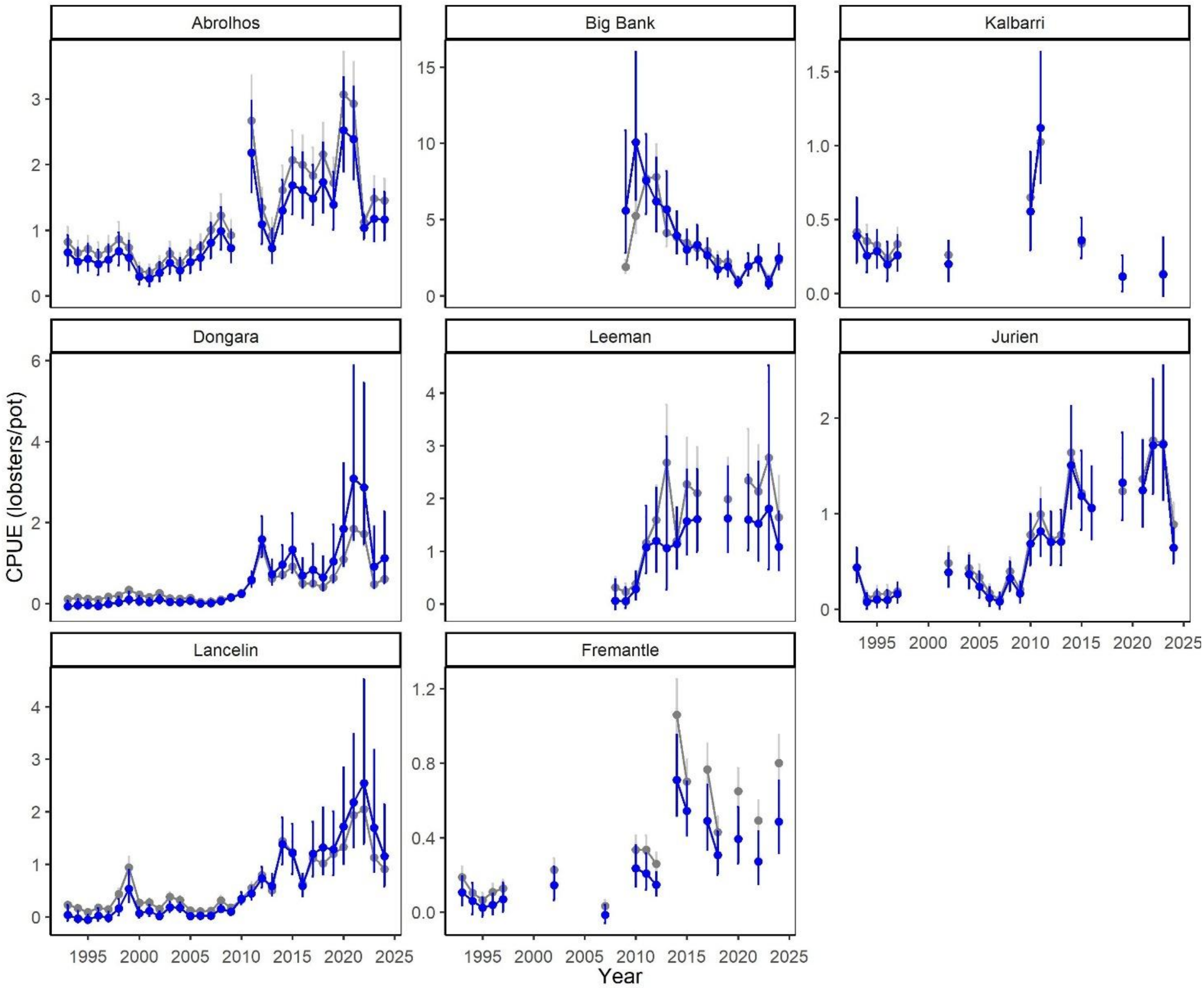

Figure 3.16). Most locations then displayed a subsequent increase with harvest levels remaining low and average to above average recruitment started to re-enter the breeding stock, resulting in this build-up of residual biomass levels. Commercial quotas have since progressively increased from 5,500 t in 2010 to 7,300 t in 2024, which has slowly started to reduce the residual biomass down to levels which remain above pre 2008 (Figure 3.15,

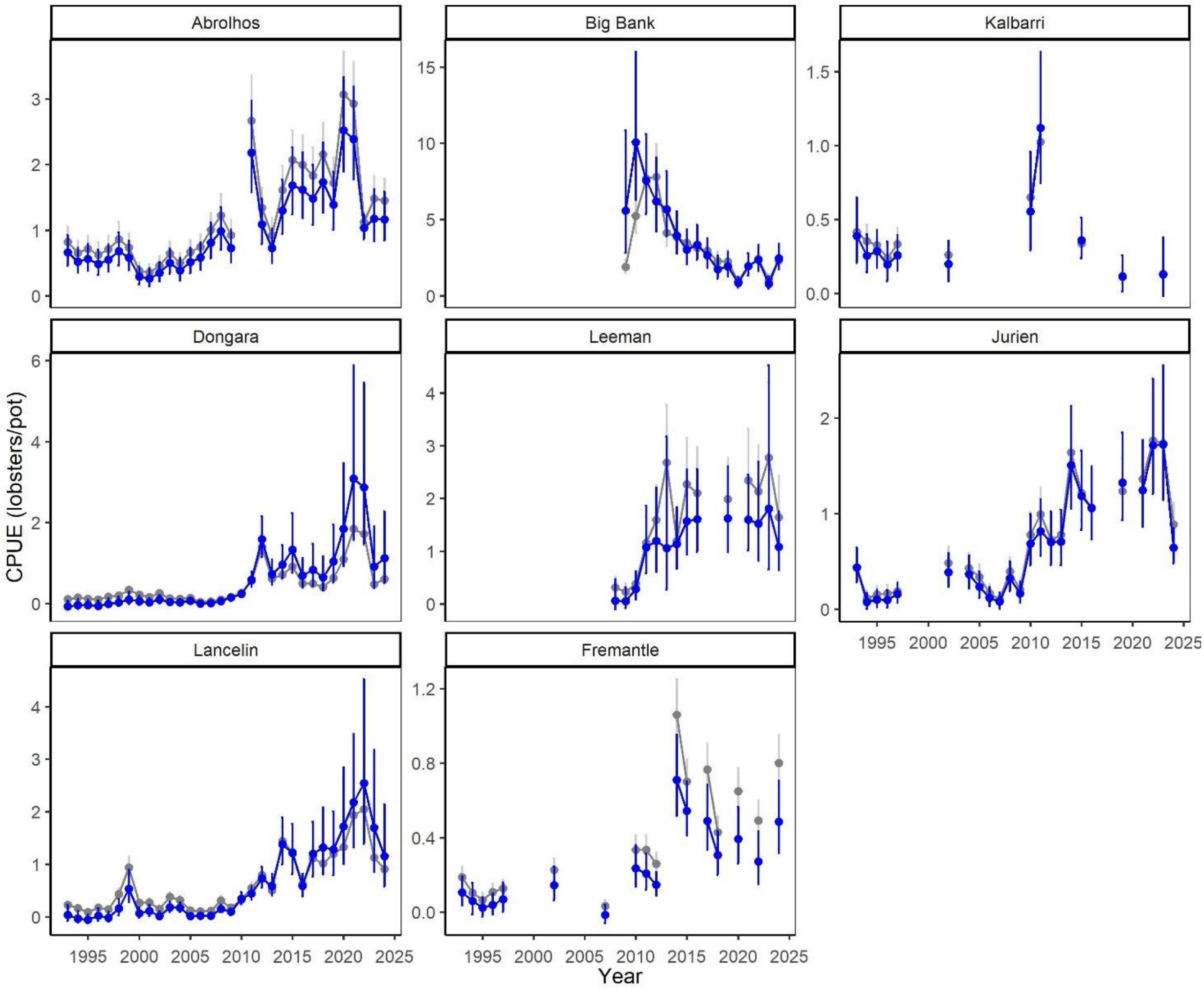

Figure 3.16). Some areas in 2024 showed a sharp decline (Leeman, Jurien, Lancelin), which appear to be catchability related since Leeman is an area closed to fishing, so it is very unlikely that its female biomass levels could drop by 75% in one year (Figure 3.15).

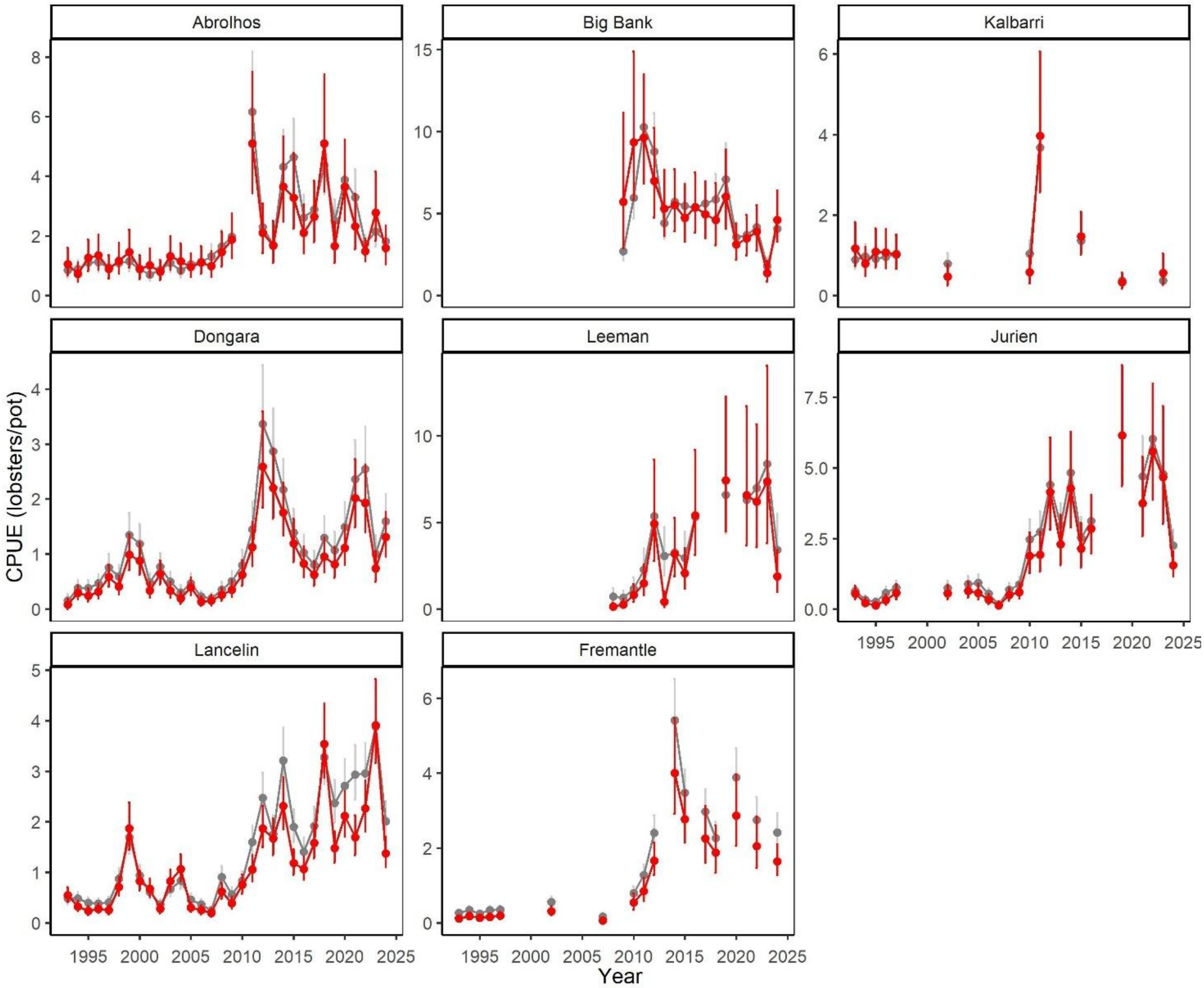

Figure 3.15. Annual fishery independent breeding stock survey female biomass catch rates (+ 95% CI) at eight locations throughout the fishery in deep water. Unstandardised (grey) and standardised (red) indices are shown.

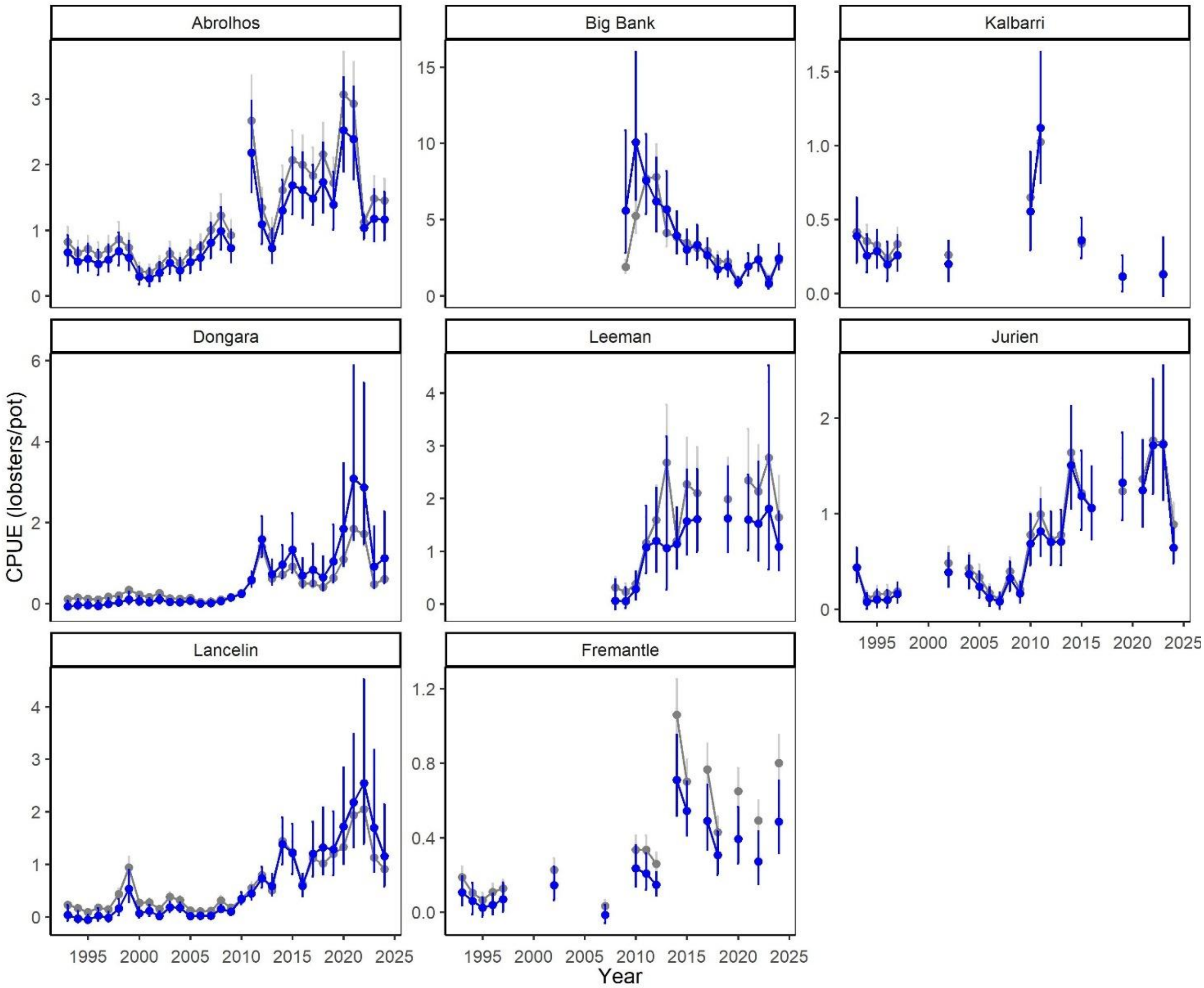

Figure 3.16. Annual fishery independent breeding stock survey male biomass catch rates (+ 95% CI) at eight locations throughout the fishery in deep water. Unstandardised (grey) and standardised (blue) indices are shown.

Fishery independent biomass indices indicate that breeding biomass is above historic levels throughout the fishery. This indicates the stock is at a low risk of being over-fished.

3.1.5.4 Spawning Index

Egg production is estimated by the independent breeding stock survey as a catch rate of egg / pot lift. The spawning stock biomass of the fishery is estimated by the integrated model (see section 5.1.7). The IBSS derived egg production indices are also standardised for pot type, pot soaking and reproductive phase using a linear model.

Model standardisation only had an impact at certain locations (e.g. Big Bank, Leeman, Jurien and Fremantle), primarily due to the correction for female reproductive stage and month of survey.

IBSS egg production showed a similar trend throughout most locations increasing from a low point in the early 1990s to peak around 2000, before declining again until ~2010, after which all areas reached their maximum values around 2013 (

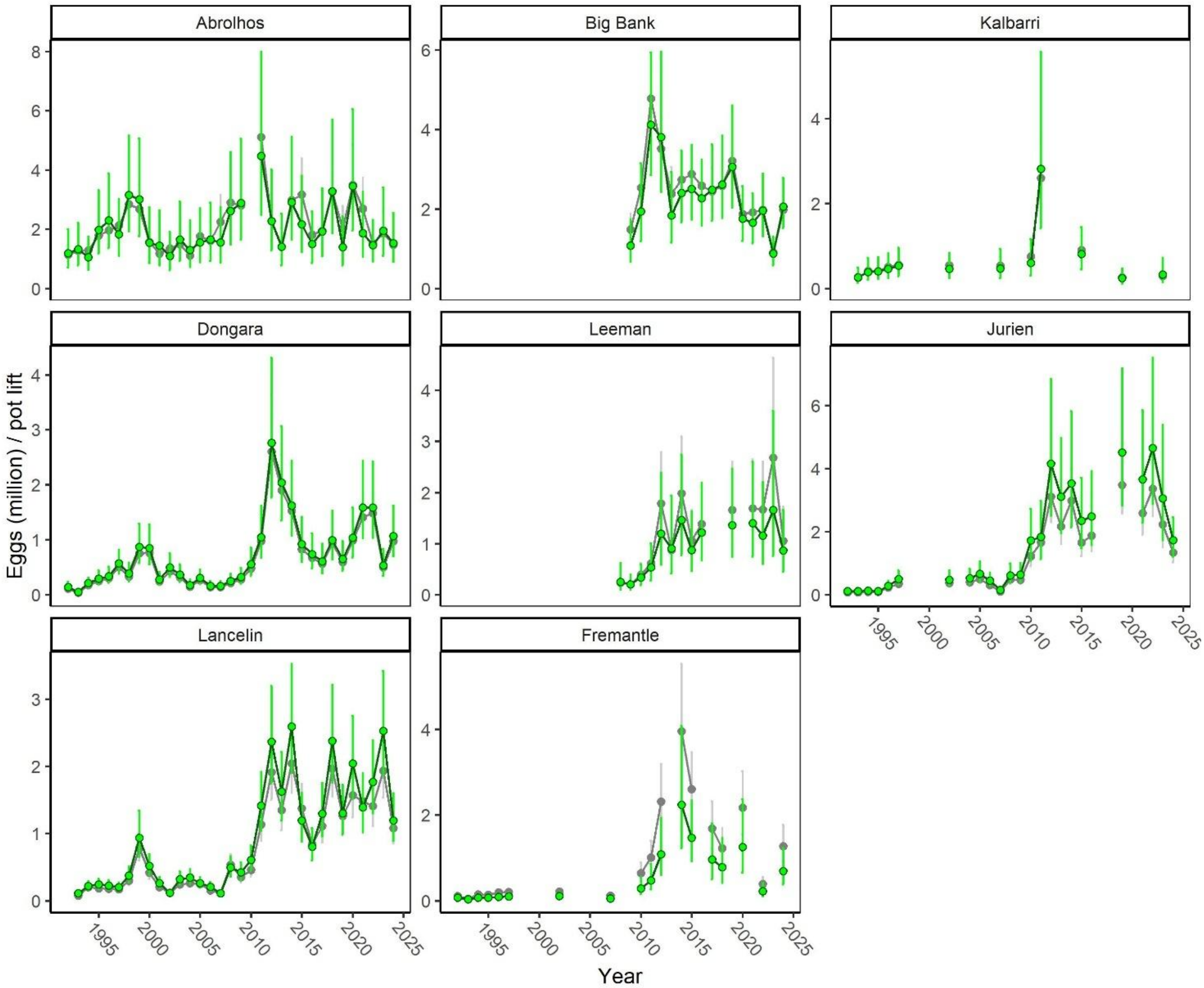

Figure 3.17). In some northern areas egg production has declined back down to levels similar to the ~2000 peaks (e.g. Dongara) whereas at the centre of the fishery, levels have remained well above (e.g. Jurien and Lancelin). In the Leeman closure egg production remains at or close to its timeseries maxima which is unsurprising since this area is closed to fishing (

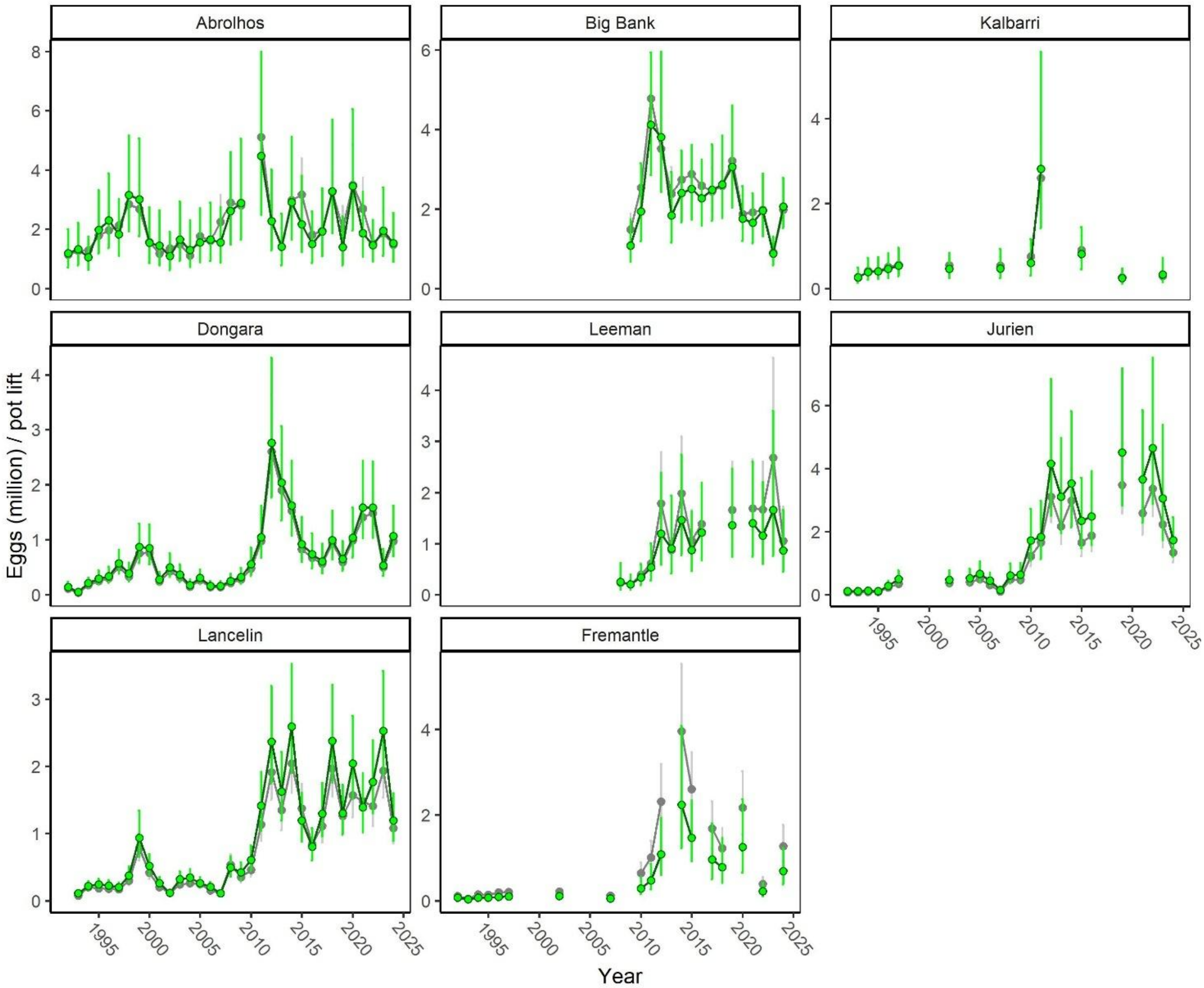

Figure 3.17). In the most northern site (Kalbarri), levels are currently close to the lowest for the entire timeseries. These patterns suggest that throughout the fishery, egg production is at its greatest historical levels in the centre of the fishery but not performing as well towards the northern end (

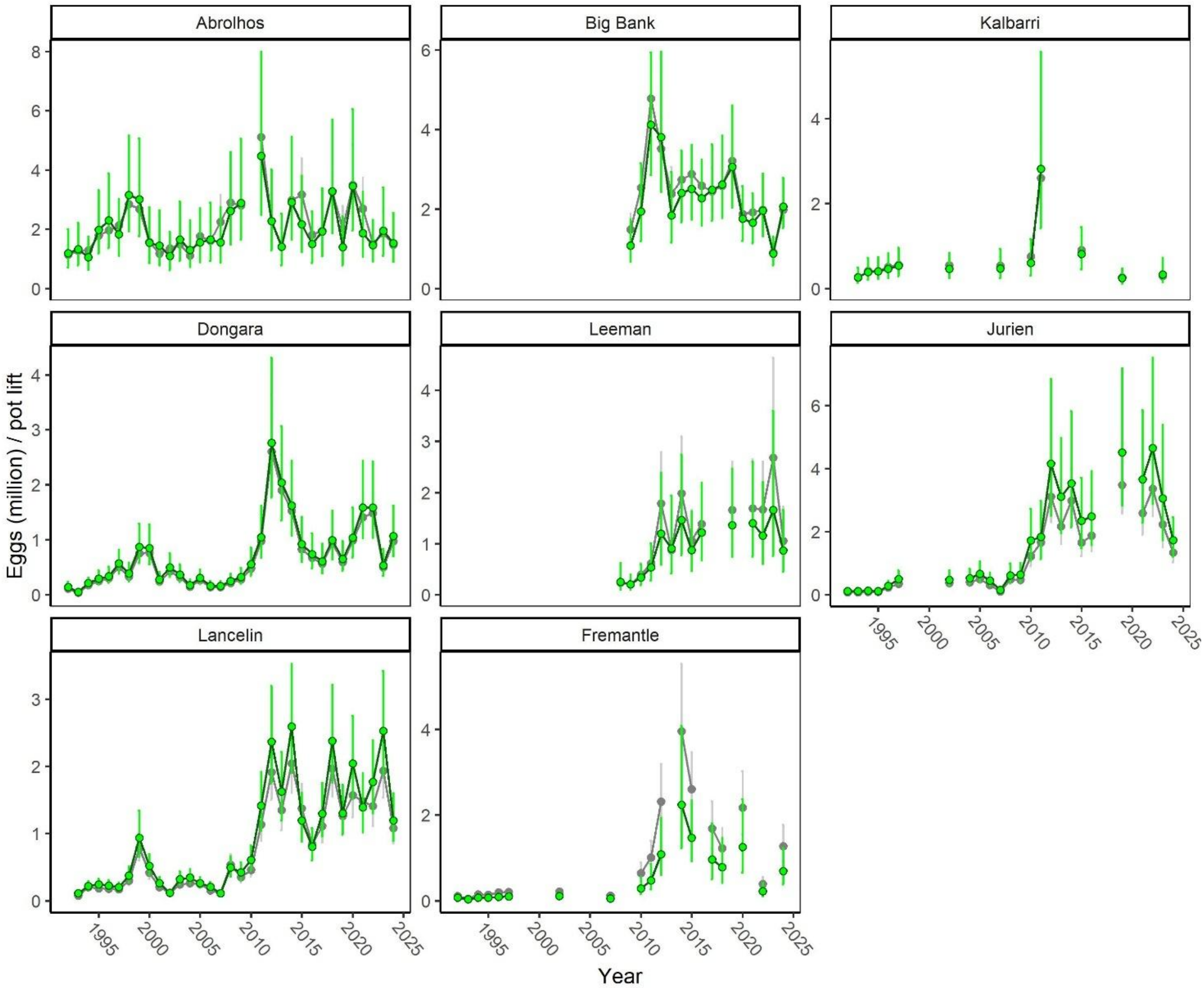

Figure 3.17). Egg production does also appear to have dropped in the most recent surveys at the southern end of the fishery, but this may be associated with catchability as it coincides with a decline in the Leeman closed area.

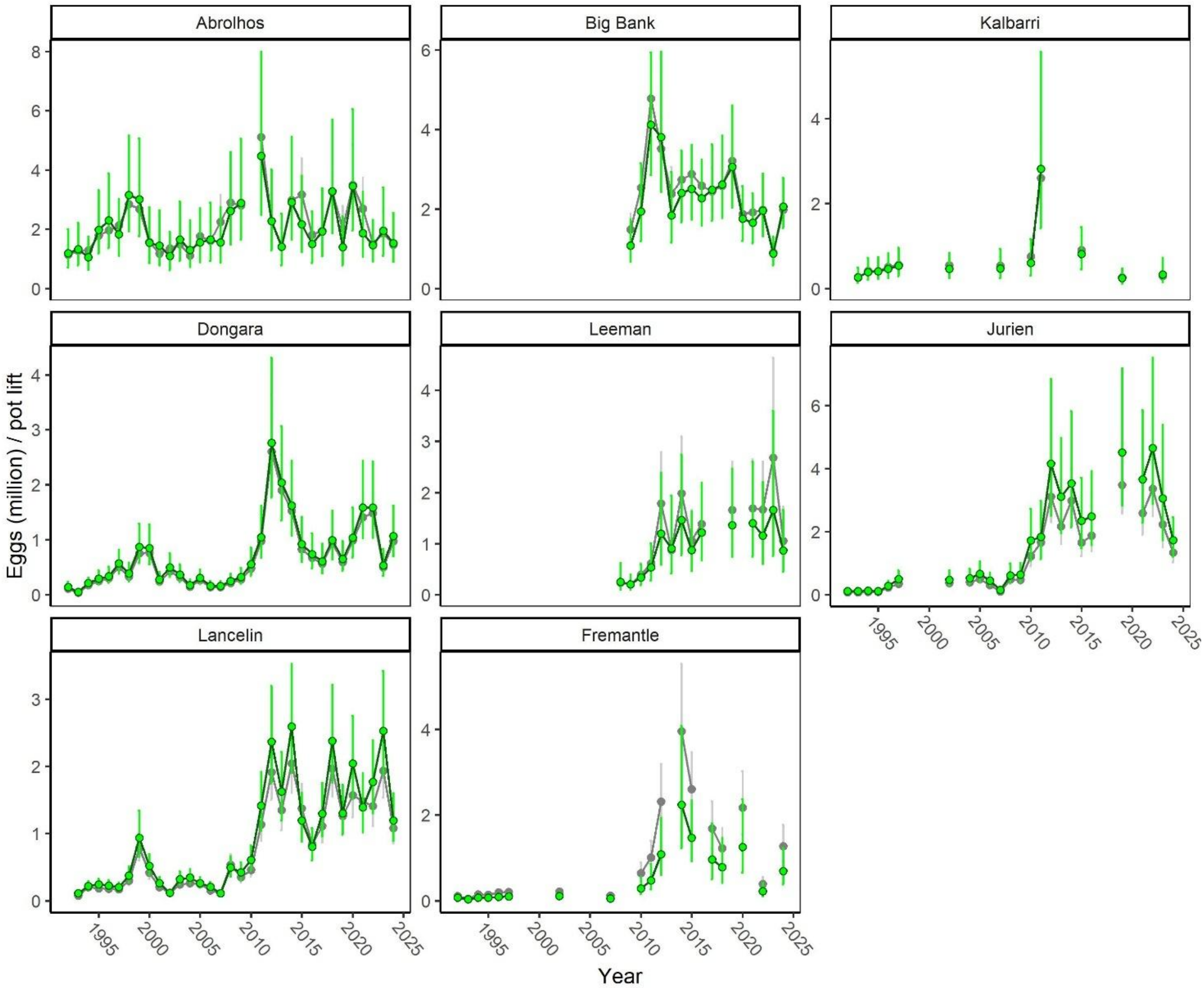

Figure 3.17. Annual fishery independent breeding stock survey egg production catch rates (+ 95% CI) at eight locations throughout the fishery in deep water. Unstandardised (grey) and standardised (green) indices are shown.

Fishery independent egg production surveys indicate that breeding biomass is above historic levels throughout the fishery. This indicates the stock is at a low risk of being over-fished.

3.1.5.5 Stock Recruitment Relationships (SRR)

Stock recruitment environment relationships were reported by Caputi et al. (1995) who found that, for three sites covering the main regions of the fishery, environmental effects explained the main fluctuations in post larval recruitment (puerulus) in the two coastal sites, Dongara and Alkimos, with the spawning stock not being significant. However, a reduction in spawning stock appeared to be the main (significant) factor explaining the decline in settlement at the Abrolhos. The Caputi et al. (1995) study supported management changes that increased protection of breeding females leading to an increase in fishery wide egg production by the 2000s. However, a recruitment failure in 2008, when egg production was well above historical low levels, indicated that egg production levels may not be having the influence on Abrolhos recruitment as previously reported by Caputi et al. (1995). A subsequent study re-examined the relationships between egg production, the environment, and recruitment using a considerably longer timeseries. This reanalysis again found that the environment was the primary driver of recruitment (de Lestang et al. 2015). However, in addition environment effects, the study suggested that a change in spawning time (egg release) may have contributed significantly to the 2008 recruitment failure. Subsequent analysis based on three dimensional larval dispersal modelling within an oceanographic model highlighted that transport mechanisms, which assist pueruli in reaching nearshore habitats, were highly influential for recruitment success (Kolbusz et al., 2022b). This work showed that larval settlement may have been inhibited by a strengthening of the southward flowing Leeuwin Current over the austral summer at the settlement stage. As a result, modelled pueruli were transported significantly less northward, in some cases southward. Hatching stage trajectories also suggest increased dispersal off the coast during 2007 and 2008, transporting modelled larvae further offshore and possibly contributing to decreased recruits into the fishery. A subsequent study has recently been funded by the Fisheries Research and Development Corporation (FRDC) through the Western Rock Lobster Councils' (WRLc) independent partnership agreement to re-examine the environments impact on puerulus settlement. This project will be completed by 2028.

3.1.6 Surplus production Model - JABBA

Just Another Bayesian Biomass Assessment (JABBA) has been used to fit a generalized Bayesian State Space surplus production model (SPM) to derive a data moderate assessment of the WRL stock. This model used total landings (commercial and recreational) since 1945, and a fishery wide index of abundance derived from the fishery independent breeding stock survey which started in 1992 (de Lestang et al., 2016). The index of abundance is a catch rate of both female and male lobster ≥ 76 mm CL standardised to account for location, month, pot type, soak time, and female reproductive condition (see Section 5.1.5 for more details). For details on model development, testing, sensitivity analysis and implementation see Appendix 3.

The optimum model tested was a Pella-Tomlinson model with a prior on initial depletion set to virgin levels, B_{msy}/K set to 0.4 and additional observation variance estimated. This model estimated maximum sustainable yield (MSY) to be at 12,334 t, with current levels of B/B_{msy} (1.87, 1.14 – 2.97 95% CI) and F/F_{msy} (0.29, 0.17 – 0.50) suggesting the fishery is not over-fished and over-fishing is not occurring (Figure 3.18).

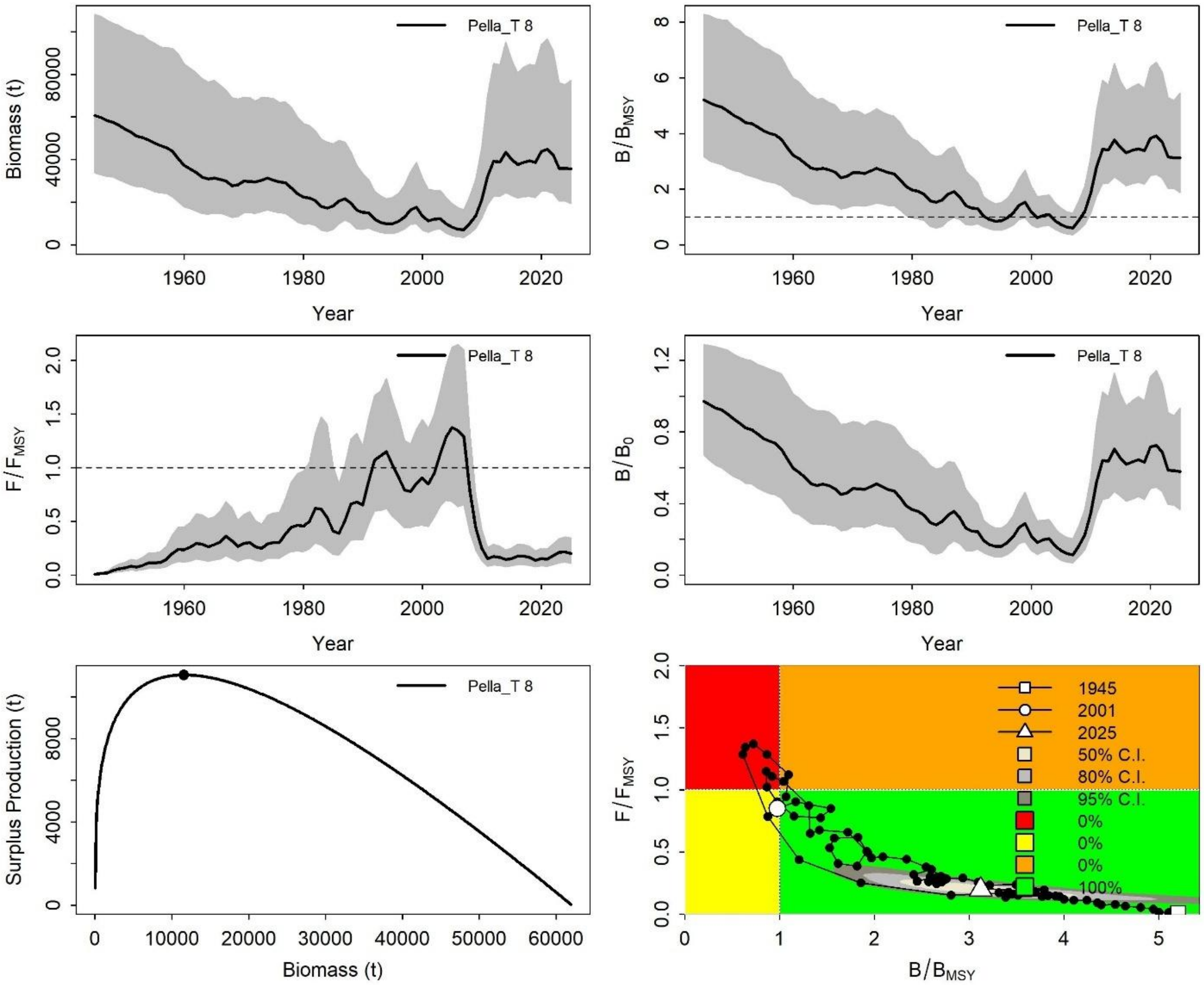

Figure 3.18. Summary of JABBA model 8 showing (clockwise from upper left) estimated biomass, B/B_{msy}, B/B_0, Kobe plot, Surplus production and F/F_{msy}. Median values shown as a solid line with associated 95% credible intervals. Note reference levels shown are relative to maximum sustainable yield of the entire stock (female and male), and are different to those used for management of this resource (as described in the WRL harvest strategy which relate to egg production: DPIRD, 2024).

The JABBA model estimates that the resource is not over fished and over-fishing is not occurring.

3.1.7 Integrated biomass model

3.1.7.1 Model description

The WRL integrated assessment model is used to derive indices that represent the condition of the lobster stock and fishery. The model (implemented in ADMB; (Fournier et al., 2012)) is length based and tracks the west coast population of WRL from 1975 until present, in 11 spatially explicit areas, over 11 within year timesteps. The development and implementation of this model has been externally reviewed three times (de Lestang et al., 2019; DPIRD, 2010, 2008) and is fully described in de Lestang et al. (2016). Data sets fitted to by the model are shown in Table 3.1.

Table 3.1. Data sets used as covariates in the integrated model and their temporal coverage.

Data set	Temporal coverage
Commercial Catch and Effort	November 1975 – December 2024
Commercial Catch rate	November 1975 – December 2024
Commercial Size composition	November 1975 – December 2024
Commercial High Grading rate (%)	November 2009 – December 2024
Recreational Catch	November 1975 – December 2024
Independent Deep water catch rates	October 1992 – October 2024
Independent Deep size composition	October 1992 – October 2024
Independent Shallow water catch rates	March 2020 – March 2025
Independent Shallow water size composition	March 2020 – March 2025
Independent Puerulus Settlement	May 1973 – April 2025
Tag Recaptures	November 1988 – December 2024
Water Temperature	November 1975 – December 2024

A new model, Integrated Model Using Length Transition: IMuLT (which differs in implementation software, spatial and temporal structure as well as using a contemporary form of stock dynamics) is currently being developed by DPIRD in conjunction with University of Washington/CSIRO and the Institute for Marine and Antarctic Studies (IMAS). It is envisaged that IMuLT will replace the current ADMB model version by 2028.

The current ADMB integrated model is updated annually and used to assess several future harvesting (quota) scenarios. The model assumes that the current (2024) season's biological controls (e.g. minimum size at 76 mm and no maximum size limit or setose protection rules) are maintained in future seasons. Five-year projections of stock levels use the most recent four completed seasons of puerulus settlement data, with a fifth season of puerulus settlement data being based on the 25^{th} percentile of the historical data range (a five-year projection is required by the Harvest Strategy). A continuation of the current TAC (commercial = 6800 t and recreational = 500 t) is used for all “current state” projections. To derive the Annual Harvest Level (AHL) for the upcoming fishing season (2025 financial year), a different set of projections are produced based on a constant harvest rate of 39% (Caputi et al., 2015). The AHL represents the total catch that would be taken by the fishery in the fifth projected year if it was to fish constantly at a harvest rate of 39%. Recreational catches for projected years are set at 500 t based on the current allocation in the harvest strategy (DPIRD, 2024; Smallwood et al., 2023).

3.1.7.2 Model updates

There have been no structural model updates implemented for the 2024/25 assessment.

3.1.7.3 TARC setting

Integrated model projections using a constant harvest rate of 39% in the north (and B zones combined) and south (zone C) indicate that the fishery would land almost 11,000 t in the first year (2026/27) (Figure 3.19: first red point). After this peak, lobster biomass would decline, as would catches and by the fifth-year landings would be 7324 t (green point), which is a small decline on last year’s AHL estimate of 7630 t. A decline is expected due to the recent string of below average recruitments experienced by the fishery. With an estimated AHL of 7324 t, the total allowable recreational catch (TARC) for the 2025/26 recreational fishing season would be set at 366 t. However, under the current harvest strategy (DPIRD, 2024), the TARC has been set at 500 t for a transitional period of five seasons (2024/25 – 2028/29). The transitionary TARC reflects the average recreational sector catch for the last five years (2018 – 2022) and will provide a stable catch for the recreational (including charter) sector as the biomass trends downwards towards the long-term AHL (target level).

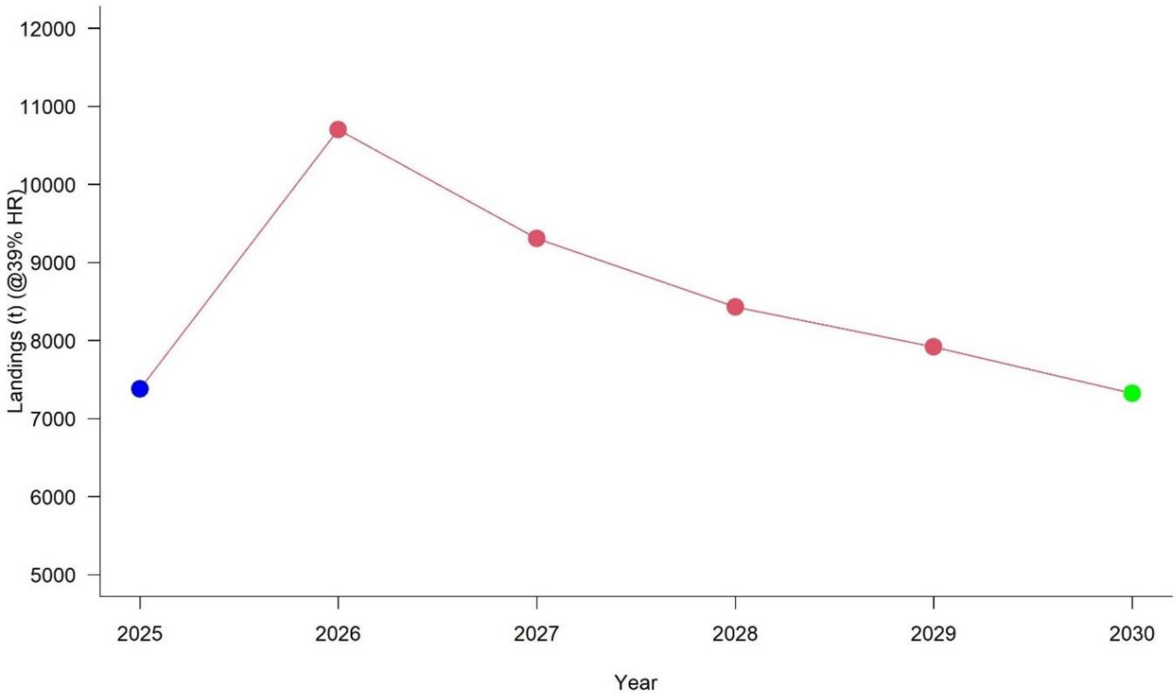

Figure 3.19. Model estimated projected total catch of WRL that would be landed with a constant harvest rate of 39%, with the current fishing season shown in blue (not based on fishing at 39%), and the fifth projected year, which defines the AHL, shown in green.

3.1.7.4 Model output legal biomass

Model estimated mean legal biomass has increased throughout the fishery since management changes across 2008 and 2009, reaching a peak in ~2020 (Figure 3.20). This peak occurred because of a combination of conservative TACs since 2008 and a drop in catches during the Covid 19 pandemic. Since the 2020 financial year, biomass has started to decline in concert with a progressive increase in overall landings (Figure 3.20). Biomass levels will continue to decline in all management areas at current levels of TAC but are projected to remain above historic levels by the 2030 financial year.

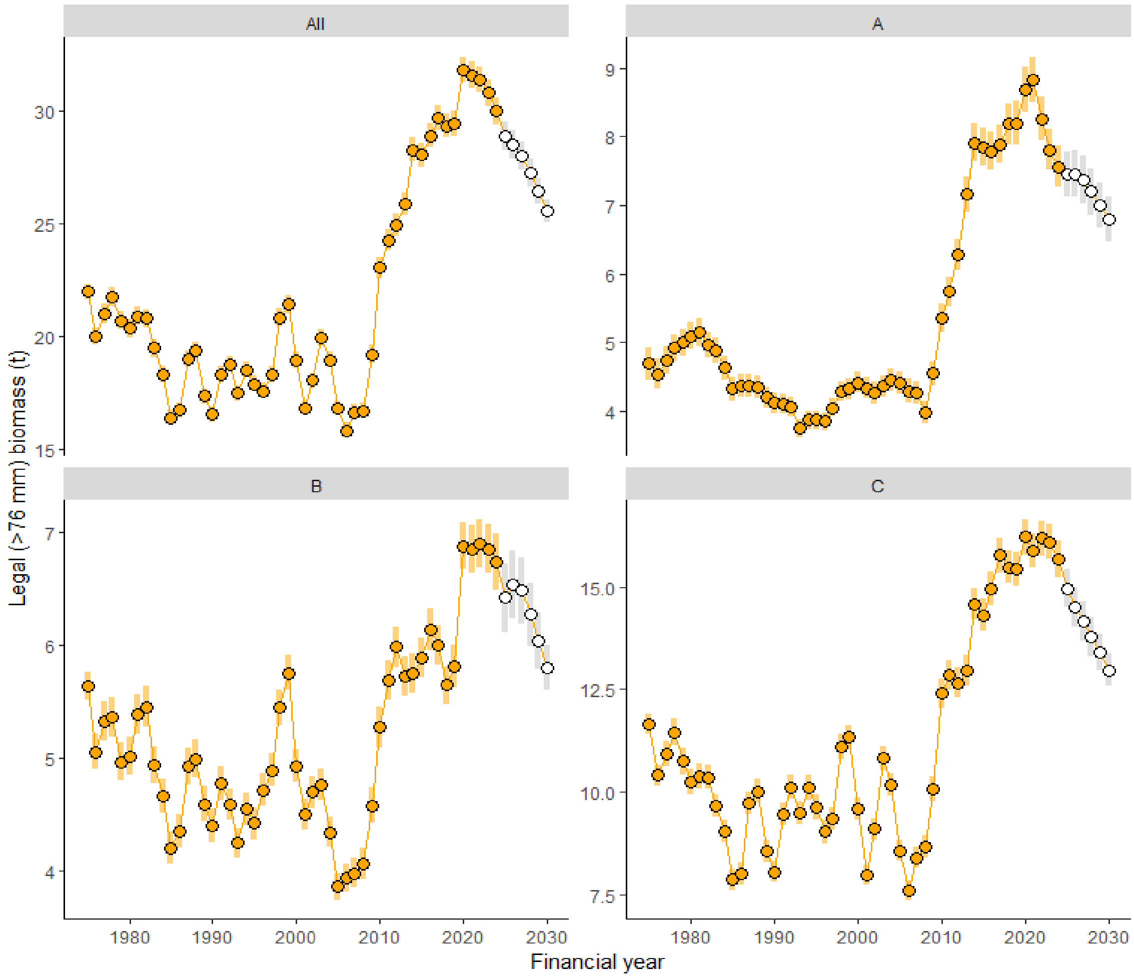

Figure 3.20. Model estimated mean legal (≥ 76 mm CL) biomass (± 95% CI) of lobster combined over the fishery (all) and in each management zone. Solid orange points represent years the model has observed data and open points are projections based on a continuation of current TAC settings.

The integrated model estimates legal biomass is well above historic levels and there is a low risk of the stock being over-fished.

3.1.7.5 Model output egg production

Egg production is determined in the model for four breeding stock management areas; Abrolhos (model areas 9, 10 Figure A3.1); North (model areas 8 and 11); Central (model area 6); and South (model areas 2,4). This spatial aggregation is required by the Harvest Strategy and egg production is used as the primary indicator for sustainability (DPIRD, 2024). Estimated egg production progressively declined in most breeding stock management areas since the start of the timeseries, through until the 1993 management changes when protection of breeding females was increased (Figure 3.21). A second marked increase in egg production (to levels well above the threshold) occurred following the 2008/2009 management changes when commercial catches declined by 50%. After reaching very high levels in ~2013 financial year, egg production dipped as the low puerulus recruitment in 2008/2009 started to enter the breeding stock at an age of five to six years post settlement (Figure 3.21). Subsequently, levels increased again in concert with increased puerulus settlement but have started to decline slightly over the past two seasons. Egg production throughout the fishery remains high and well above threshold reference levels over the projected five financial years based on a continuation of the current TACC (6800 t). It is projected to track towards egg production levels projected under a fishing scenario with a harvest rate of 39% and average (2010 – 2024) recruitment.

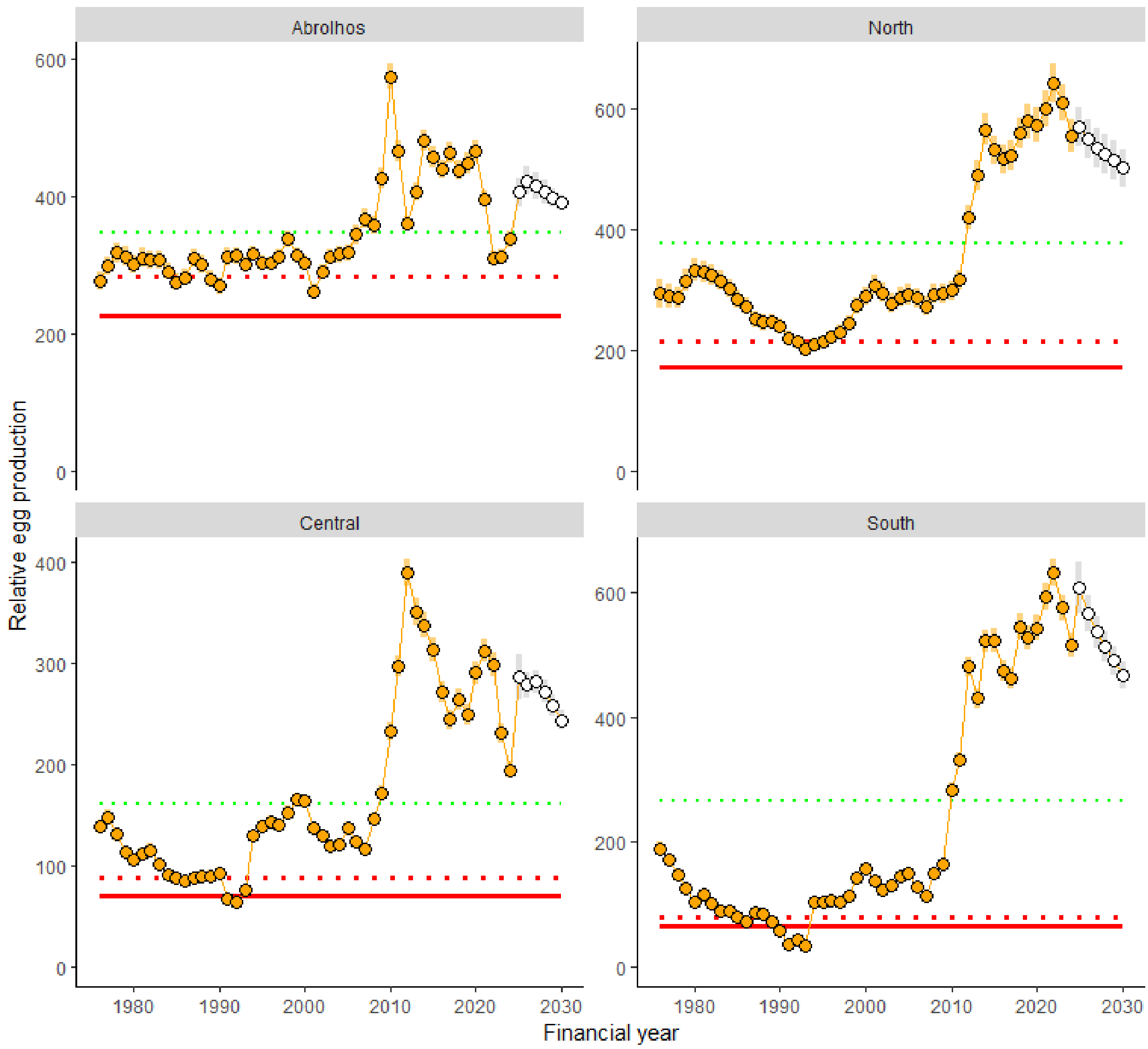

Figure 3.21. Integrated model estimated egg production (± 95% CI) of fishing in the four breeding stock management areas. Solid orange points represent years the model has observed data, and open points are projections based on a continuation of current TAC settings. The dotted and solid red lines represent the threshold and limit reference points, respectively. The dotted green line represents the egg production levels that would occur if the target harvest rate of 39% was achieved for ten consecutive years under average recent (2010 – 2024) recruitment.

The integrated model estimates of egg production are well above historic levels and suggests a relatively low level of breeding lobster depletion across the fishery. Projections indicate that threshold and limit reference points will not be breached under current TAC settings. This indicates the stock is at a low risk of being over-fished.

3.1.7.6 Model output harvest rate

Model estimated harvest rates are presented in two areas: combined A and B zones (AB) which represents the northern half of the fishery (model areas 5–11), and C zone which represents the southern part of the fishery (model areas 1 – 4, Figure A4.1). This spatial aggregation is required by the Harvest Strategy and harvest rates are used as a secondary indicator.

Harvest rates increased rapidly throughout the fishery across the first ~30 financial years of the time series as total catches increased, and legal biomasses decreased (Figure 3.22). The interannual variation in harvest rates were due to relatively constant effort and variable recruitment entering the fishery. By the mid-2000s harvest rates had reached very high levels with ~70% of all lobster being taken each financial year. Following the significant management changes in 2008/2009, when lobster catches halved, harvest rates dropped rapidly to historical lows of ~20% as then biomass rapidly increased (Figure 3.22). Harvest rates then started to increase, but dropped again following Covid 19, mainly due to the very low catches in this financial year, before again starting to increase with increasing catches. Harvest rates remain low throughout the fishery and are starting to increase into the proxy for maximum economic yield (MEY) region of 0.29 – 0.39 (Caputi et al. 2015, 2018). Projections indicate that harvest rates will continue to progress towards the harvest strategy target of the upper level of this region.

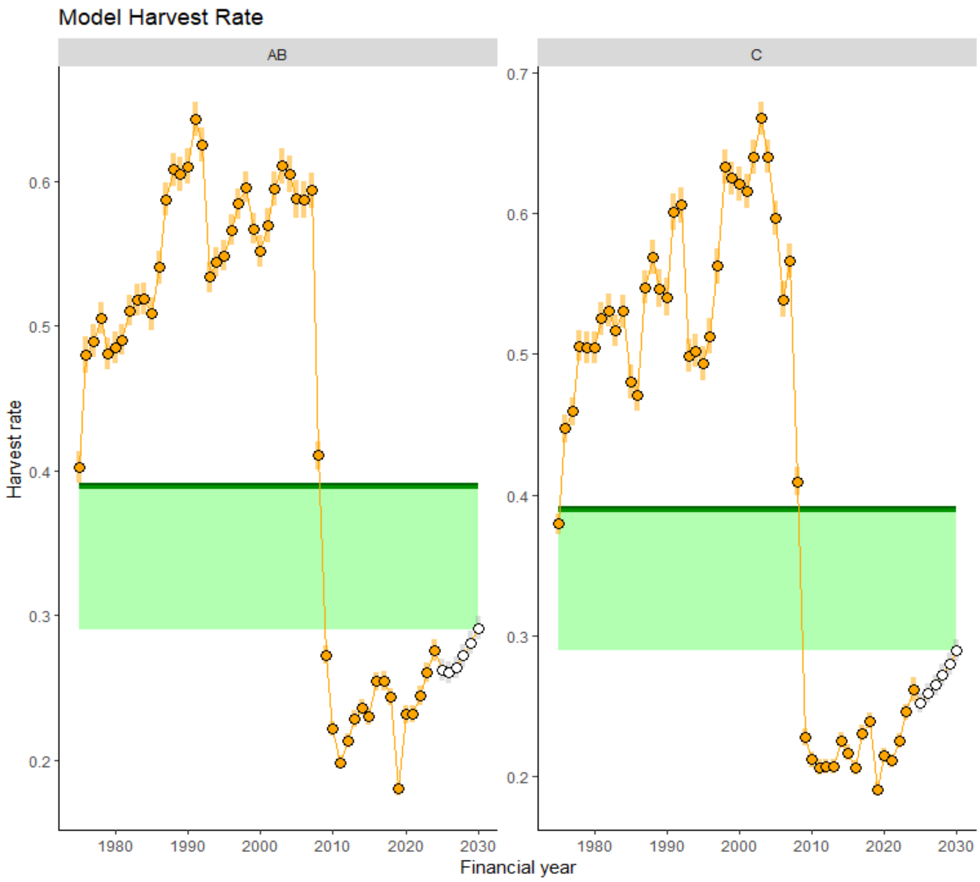

Figure 3.22. Model estimated mean harvest rate (± 95% CI) of fishing in the northern (management zones A and B: AB) and southern (management zone C) areas of the fishery. Solid orange points represent years the model has observed data, and open points are projections based on a continuation of current TAC settings. The light green box represents the harvest rates associated with MEY and the dark green line the upper margin of this region and the current harvest rate target.

The integrated model estimates of harvest rate are below that associated with proxy for MEY. This indicates the stock is at a low risk of being over-fished.

3.1.8 Environmental Impacts

Western rock lobsters are ectothermic animals and thus their metabolic rate and the timing of various life stages are intrinsically linked to their surrounding environment. Water temperatures are a dominant driver (in terms of relationships described in the literature), and the impacts of changes are exhibited by a range of biological traits exhibited by this species. For example, factors include size at maturity (Figure 3.23), the timing of the onset of spawning (Figure 3.24), the timing of the onset of migration (Figure 3.25) and the microsporidium infection rate for lobster (Figure 3.26; Table 3.2). In addition to water temperatures the biology and behaviour of this species is also markedly influenced by moon phase, ocean swells, ocean turbidity, and food sources (Table 3.2).

Table 3.2. Summary of environmental drivers known to impact the various life stages of WRL.

Life stage/behaviour	Environmental driver	Reference
Larval survival	Water temperature and ocean currents	(Säwström et al. 2014, Wang et al. 2015)
Puerulus settlement	Water temperature and ocean currents, winter storms	(Caputi and Brown, 1993; de Lestang et al., 2015; Kolbusz et al., 2022a)
Juvenile growth	Water temperature, lobster density and food availability	(Edgar 1990, de Lestang 2018)
Migration: timing, lobster size, direction, and distance.	Water temperature, swell and Leeuwin current	(Caputi et al. 2010, de Lestang 2014, de Lestang & Caputi 2015)
Maturity: size and timing of reproduction	Water temperature	(de Lestang & Melville-Smith 2006, Melville-Smith & De Lestang 2009, Melville-Smith & de Lestang 2010, Caputi et al. 2010)
Catchability	Moon phase, swell, water temperature	(Srisurichan et al. 2005, Melville-Smith & Beale 2009)

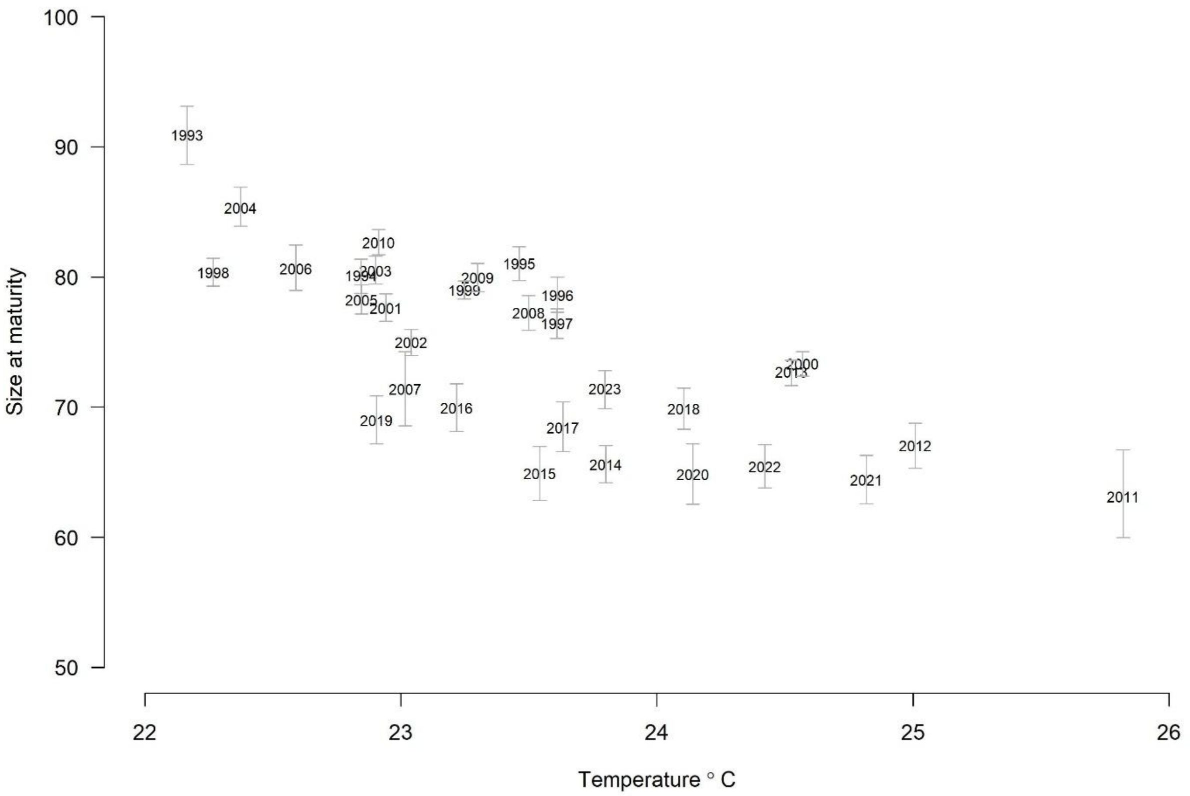

Figure 3.23. Plot showing relationship between bottom water temperature near Dongara averaged over January to March and size at maturity (±95% CI) of female lobsters at Dongara measured later (in September – November) that same year.

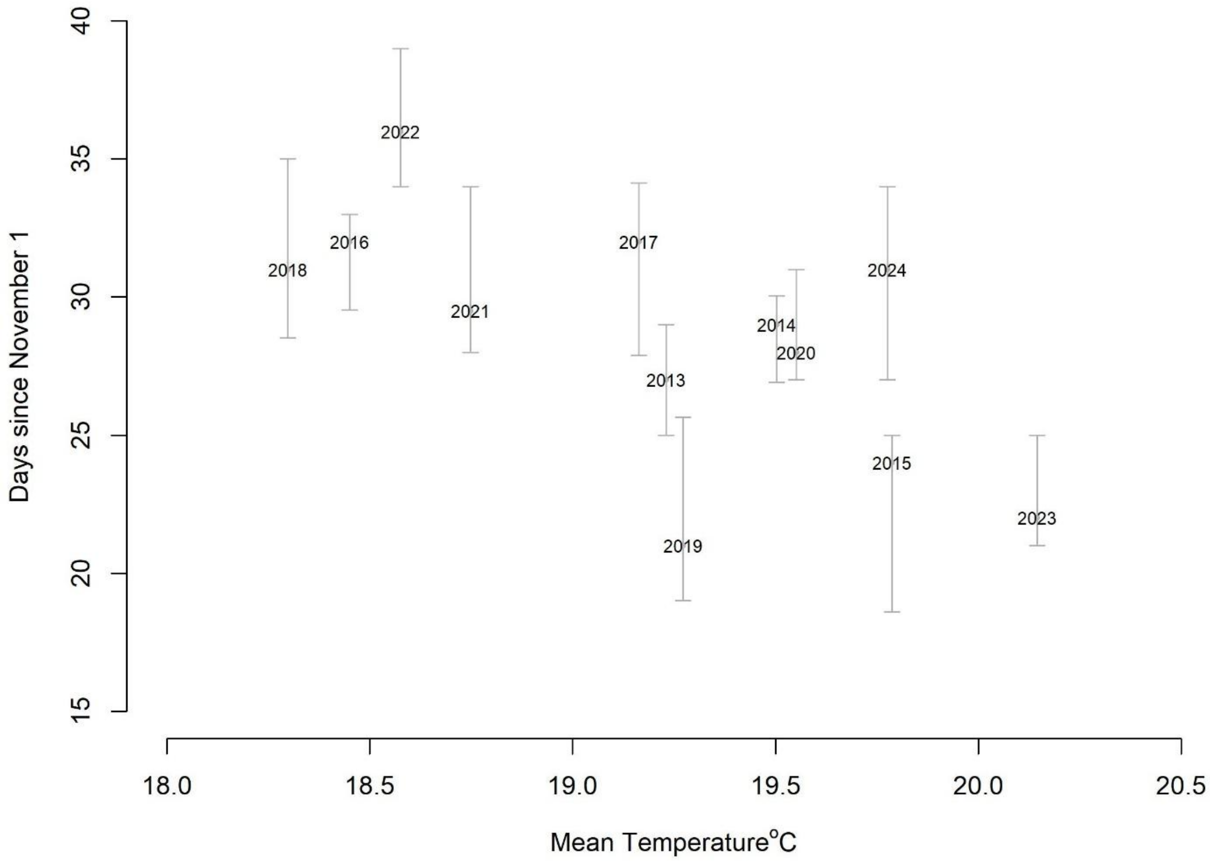

Figure 3.24. Relationship between mean bottom water temperature off Jurien from August/September and the mean timing of onset of spawning. Grey error bars represent 95% CI.

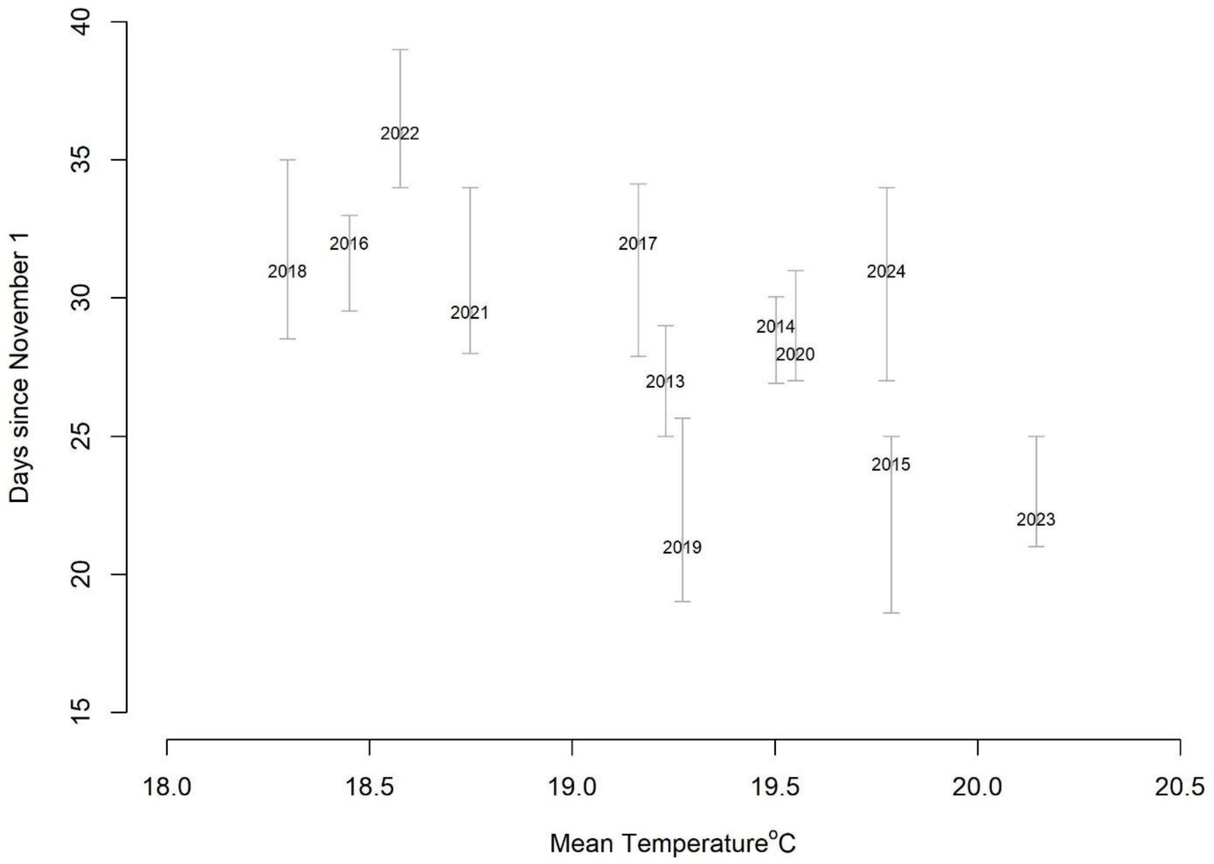

Figure 3.25. Relationship between mean shallow water temperatures in October/November and the mean (± 95% CI) timing of the start of the annual white lobster migration.

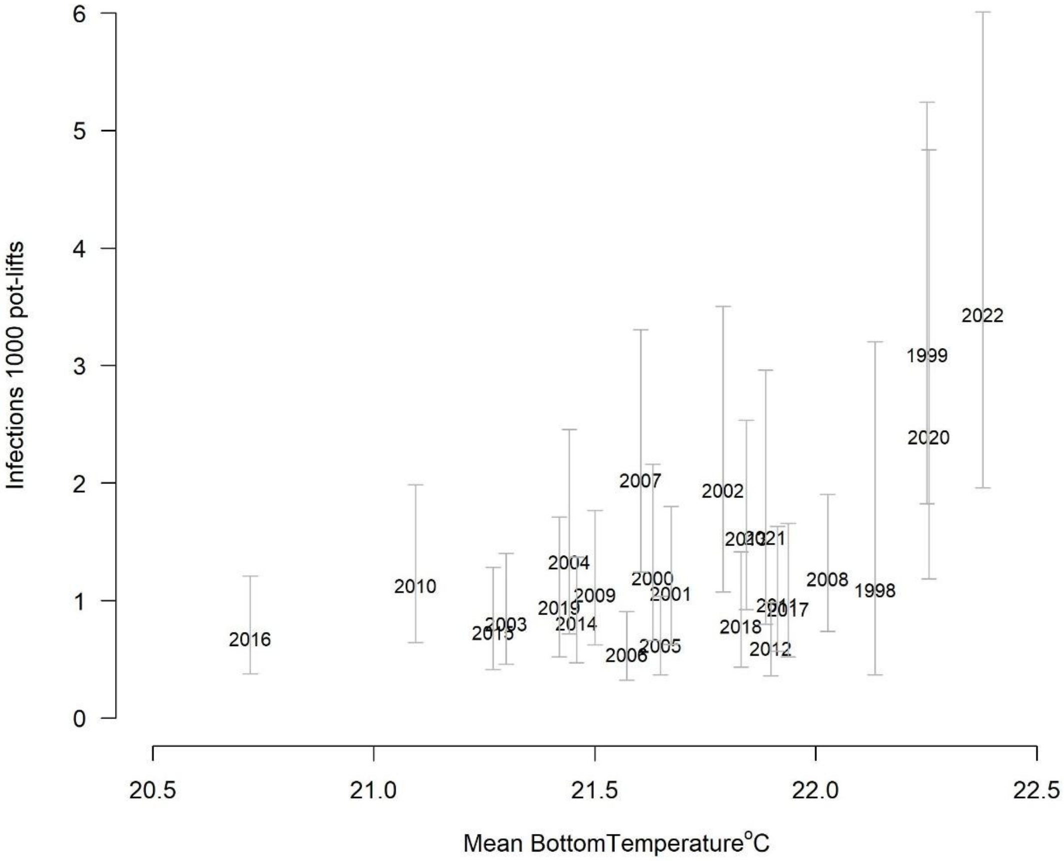

Figure 3.26. Plot showing relationship between mean bottom water temperatures in June/July and the annual mean (± 95% CI) catch rate of lobsters infected with microsporidium.

3.1.8.1 Water temperature observations

Average annual sea surface temperatures (SST) were sourced from https://www.metoffice.gov.uk/hadobs/hadisst/ (Rayner et al., 2003). This data set contains spatial 1° measurements of SST from 1870 until 2023. An annual average SST was calculated from a subset of this data set, restricted to the area adjacent to and overlapping the lobster fishery, with the bounds of -26 to -34° S and 111 to 115° E. These data span almost 150 years and show great inter-annual variability of up to 0.5° C between successive years (Figure 3.27). Within the time series two main patterns exist, a shorter-term cyclical trend with a wavelength of ~ 40 years (blue line), being high over the first 20 years (1870 – 1890), then low over the subsequent 20 years (1890 – 1910) and continuing this pattern throughout. Over the longer-term, water temperatures showed a slight decline over the first 40 years, before a rapid rise started in 1950, and has continued through to the end of the timeseries. Over this periods there has been an increase of ~1° C in SST from ~ 20.25° C in 1950 to ~21.25° C in 2023 (Figure 3.27, red line).

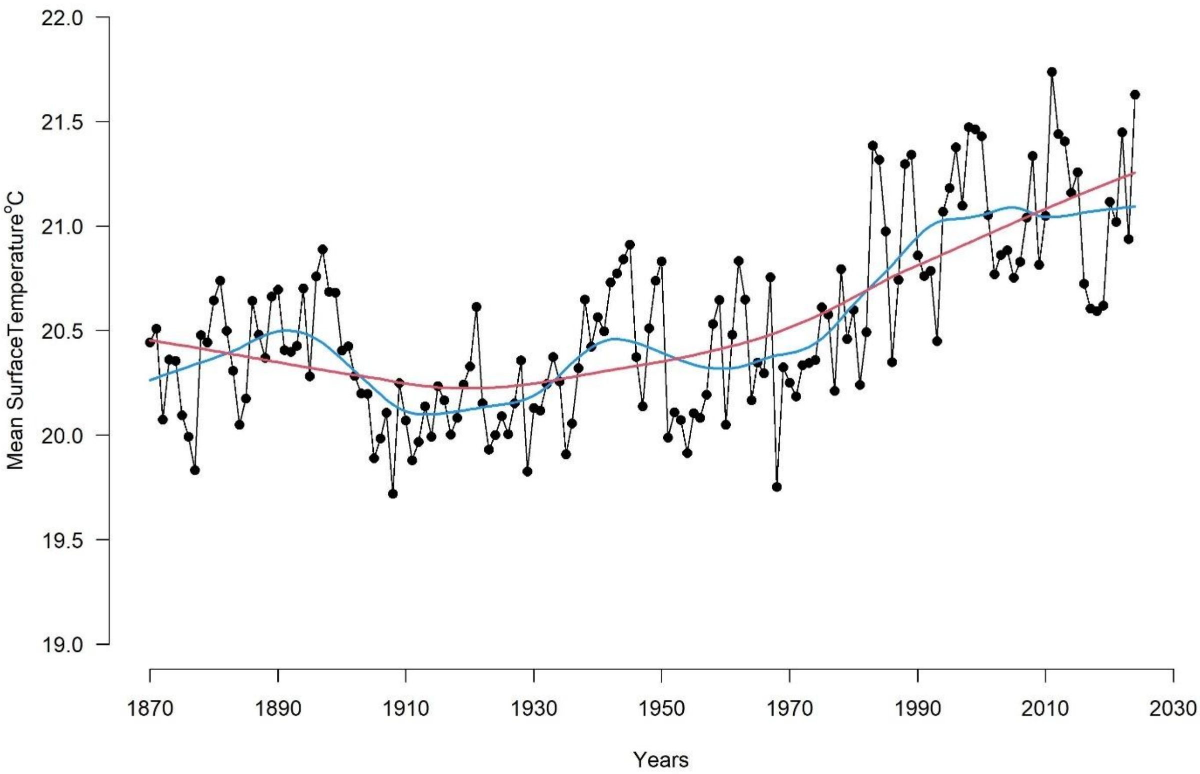

Figure 3.27. Average annual sea surface average water temperature adjacent to and overlapping the WRL fishery. Two LOWESS smoothers (Cleveland, 1981) were fitted with either a short (blue line) or longer span (red line) to show the general trends.

Over the past 12 months water temperatures in shallow regions at the northern (Kalbarri) and southern (Fremantle) ends of the main fishing grounds have shown similar variation from the long-term average (Figure 3.28). In both locations SST was ~ 1° above the median in August and September, returned to the median for a short period before again increasing in January to up to 2° above the median in some months through until July 2025. The above average SST in October/November is considered the cause of the early whites' migration in 2024 (Figure 3.28). The fishery narrowly missed a marine heatwave in February/March due to a cooling severe tropical cyclone (TC Sean) which progressed down the coast in late January 2024.

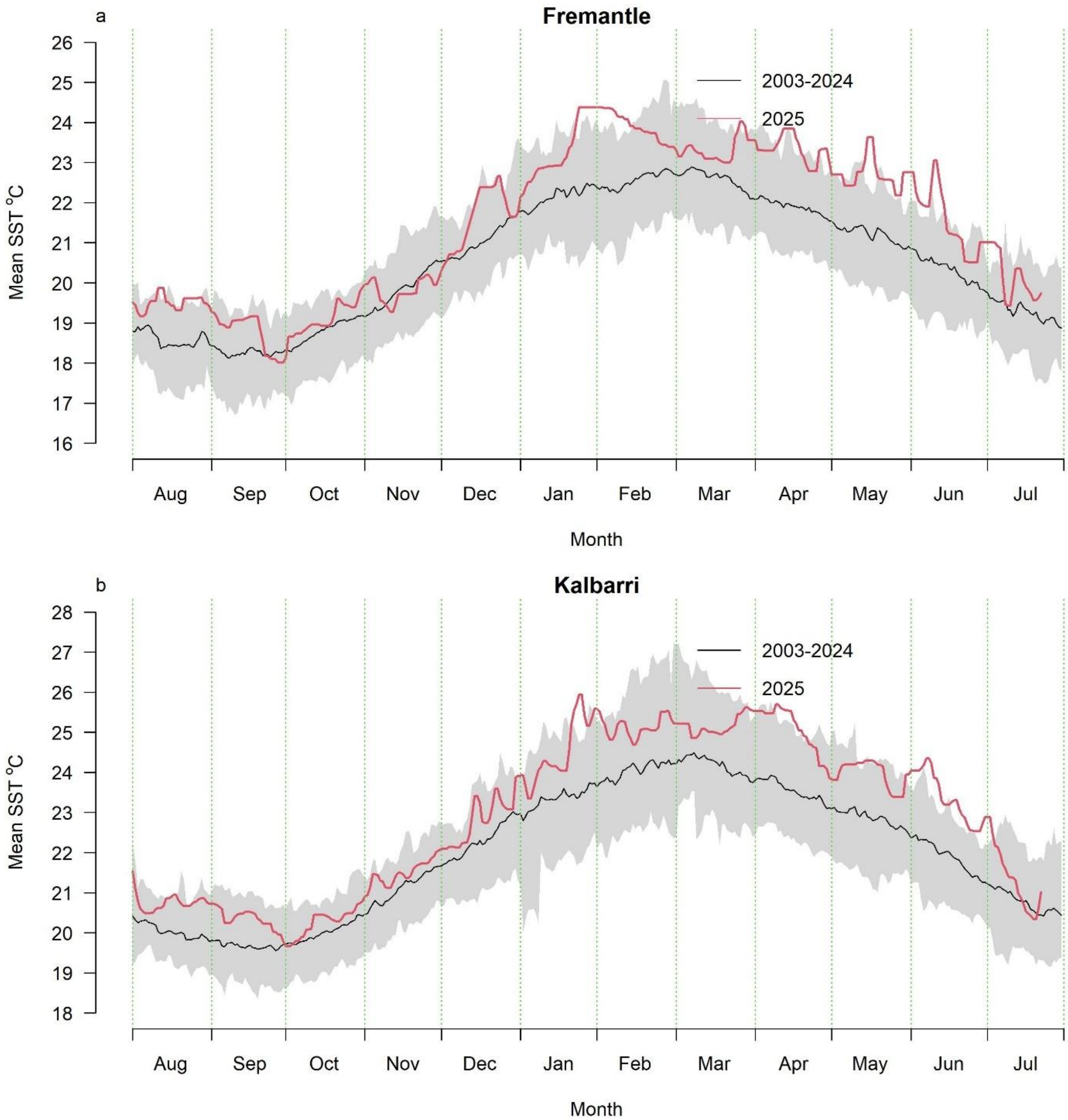

Figure 3.28. Daily sea surface average water temperature inshore at Fremantle (a) and Kalbarri (b) over the past 12 months (red) and as an average (black ± 95% CI [grey]) across the last 21 years.

3.1.8.2 Ocean Currents

Ocean currents can be difficult to monitor as they require the synthesis of a range of data inputs in an oceanographic model. Along the West Coast of Australia proxies for Leeuwin Current (LC) strength can be developed from sea level anomalies, such as variation from predicted tide or relative changes in the Fremantle sea level (FSL). Stronger current flow results in positive anomalies (the sea level is higher than average or expected). The FSL has been used in this report due to its timeseries length, having been consistently collected since January 1897. In recent year however, the index has been broken due to the redevelopment of the Fremantle traffic bridge. These latter observations have been based on data collected at the Hillarys boat harbour (data range 1991 – present), with an adjustment factor between the two datasets derived from a linear model with a very high correlation (R^2 = 0.971). Both datasets can be downloaded from https://www.psmsl.org.

To derive sea level anomalies, the timeseries is fitted with a lowess smoother to determine an “average” sea level that changes over time due to long-term climate change (sea level rise as ice deposits melt). The anomaly is then determined as the difference between a monthly measurement and the long-term smoothed average. Over the entire timeseries, the anomaly varies by as much as 60 cm (30 cm above and 30 cm below) and displays a progressive ~10 year cycle between strong and weak LCs (positive and negative anomalies) (Figure 3.29, red line). If this pattern continues, then the cycle is currently at the top the positive phase, indicating a strong LC, and may decline over the next few years. The current strength in January, as identified by the orange points (, bottom), shows that this month is normally a period of week current and generally well below that in June, when the current is at its strongest (blue point). The unusually high January point in 2025 indicates the strong LC that results in the late 2024/early 2025 marine heatwave experienced between the Kimberly and Gascoyne regions). The current strength in January 2011 was also unusually high and resulted in that year marine heatwave which impacted the WRL fishery.

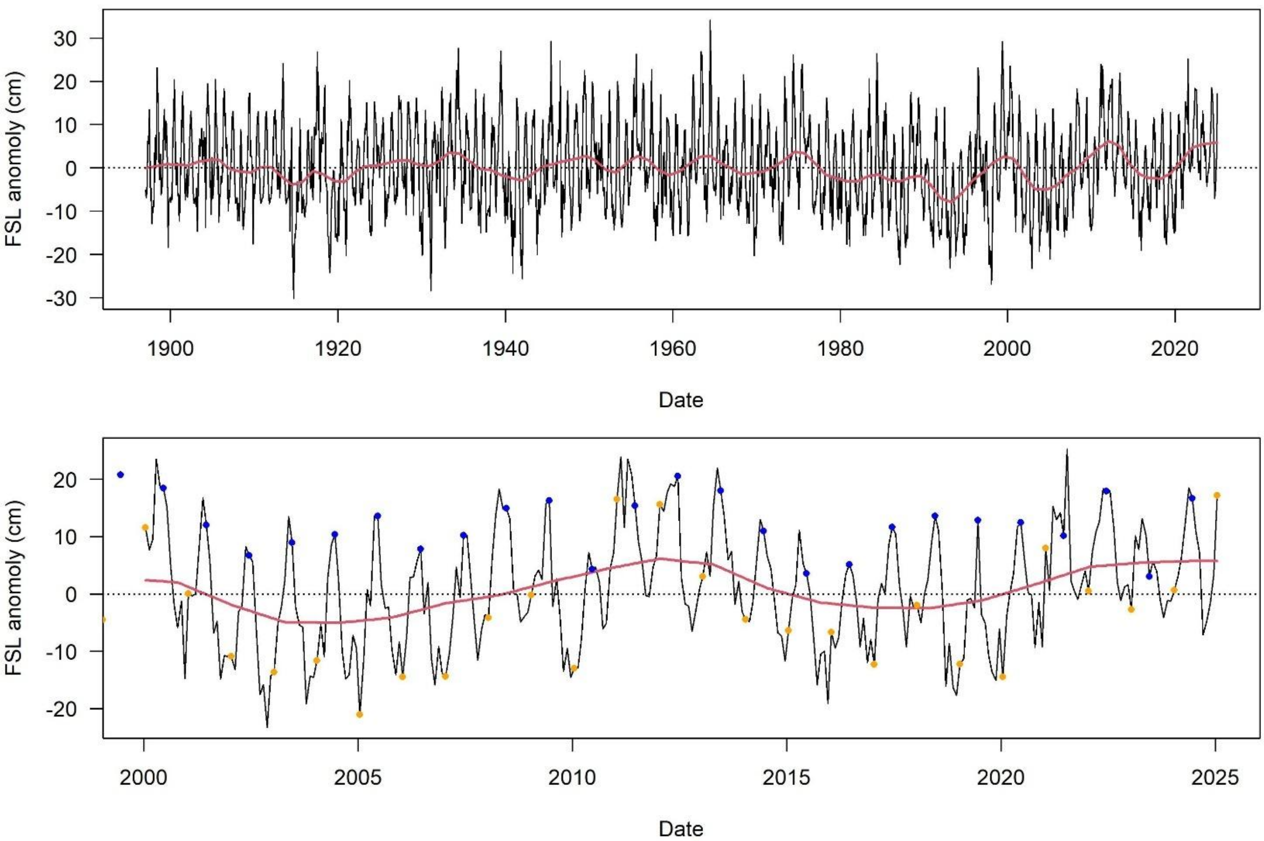

Figure 3.29. (top) Fremantle sea level anomaly (black line) with a smoother fitted to show the progressive average change between years. (bottom) As above but limited to 2000 onwards with January and June points highlighted by the orange and blue points, respectively.

3.1.8.3 Indian Ocean Dipole

One of the key drivers of Australia's climate (especially that on the west coast) is the Indian Ocean Dipole (IOD). This index is the anomaly between sea surface temperatures of the tropical western and eastern Indian Ocean, which impact the movement of weather patterns across this region. During the positive phase of IOD westerly winds weaken along the equator allowing warm water to shift towards Africa and cool water to rise from the deep ocean in the east (offshore of Australia). This temperature difference results in less moisture than normal in the atmosphere to the northwest of Australia and changes the path of weather systems coming from Australia's west, often resulting in less rainfall and higher than normal temperatures (including SST on the shelf) over Western Australia during winter and spring.

Over recent years the IOD has progressively been moving more towards positive levels, especially since ~ 2010 (Figure 3.30). A significant linear relationship (p < 0.01; R^2 = 0.13) exists between the annual average of the IOD lagged one, two and three years and the annual SST experienced by the WRL fishery (Figure 3.31). Note due to the autocorrelation that exists within oceanographic temperature data, the orcutt package in R was used to first remove all auto-correlation from the dataset.

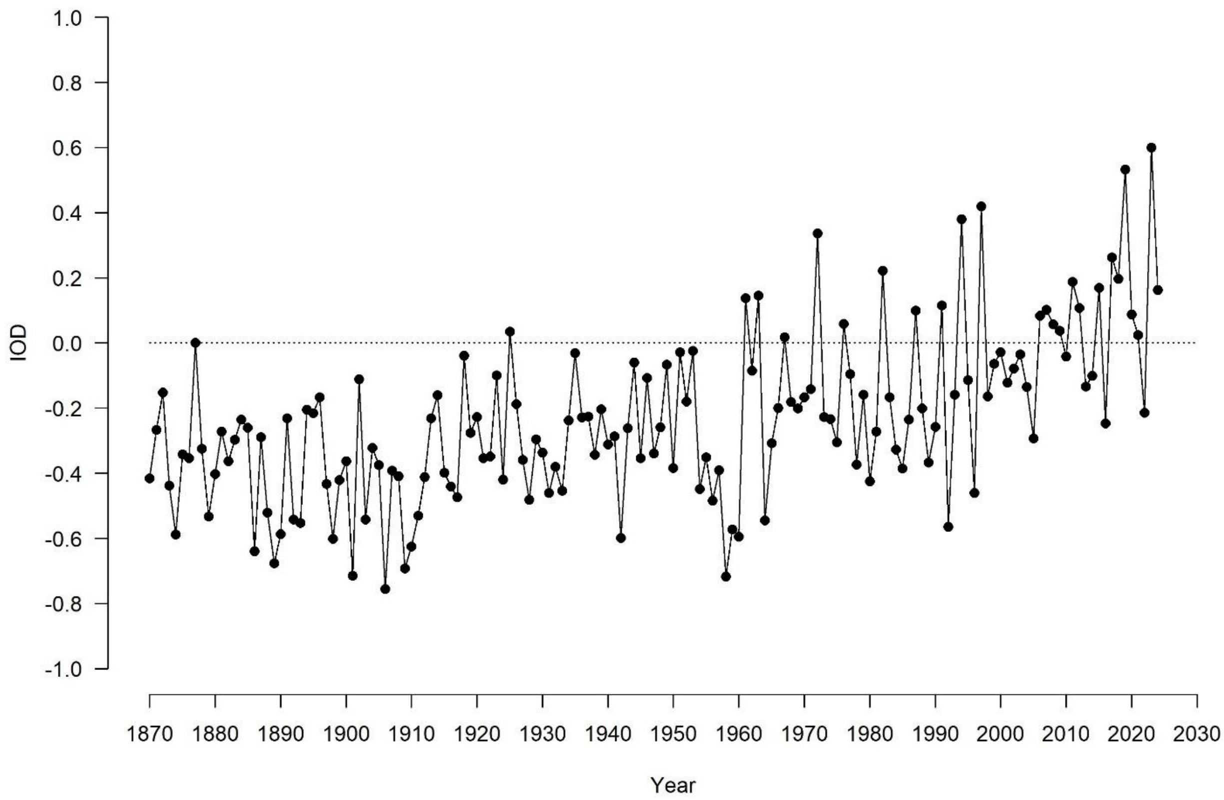

Figure 3.30. Annual average Indian Ocean Dipole.

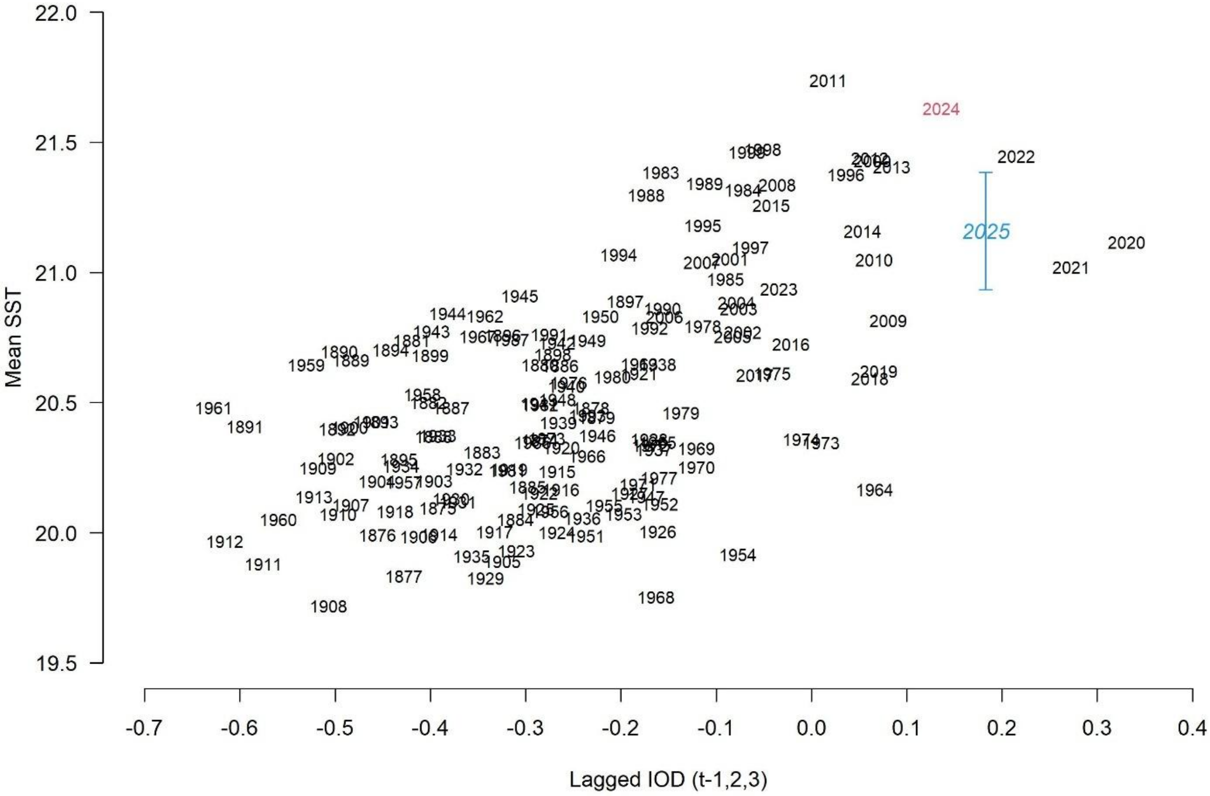

Figure 3.31. Relationship between average Indian Ocean Dipole (combination of annual indices lagged one, two and three years) and SST for the area covering the WRL fishing grounds. The most recent year is shown in red, with a linear model derived prediction of SST in the following year shown in blue (±95% CI of prediction).

3.1.8.4 Environmental prediction

Water temperatures for the 2025 fishing season (2025/26) are predicted to be average to above average based on four sources: (1) Recent sea level anomalies; (2) The Australian Community Climate Earth-System Simulator – Seasonal (ACCESS–S) [http://www.bom.gov.au/oceanography/oceantemp/sst-outlook-access.shtml]; (3) Projections based on the trends displayed by the two smoothers fitted to the annual SST (Figure 3.27); and (4) A forecast based on the relationship between SST and the Indian Ocean Dipole (IOD) (Figure 5-28). Above average water temperatures increase the risk of a marine heat wave occurring, as was the case in 2011, which had negative impacts on the juvenile habitats at the northern end of the fishery.

3.1.9 Risk based Weight of Evidence Assessment

<table>
<tr><th>Category</th><th>Line of Evidence</th></tr>
<tr><td>Catch</td><td>>99% of the TAC was landed.</td></tr>
<tr><td colspan="2">Level 1 Assessment
Catch data does not indicate a high level of lobster depletion in any region of the fishery, indicating the stock is at a low risk of being over-fished.</td></tr>
<tr><td>Effort</td><td>Effort levels remain low relative to historic levels.</td></tr>
<tr><td>Catch Rate</td><td>Catch rate indices remain well above historical levels.</td></tr>
<tr><td colspan="2">Level 2 Assessment
Effort and catch rate data do not indicate a high level of lobster depletion in any region of the fishery, indicating the stock is at a low risk of being over-fished.</td></tr>
<tr><td>Size Composition</td><td>The size composition of the stock remains high relative to historic.</td></tr>
<tr><td colspan="2">Level 3 Assessment
Carapace length data collected by the various surveys does not indicate a high level of lobster depletion in any region of the fishery. This carapace length data indicates the stock is at a low risk of being over-fished.</td></tr>
<tr><td>Fishery Independent Index</td><td>Empirical recruitment has been slightly below average in recent years.
Empirical biomass remains very high throughout the fishery.</td></tr>
<tr><td>Biomass Dynamic Model</td><td>Modelled biomass levels remain very high throughout the fishery.</td></tr>
<tr><td colspan="2">Level 4 Assessment
Fishery independent recruitment surveys do not indicate an unexpected reduction in recruitment levels. Fishery independent indices indicate that breeding biomass is above historic levels throughout the fishery. The BDM model estimates that the resource is not over-fished, and over-fishing is not occurring Resource appears sustainable</td></tr>
<tr><td>Integrated Model</td><td>The integrated model estimates of egg production are well above historic levels and suggest a relatively low level of breeding lobster depletion across the fishery. Projections indicate that threshold and limit reference points will not be breached under current TAC settings.</td></tr>
</table>

Level 5 Assessment The integrated model indicates that threshold and limit egg production reference points will not be breached under current TAC settings over the projection period (5 years). This indicates the stock is at a low risk of being over-fished. The model also estimates that harvest rates are below that associated with the MEY proxy of 39%. This indicates the stock is at a low risk of over-fishing.	
Environmental Impacts	All life stages of the WRL have been documented to be impacted by the environment, which is progressively changing, especially increasing water temperatures. This is causing changes in the timing and size of lobsters displaying certain life history stages, including differences in the magnitude and timing of puerulus settlement, whites' migration and reproduction.
Economic Impacts	The key overseas market for western rock lobster (China) has reopened. Beach prices have increased as a result.
Social Assessment	The number of commercial operators continues to decline. Recreational fishers continue to have access to good catch rates of lobster. Back of Boat Sales to the public remain good and participation by industry in this program remains strong.
Risk Assessment In addition to low vulnerability, fishing practices afford protection to a large portion of the breeding population (almost all females and small maturing males). Catches, catch rates, size composition, independent surveys and modelling do not indicate overfishing. Overall, egg production is above the threshold levels (> 75% certainty) and harvest rates are below targets, therefore the resource is considered sustainable. C1 Minor (HR Below Target): Likely (L3) C2 Moderate (Biomass above Threshold): Unlikely (L2) C3 High (Biomass between Limit and Threshold): Remote (L1) C4 Major (Below Limit): Remote (L1) Therefore, the overall weight of evidence assessment for western rock lobster during 2024 is a **Low** risk (C4 x L1).	

Consequence (Stock depletion)	Likelihood			
	L1 Remote (<5%)	L2 Unlikely (5-20%)	L3 Possible (20-50%)	L4 Likely (>50%)
C1 Minor (above Target)				Negligible

C2 Moderate (between Target and Threshold)		Low		
C3 High (between Threshold and Limit)	Low			
C4 Major (below Limit)	Low			

3.1.10 Harvest Control Rules and Season Advice

The harvest controls in the current harvest strategy relate to the egg production and harvest rates. As egg production is projected to be above threshold levels and the harvest rates are below 39% the control rules indicate that no action is required.

4 Ecological Assessment

4.1 Retained Species

Commercial lobster fishers can retain other species of rock lobsters, octopus, and champagne crabs that are caught as by-product of lobster fishing. All catch of these species must be detailed in catch disposal records. These data are included in the stock assessments for the West Coast Deep Sea Crustacean Managed Fishery (champagne crab) and Interim Octopus Managed Fishery (octopus). Both these stocks are classified sustainable (https://library.dpird.wa.gov.au/an_sofar/). The catches by the WCRLMF reported during the 2024 financial year are detailed in Table 4.1.

Table 4.1. Species and quantity of by-product (kg) retained during the 2024 financial year.

Species common name	Landings (kg)
Champagne Crab	962
Octopus	13902
Tropical Rock Lobster	2
Southern Rock Lobster	5

4.2 Bycatch

Other species captured in lobster pots that are not available to be sold are defined as “by-catch species” and may be retained by the fisher for personal consumption (based on a recreational bag limit) or returned to the sea. All by-catch must be detailed in catch disposal records (CDR), which can result in the use of nonstandard names. As such, records in the CDR have been summarised to combine, where possible, the same species under an official common name. For example, “Bluebone”, “Baldys” and “Groper” have all been pooled under the common name of “Baldchin Groper”.

During the 2024 fishing season, Baldchin Groper and Pink Snapper contributed 56.6% and 21.3% of by-catch, respectively (Table 4.2). It should be noted that not all by-catch caught is retained, with the majority being returned to sea alive (noting they would experience some level of discard mortality).

Table 4.2. Species common name and catch (kg) for the 2024 financial year of species with an annual catch >10 kg.

Species common name	Catch (kg)
Baldchin Groper	4764.9
Pink Snapper	1795.8
Wobblegong Shark	557
Cuttlefish	369.8
Red Throat Emperor	369.6
Breaksea Cod	219.6
West Australian Dhufish	141
Chinamen Cod	95.1
Coral Trout	15.3
Spangled Emperor	14.5
Harlequin fish	11
Leather Jacket	10

4.3 Endangered, Threatened and Protected Species

Compliance checks are undertaken on both commercial and recreational sectors to educate and ensure adherence to current management arrangements. In an average year compliance conducts over 500 and 4000 checks on each sector, respectively. Furthermore, it is a requirement that all interactions with ETPs are recorded in the catch disposal records (CDR) submitted on the completion of each fishing trip.

4.3.1 Sea Lions

Accidental drowning of Australian sea lion pups in WRL pots instigated the implementation of sea lion exclusion devices (SLED) in areas where these interactions were occurring (Campbell et al. 2008). An ecological risk assessment (ERA) in 2013 re-assessed this issue after the implementation of SLEDs as a low risk (Stoklosa, 2013). Prior to SLED implementation, the historical level of sea lion drownings was three per season. In 2024 there were zero interactions recorded. The performance measure for the fishery is that there is no increase in the rate of capture of sea lions. Therefore, **the fishery met this performance measure**.

Compliance checks are undertaken on the adherence of fishers to SLED regulations. In the 2024 financial year the fishing gear of 502 recreational fishers and 96 commercial operators were checked for compliance. This resulted in the issuing of two infringements, with three warnings for SLED compliance.

4.3.2 Dusky Shark

To address concerns over the impact of entanglement on the Dusky shark (*Carcharhinus obscurus*) population from discarded bait bands, a state-wide ban on bait bands on fishing vessels was implemented on the 15 November 2011. An ERA re-assessed this issue after the implementation of the state-wide ban as no longer being a credible threat (Stoklosa 2022) and was therefore not assessed any further. Compliance checks are undertaken on the adherence of fishers to bait band regulations and in 2024 these resulted in no infringements and no warnings.

4.3.3 Whales

The largest population of humpback whales (*Megaptera novaeangliae*) in the southern hemisphere (Leaper et al. 2008) migrates along the West Australian coast annually. Traditionally this population has had a small interaction with the WRL fishery. Entanglements between 1990 and 2010 ranged from 0 to 6, averaging just over 1 entanglement annually. However, in 2011 there was an increase in whale entanglements which ultimately peaked with 17 in 2013 due to increased fishing during the whale migration period when the season was extended to 12 months and a strong population recovery of humpback stocks.

In July 2014 a series of gear modifications were introduced to mitigate entanglements between humpback whales and WRL gear (How et al. 2021). These modifications are implemented during the whale migration period (May – October) each year since. An ERA re-assessed this issue after the implementation of these mitigation measures as being a low risk (Stoklosa 2022). The performance measure for this fishery is that entanglements in WRL gear is within the historic range. In the 2024 financial year, five entanglements were recorded, and therefore, **the fishery met this performance measure**. Compliance checks are undertaken on the adherence of fishers to whale gear mitigation regulations and in 2024 these resulted in the issuing of three infringement and four warnings.

4.4 Habitats

Interactions between the fishery (pot setting) and habitats throughout the fishery are directly examined using pot cameras and the risk that fishing is having detrimental effects on the habitats is assessed intermittently as part of ecological risk assessments (Stoklosa, 2022). The most recent risk assessment considered that there was a low risk that fishing could result in serious or irreversible harm to habitat structure and function (Table 4.3).

POTBot cameras are deployed in the pots of commercial fishers throughout the fishery. These fishers are chosen (based on their fishing locations and willingness to participate) to extend this monitoring across the extent of the commercial fishery. POTBots are retrieved from fishers, typically monthly, and their text data (dates, deployment positions, and water temperature) are recorded into a database and videos onto a hard drive. Videos are scanned by a trained staff member and the visible habitat classified in conjunction with the presence of any key interesting species (e.g. Dhufish, Break Sea Cod, Baldchin Grouper, Shark). In the 2024 financial year 67 geo-positioned videos were collected and analysed from the WRL fishery (Figure 6.1). Since the program's inception in 2021 a total of 218 geo-positioned videos have been collected and analysed within this fishery.

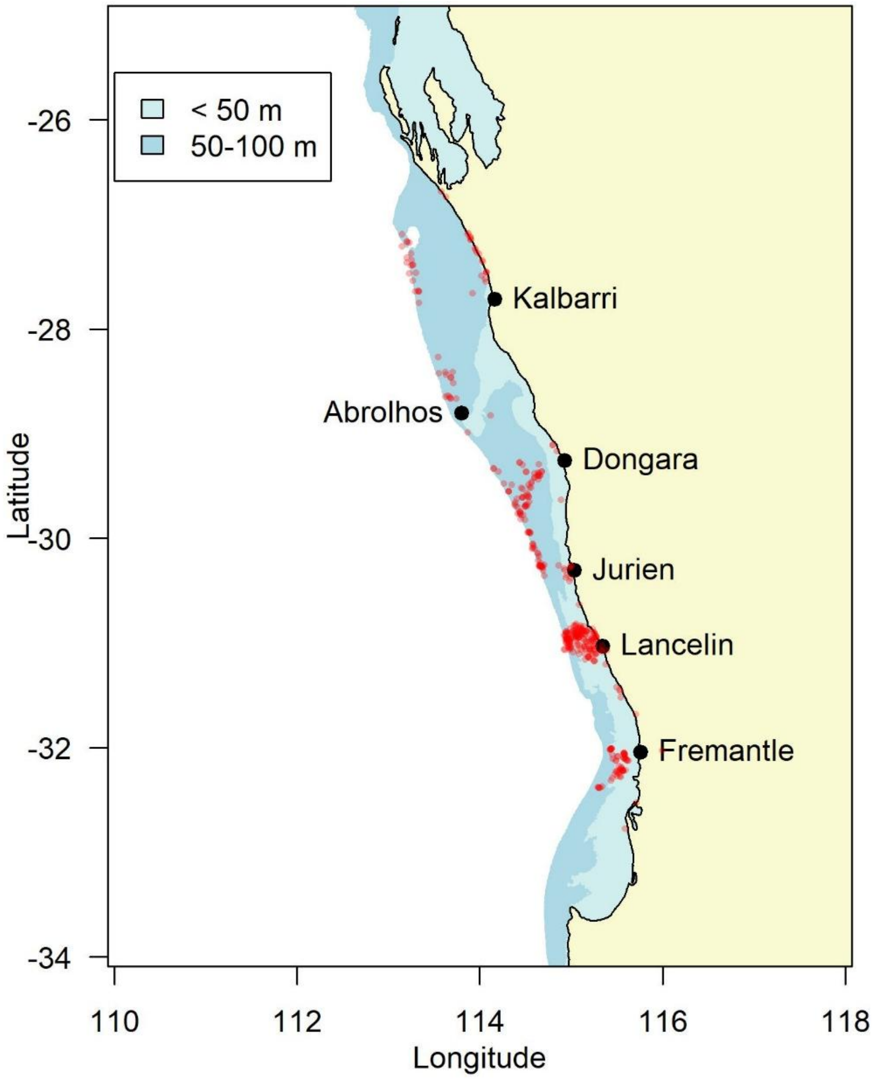

Figure 4.1. Map showing all POTBot deployment locations since 2021. Note points show over plotting, with intensity of red representing multiple points.

4.5 Ecosystem Effects

Effects of the WCDSCF on the ecosystem involve a cumulative assessment of;

- Current management arrangements
- Annual catch of all retained and by-catch species
- Bait usage
- ETP interactions
- Extent of area fished, and
- Annual fishing effort

As stated previously, these performance measures were within their respective targets (where appropriate), and as such, the cumulative impacts of WCRLMF are considered to be unlikely to be generating an unacceptable level of risk to ecological processes. In addition, the ecological risk assessment conducted in 2022 assessed the risk of the WCRLMF fishing to ecosystem structure as a negligible risk, except for translocation of diseases which was scored as a medium risk (Stoklosa, 2022).

4.6 Harvest Control Rules and Season Advice

The West Coast Rock Lobster Resource (WCRLR) Harvest Strategy (HS) establishes the specific set of decision rules that determine the appropriate harvest levels for all sectors to meet the ecological, economic and social objectives established for the resource. The main objective of the HS is to deliver predictable, ecologically sustainable harvest levels and allocations of WRL that maintains the stock near a target harvest level, thus optimising the opportunities to generate overall, long term economic benefits to the state from commercial lobster fishing, processing, and ancillary activities, while optimising experiences for the recreational (including charter) sector.

The harvest strategy outlines three reference levels to assess the performance of the fishery against, a target, threshold and limit. This target is the optimum value to deliver economic and/or social objectives. The target reference level is based on a proxy for MEY and is set at 0.39 which approximates the level of fishing consistent with MEY whilst also providing benefits to all sectors. The threshold reference level aims to maintain egg production above those levels experienced by the WCRLR prior to it becoming fully exploited. These levels are applied as a threshold reference level (i.e. below which exploitation will be reduced) rather than as a target level, to ensure management is precautionary. As there had not been any evidence of recruitment overfishing in the 1990s, the egg production levels in the early – mid 1980s were considered greater than the minimum sufficient level required to ensure ongoing recruitment to the WCRLR. Average levels of egg production estimated for the early 1980s (an average of 1982 – 1984) in each main breeding stock management area (BSMA) of the WCRLR have been used to determine threshold reference levels (for the northern end of the fishery, which was exploited later, the early 1990s have been used). Limit reference levels for each of these BSMAs were set at 20% below threshold levels.

The fishery is assessed annually, and an allowable harvest limit (AHL) is determined based on moving the harvest rate towards the target reference level of 39%. Additionally, egg production levels are compared to threshold and limit reference points to ensure that projections of egg production over a five-year outlook remain above the threshold level with a certainty of 75%.

The harvest strategy not only encompasses the target species, but also other ecological components including by-product, by-catch, endangered and threatened species (ETP), the habitat of the fishery and broader ecosystem effects such as bait disposal, discarded and lost gear and pollution.

As all aspects of the harvest strategy are considered either a low or medium risk, no changes are required for the 2026/27 fishing season.

Table 4.3. Risk for each ecological component assessed (Stoklosa, 2022).

Component	WCRLMF
Retained Species	Low
Bycatch	Medium
ETPs	Low
Habitat	Low
Ecosystem Effects	Low

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Appendix 1 – Management timeline

Table showing all major management regulatory changes introduced into the WCRLMF.

Year / Season	Regulation
1897	Minimum legal whole weight of 12 oz (340 g). This measurement is equivalent to, and eventually evolved into, the 76 mm carapace length minimum size currently in force in the fishery (Figure 3.2 for measurement detail).
1899	Females carrying spawn were given full protection by requiring them to be returned to the sea.
1962	Closed seasons: coastal fishery 16 August–14 November; Abrolhos Islands fishery 16 August–14 March.
1963	Limited entry introduced: boat numbers were fixed (858) and the number of traps per boat was limited to three per foot (0.9 m) of boat length.
1965	Boat replacement policy required a boat to be replaced with one of the same length. This stopped fishers replacing a boat with a larger one and hence obtaining additional traps to use under the three traps/foot of boat length regulation. This froze the number of traps in the industry at 76 623.
1966	A 51 x 305 mm escape gap was introduced into all traps to allow sub-legal sized lobsters to escape before the trap is brought to the surface.
1971/72	Escape gap increased to 54 x 305 mm.
1973	Multiple entrance traps were banned.
1977/78	Fishing season was shortened by 6 weeks from (15 November–15 August to 15 November–30 June) to protect newly mated females and to constrain fishing
1979	Boat replacement policy was changed to allow a boat's trap quota (entitlement) to vary from seven to ten traps per metre of boat length. This gave fishers the flexibility in the size of replacement boats that they could have for a given trap
1984	Maximum size of traps was established; based on a maximum volume of 0.257m3
1986	Number of escape gaps (54 x 305 mm) in traps was increased (from one) to three or four (depending on the positions of the gaps).
1986	Trap numbers of all license holders were reduced temporarily by 10% for the 1986/7 season. Total trap numbers were reduced from 76 623 to 68 961 for one
1987–1991	Trap numbers were reduced permanently by 10%, at 2% per year for 5 years.
1992/93	10% reduction in traps in Zone B (15 November–9 January) Closure of Zone B (10 January–9 February) Return of setose females required (November–February) Maximum size for females of 115 mm (Zone C) and 105 mm (Zones A&B) introduced. Home porting in Zone C. Access to Big bank after 24th February
1993/94	18% reduction in traps Minimum size increased to 77 mm in November–January Required return of females that are setose or above a maximum size (105 mm Zone A and B; 115 mm Zone C) Home porting in Zone C restriction lifted

2000/01	Unitisation of the fishery to more explicitly incorporate the 18% pot reduction in the current pot entitlements Individual numbering of pot entitlements The ability of those with access to 63 or more pot entitlements and a fishing boat licence to apply for a new managed fishery licence The ability of fishermen to retain an inactive managed fishery licence by retaining an inactive fishing boat licence and one or more inactive pot entitlements
2001/02	Use of animal hide as bait prohibited
2003/04	Removal of 150 pot rule
2005/06	Three-year effort reduction package 15% effort reduction in Zone B 10% pot reduction 15 November–15 March 10% pot reduction in Zone A 15 March–15 April Summer closure in Zone B 15 January–9 February Sundays off in Zone B 15 March–30 June Closed Christmas and New Year's day 5% effort reduction in Zone C Closed 15 November–24 November Five three-day moon closures 1 February–30 June Closed Christmas and New Year's day
2006/07	A and B Zone fishers who nominate to fish the Big Bank from 10 February must remain in Big Bank until midday on the last day of February of the season. Big Bank then becomes part of the B Zone fishery and any Zone A or B fisher can go there or leave it as they please.
2007/08	Effort reduction: unit values (number of pots per unit) of Zone A – 0.74 from 15 November to 15 April then 0.82 til season end Zone B – 0.74 from 15 November to 15 March then 0.82 til season end Zone C – 0.82
2008/09	15 November - Effort reduction: unit values (number of pots per unit) of Zone A – 0.66 Zone B – 0.66 Zone C – 0.74 Sunday closure for all zones and all season with the exception of the first two weeks in Zone A 30 November - Effort reduction: unit values (number of pots per unit) of Zone A – 0.54 Zone B – 0.54 Zone C – 0.62 24 February - Closure of Big Bank for the remainder of the season 1 March - Effort reduction: unit values (number of pots per unit) of Zone A – 0.42 Zone B – 0. 42 Zone C – 0.50 6 March – Saturday and Monday closures for all zones and all season Sunday closure for the first two weeks of Zone A continuing all season Removal of Zone C moon closures 15 March - Maximum size of female lobsters in Zone A and B reduced to 95mm Minimum size in Zone C increased to 77mm 1 May - back to 5 fishing days per week (Saturday and Sunday closures)

2009/10	Effort reduction: unit values (number of pots per unit) of: Zone A – 0. 36 Zone B – 0.40 Zone C – 0.44 Temporal closures: Zone A – 4 days a week all season Zone B & C – 4 days a week during “whites” and “reds” peaks (December 1 to December 31 and March 15 to April 14) Zone B & C – 5 days a week for rest of the season Changes in maximum female size: Zone C – 115 mm to 105 mm Minimum size of 77 mm all season All pots must have at least three escape gaps 55 mm high and 305 mm wide Nominal Total Allowable Commercial Catch (TACC) of 5,500 tonnes set for the 2009/10 season. Removal of soaking periods prior to the start of the season (provision made to load and bait pots and move in the Fishery 7 days before the start of the season) Big Bank to remain closed Rock Lobster processors to submit weekly catch (only) returns, to be received by the Department no later than COB Tuesday, each week of the season (in addition to monthly reporting requirements) Carrier boats permitted to carry more than 4 rock lobster pots. December 2009 Prohibit fishing in Zone B between 25 December 2009 and 10 January 2010 inclusive; Continue the prohibition on fishing on Friday, Saturday and Sunday each week throughout the remainder of the first half of the season in Zone B; Prohibit fishing in Zone C between 25 December 2009 and 3 January 2010 inclusive; and B Zone summer closures removed. January 2010 Closure in Zone B extended to 25 January; and Prohibit fishing in Zone C between 16 January and Prohibit fishing on Fridays in Zone C from 1 Feb to end of season. February 2010 Prohibit fishing in Zone C between 12 March and 21 March Change unit value to 0.30 for Zone C effective 21 March; Zone A prohibited from fishing in Zone B for the remainder of the season as of 15 February 2010; and Prohibit fishing in Zone B between 12 March and 11 April. 17 February 2010 Zone B permitted to fish Friday’s for the remainder of the season. May 2010 Zone C closed for the remainder of the season – effective 10 May; Zone A closed for the remainder of the season – effective 17 May. June 2010

2010/11	Total Allowable Commercial Catch (TACC) of 5,500 tonnes set for the 2010/11 season. Individual catch limits introduced with the following number of kilograms per unit: Zone A – 36kg from 15 November to 14 March Zone A – 51kg from 15 March to end of season Zone B – 81kg for entire season Zone C – 75kg for entire season Pot usage set at 0.5 pots per unit for all zones. Fishing prohibited weekends Big Bank to remain closed Season extended to 31 August Zone C start date moved from 25 November to 15 November 20 fathom rule removed Implementation of Sea Lion Exclusion Devices at the Pelsaert and Easter Groups of the Abrolhos Islands Introduction of crate tags catch and disposal records (Appendix A), authorised receivers, holding over book and catch weighing procedures to monitor fishers' catch. Limited "within-season" transferability of licenses and entitlement
2011/13	TACC of 6938 tonnes. Extended 14 month season 15 November 2011 to 14 January 2013 with closure between 1 October and 14 November
2013	TACC of 5554 tonnes (Zones = 1076, B = 1921, C = 2557 t). Changes to the Harvest Strategy such that there is a 50:50 share of catch between the north (A&B Zones) and the south (C Zone)
2014	TACC of 5859 tonnes (Zones A = 1076, B = 1921, C = 2862 t). Gear modifications for whale entanglement reduction introduced (see Bellchambers et al. in press)
2015	TACC of 6000 tonnes (Zones A = 1076, B = 1921, C = 2997 t). TARC of 404 t (2014/15 season). Access to Big Bank granted under research exemption (no access to research closure).
2016	TACC of 6300 tonnes (Zones A = 1134, B = 2016, C = 3150 t). TARC of 422 t (2015/16 season). • Restriction on the retention of maximum size females removed. • Introduced paying market price of rock lobster (per kilogram) in respect to exceeding entitlement. • Holding Tags removed • Holding areas described and pot storage areas removed. • Weighing points outlined • Insert the correct minimum unit holding, of 300 • Change whale season end date to 31 October
2017	TACC of 6300 tonnes (Zones A = 1134, B = 2016, C = 3150 t). TARC of 480 t (2016/17 season). • Extension of Leeman Closure to 2023 Big Bank re-opened for fishing outside of research closure.

2018	TACC of 6300 tonnes (Zones A = 1134, B = 2016, C = 3150 t). TARC of 507 t (2017/18 season). • Prohibition on Fishing for Rock Lobster Order 2018 – Mitigation measures for whales and night fishing ban
2019	TACC of 6000 tonnes (Zones A = 1190.7, B = 3116.8, C = 3307.5 t). TARC of 506 t (2018/19 season). • Reg amendments - Lobster fishing without a licence when on a charter boat and change • Setose rules for recreational fishers. • Escape gap changed.
2020 (Covid 19)	TACC of 9000 tonnes (Zones A = 1620, B = 2880, C = 4500 t) over 18 month season from 15 Jan 2020 to July 2021. TARC of 490 t (2019/20 season). • BoBs Mechanism introduced. • Increase quota over runs to 60kg. • CEO to sell forfeited entitlement. • Amend pot usage rules over winter. • Inclusion of Augusta, Mangles Bay, Pigeon Island as Approved Landing Area Big Bank research closure reduced in size to the southern half only.
2021 (2021/23 season)	TACC of 9000 tonnes (Zones A = 1620, B = 2880, C = 4500 t) over 18-month season until January 2023. TARC of 533 t (2020/21 season). • Delete reference to holding tags. • Allow to transition pots between zones with written permission. • Schedule 8 – Unit Value method amended.
2022 (2021/23 season)	TARC of 562 t (2021/22 season). • Prohibition on false or misleading information on CDR forms • Extension of Leeman Closure to 2027 • Inclusion of Port Coogee Marina as Approved Landing Area
2023	TACC of 4300 tonnes (Zones A = 774, B = 1376, C = 2150 t) over short season from 15 January 2023 and ending on 30 June 2023. TACC of 7300 tonnes (Zones A = 1314, B = 2336, C = 3650 t) usual season from 1 July 2023 and ending on 30 June 2024. TARC of 585 t (2022/23 season).

2024	TACC of 7300 tonnes (Zones A = 1314, B = 2336, C = 3650 t) usual season from 1 July to 30 June 2025. TARC of 500 t (2024/25 season). • amend the definition of net weight • increase back of boat sales to 999 • require the reporting of lost rock lobster pots through Fish Eye • allow for errors in both under declaration and over declaration of weights in a Catch and Disposal Record (CDR) form, registered receiver consignment form, or form submitted using Fish Eye, to be corrected by the Department of Primary Industries and Regional Development.
2025	TACC of 6800 tonnes (Zones A = 1224, B = 2176, C = 3400 t) season from 1 July 2025 to 30 June 2026. TARC of 500 t (2025/26 season). • Amendment to methodology in determining registered receiver net weights. • Removal of the ‘Big Bank' closed area (commonwealth closure still exists). • Regulation of rock lobster part possession and sale, making it an offence to be in possession of rock lobster tails in WA waters, except under certain circumstances.

Appendix 2 – Fishery Independent Shallow Survey

The independent shallow water survey (ISS) was developed by an FRDC project (2019-159) because the previous method of developing a juvenile pre-recruit abundance (PRA) was based on commercial catch data adjusted for multiple biases inherent in commercial monitoring, namely: water depth; water temperature; swell; fisher experience; pot type; escape gaps; pot pulling time; month; and location. Biases are exacerbated by recent poor sample sizes, as many fishers choose not to fish in shallow-water areas. Developing a standardized, repeatable survey in shallow areas produced an improved index of PRA that could be incorporated into the stock modelling, improving the overall assessment.

This survey also provided a platform for monitoring inshore WRL habitats. This information assists in detecting and quantifying habitat shifts that may impact the fishery. For example, there is anecdotal evidence that the heatwave temporarily modified some of these near shore habitats, leading to the altered relationship between puerulus and lobster recruitment. Long-term monitoring of juvenile habitats will likely provide a useful indicator of one of the factors affecting recruitment to the fishery.

A preliminary shallow water survey for undersize Western Rock Lobster (WRL) was conducted in May 2019 at 12 locations in water depths <10 m. These locations spanned the WCRLMF from Mandurah in the south to Kalbarri in the north and offshore at two locations in the Houtman Abrolhos Islands (Figure A2-1). The design and outcomes of the preliminary survey were provided to an industry-led working group which further developed the survey structure into a form that was considered acceptable by industry and one that would likely be supported in the longer-term.

The resultant survey design was to be conducted in March each year, over the new moon period (within five days of the new moon). Due to the shallow areas being fished (~5 m depth), and the impact swell has on lobster catchability and the setting of pots in this environment, the lowest swell period within this sampling window would be chosen. One hundred pots with escape gaps closed would be set for 24 h prior to the first day of sampling at six locations coast-wide on pre-determined GPS points. All pots should be of a standard size, and if these pot types were not available, a combination of pot types should be used to allow for the impact of pot type to be determined.

Pots are to be pulled starting at 6 am on the first day of the survey, with data collected on a digital platform and recorded on a pot-by-pot basis, unique to each gps position. Upon the completion of day-one fishing, all 100 pots are transported to an adjacent ISS location and re-set for the following days survey. With this design the entire survey is conducted coast-wide over two days and requires six fishing vessels for its completion. The electronic collection of data allows for instantaneous data analysis to aid in data quality control, as the results can be reviewed that evening by staff to ensure they have been entered correctly.

In 2021, every pot location throughout the ISS was videoed using a BOSS camera setup (Langlois et al., 2025), producing almost a 360^{o} view of the habitat of each fishing point. In all subsequent surveys pots at each location are also fitted with POTBot cameras to build a randomised library of habitat images to allow for temporal changes to be observed.

All catch data is exported to the biological lobster SQL database at DPIRD to allow for subsequent analysis.

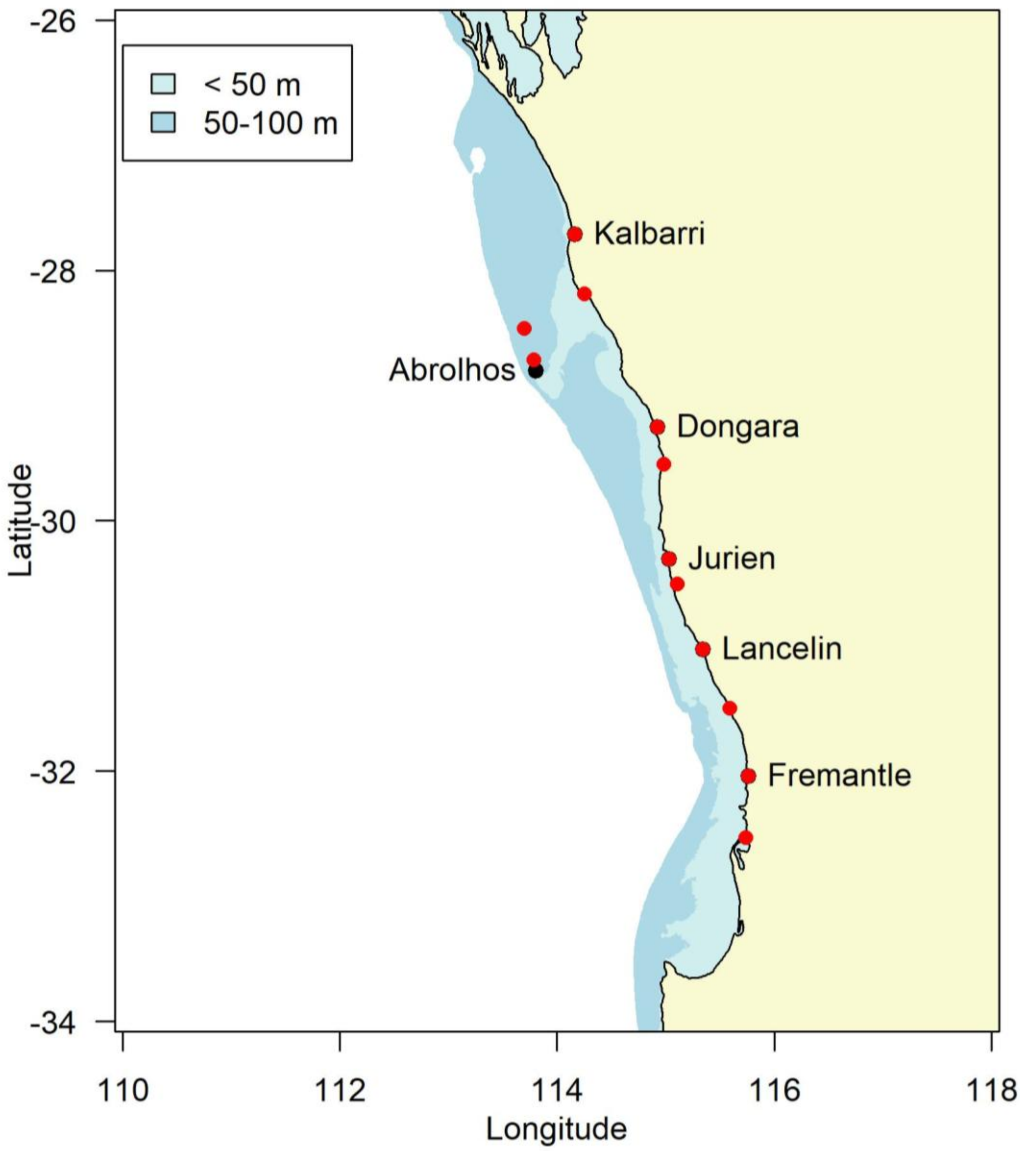

Figure A2-1. Map showing the location of each ISS site.

Appendix 3 – JABBA

Ten different model formulations (Table A3-1) were constructed using the JABBA package and compared based on fit residuals (RMSE), posterior predictive checks, the realism of biomass levels, and retrospective analysis. Initial model comparisons indicated that the Pella-Tomlinson formulation was providing the best fit to the data. This model formulation was then used in a range of sensitivity analysis as outlines in Table A3-1. Initial depletion level had a marked effect on model fit, with no initial depletion proving to be the best prior. This was not surprising since the catch time series started in 1945 with relatively small landings (550 t). Subsequent sensitivity analysis indicated that model estimates were relatively insensitive to model build with measures of fishery performance (B/B_{msy}, F/F_{msy}) and estimates of MSY being consistent across the various models tested (Figure A3-1). Posterior estimates indicated that the intrinsic rate of natural increase (r) prior should be lower at 0.2 and the shape parameter (Bmsy/K) was also better at a lower value of 0.2 (Figure A3-2). This is consistent with rock lobsters which are considered long-lived benthic invertebrates with late maturity, relatively low fecundity (compared to pelagics), and strong dependence on variable recruitment pulses driven by oceanographic conditions. As such they are considered to have low-moderate productivity.

Diagnostics from models 5 – 10 were all relatively similar and did not highlight a single best model and produced very similar estimates of MSY across the models, only varying between 11,227 and 12,334 t, across all models.

Of the models trialled, model 8 had the best posterior fit to priors (Figure A3-2), relatively low RMSE, a realistic biomass projection and a very consistent retrospective analysis (Figure A3-3). As such model 8 was the most stable of the models and was therefore chosen as the best for the assessment (Figure 3-1.8).

Table A3-1. Various JABBA models examined to understand the influence of model structure in determining stock status.

Model	Production function	Estimate additional obs variance	Minimum fixed obs error	process error variance prior	Bmsy/K (fixed para)	r prior	Initial depletion (psi.prior)
1	Schaefer	N	0.01	3,0.01	0.4	0.2,0.5	0.8, 0.1
2	Fox	Y	0.01	0.001,0.001	0.4	0.2,0.5	0.8, 0.1
3	Fox	Y	0.1	0.1,0.001	0.4	0.2,0.5	1, 0.1
4	Pella-T	Y	0.01	0.1,0.001	0.4	0.2,0.5	0.8, 0.1
5	Pella-T	Y	0.1	0.1,0.001	0.4	0.2,0.5	1, 0.1
6	Pella-T	Y	0.1	0.001,0.001	0.4	0.2,0.5	1, 0.1
7	Pella-T	Y	0.1	0.1,0.001	0.3	0.3,0.5	1, 0.1
8	Pella-T	Y	0.1	0.1,0.001	0.2	0.3,0.5	1, 0.1
9	Pella-T	Y	0.1	0.1,0.01	0.2	0.2,0.5	1, 0.1
10	Pella-T	Y	0.1	0.1,0.01	0.3	0.2,0.5	1, 0.1

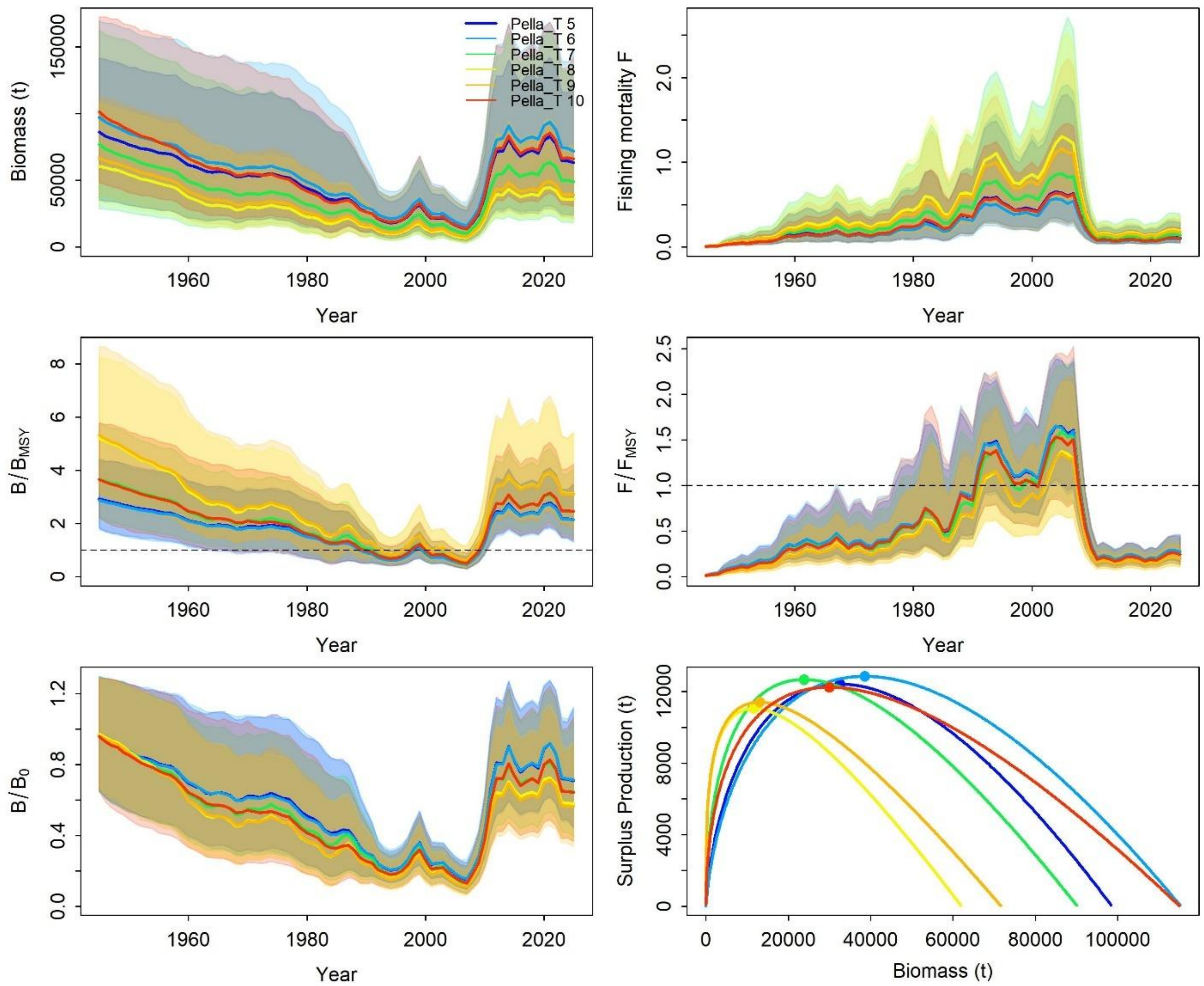

Figure A3-1. Subset of JABBA models (models 5 – 10) examined to understand the influence of model structure in determining stock status. Each plot shows the median and 95% CI. Clockwise from left top: model estimated biomass, fishing mortality, F/F_{msy}, surplus production, B/B_o and B/B_{msy}.

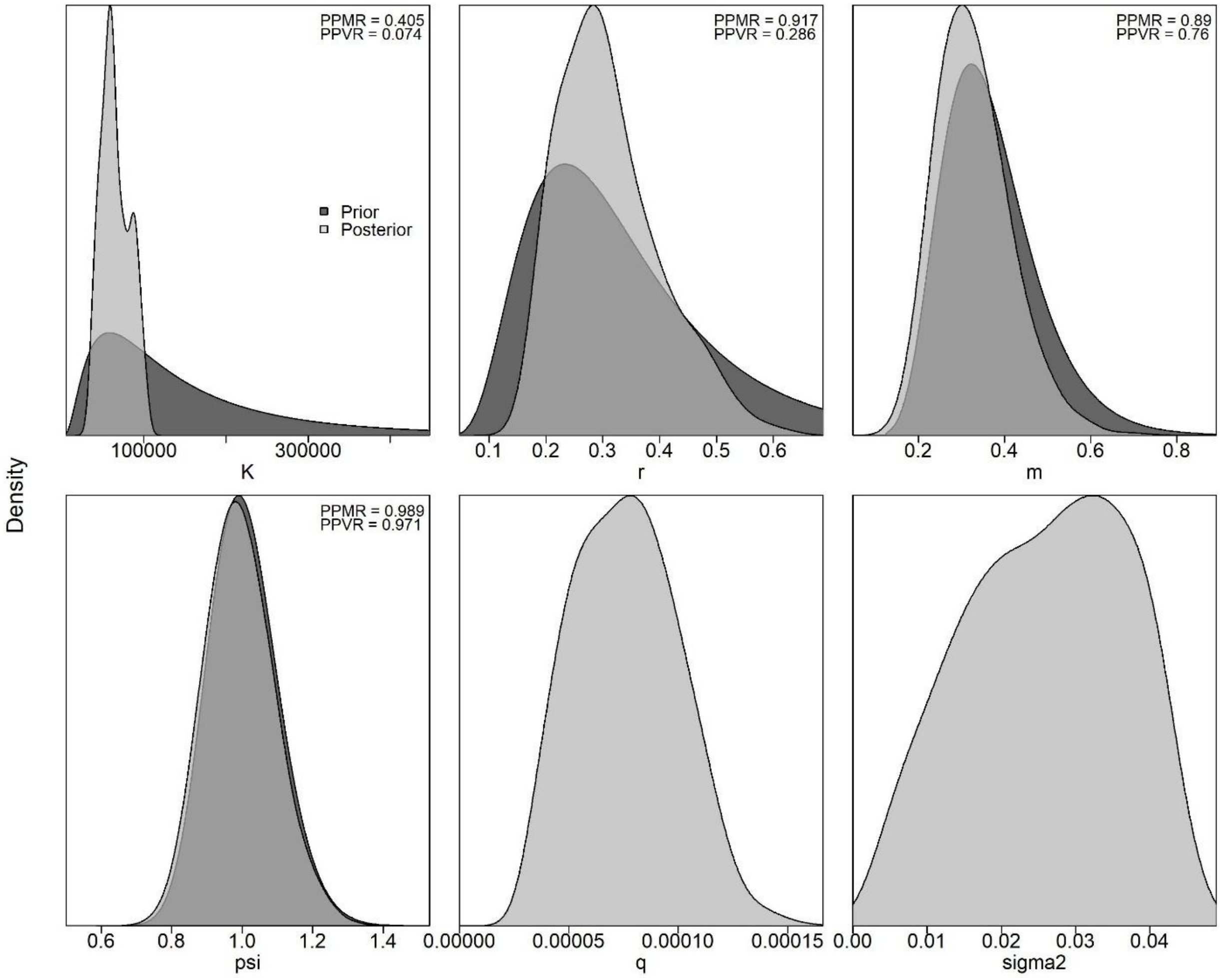

Figure A3-2. Prior and posterior distributions of estimated parameters: K, r, psi (depletion) and variances.

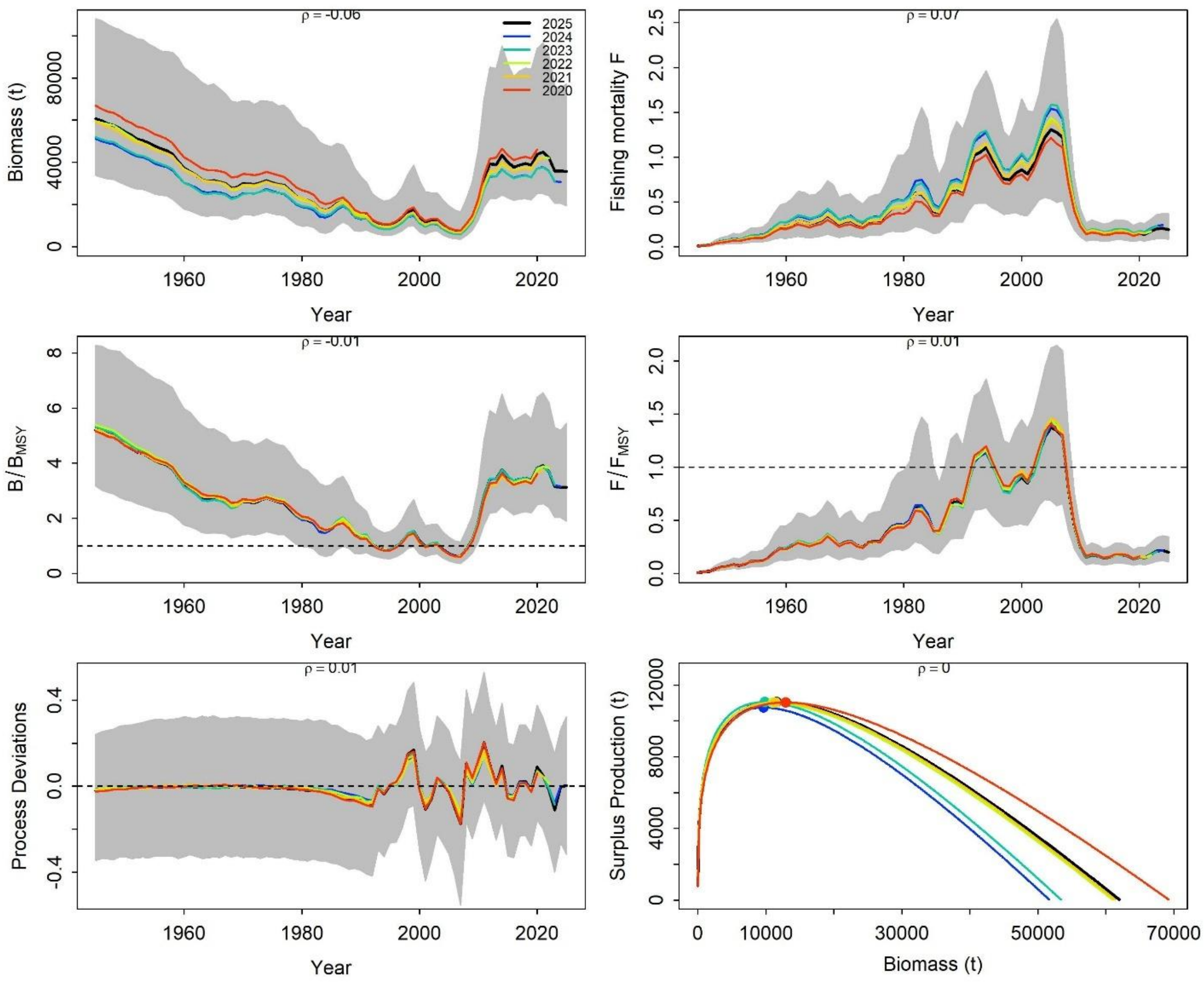

Figure A3-3. Retrospective analysis of model 8 showing the stability of the model as observed data is progressively removed (peeled back) from the model. Each plot shows the median and 95% CI. Clockwise from left top: model estimated biomass, fishing mortality, F/F_{msy}, surplus production, process deviations and B/B_{msy}.

Appendix 4 – Integrated biomass model diagnostics

The IBM is fitted to commercial and recreational catches, fishery-independent deep-water (IBSS) catch rates, puerulus settlement rates, tag-recaptures and lobster size compositions measured during either commercial monitoring or IBSS. All comparisons are conducted at the fine area (Figure A4-1) and temporal (11 timesteps) scale. Diagnostics are provided at this same spatial scale and if required (high number of comparisons) diagnostics are provided at a grouped scale (e.g. by zone or decade).

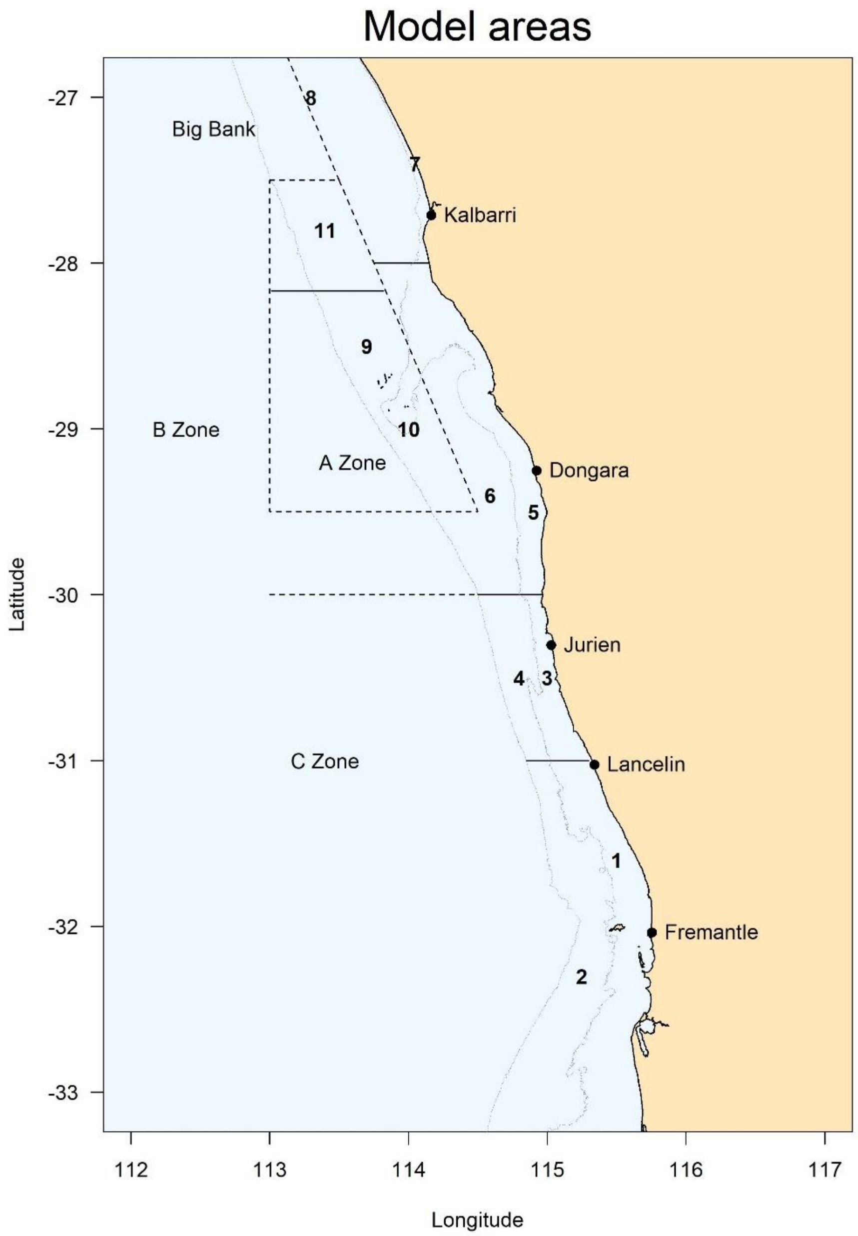

Figure A4-1. Model map showing the 11 areas used in the model and their association with the three management zones. The 40 m and 200 m isobaths are shown as light grey lines.

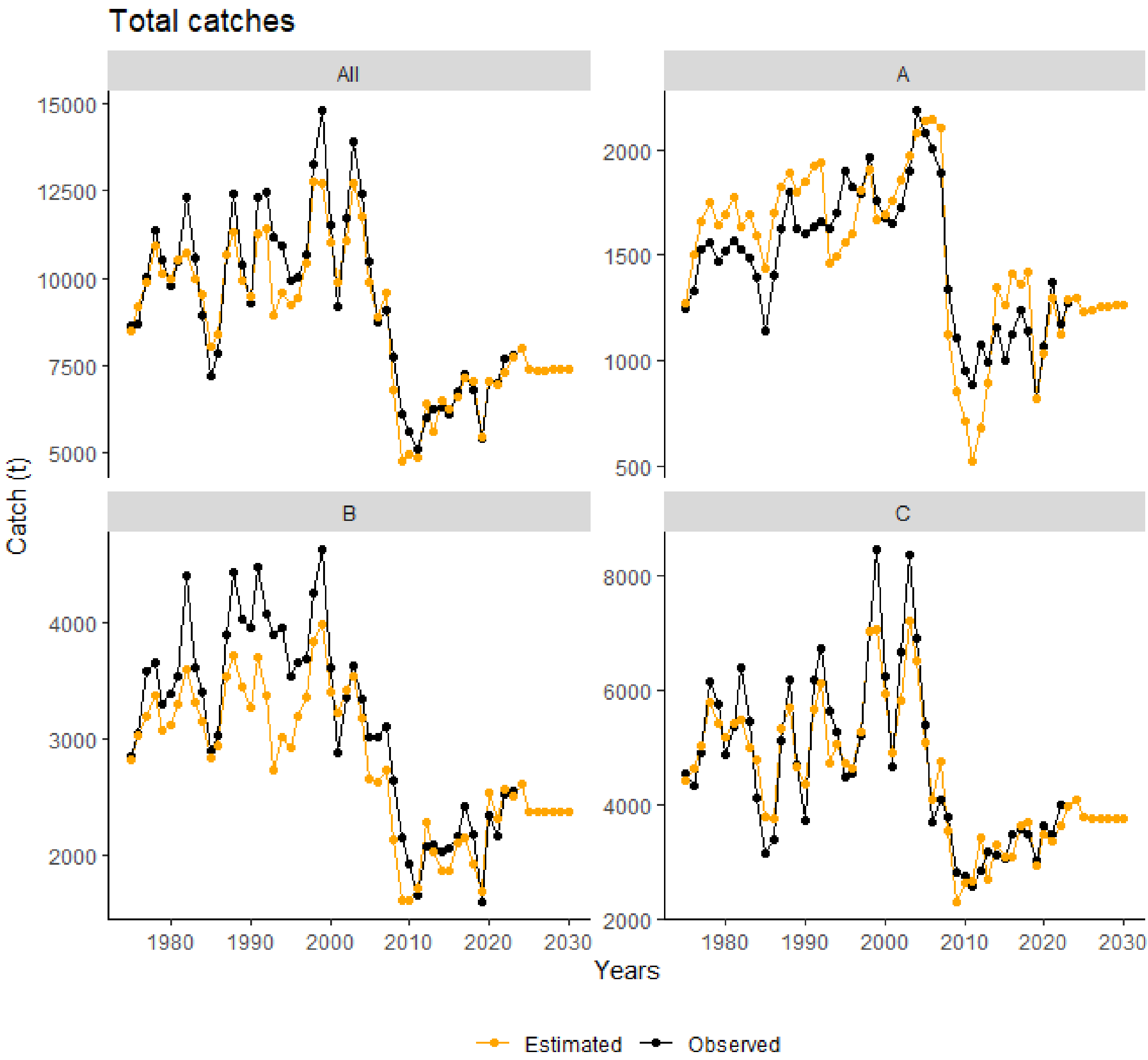

Figure A4-2. Observed and model estimated catches in each model year for the entire fishery (ALL), and within each management zone.

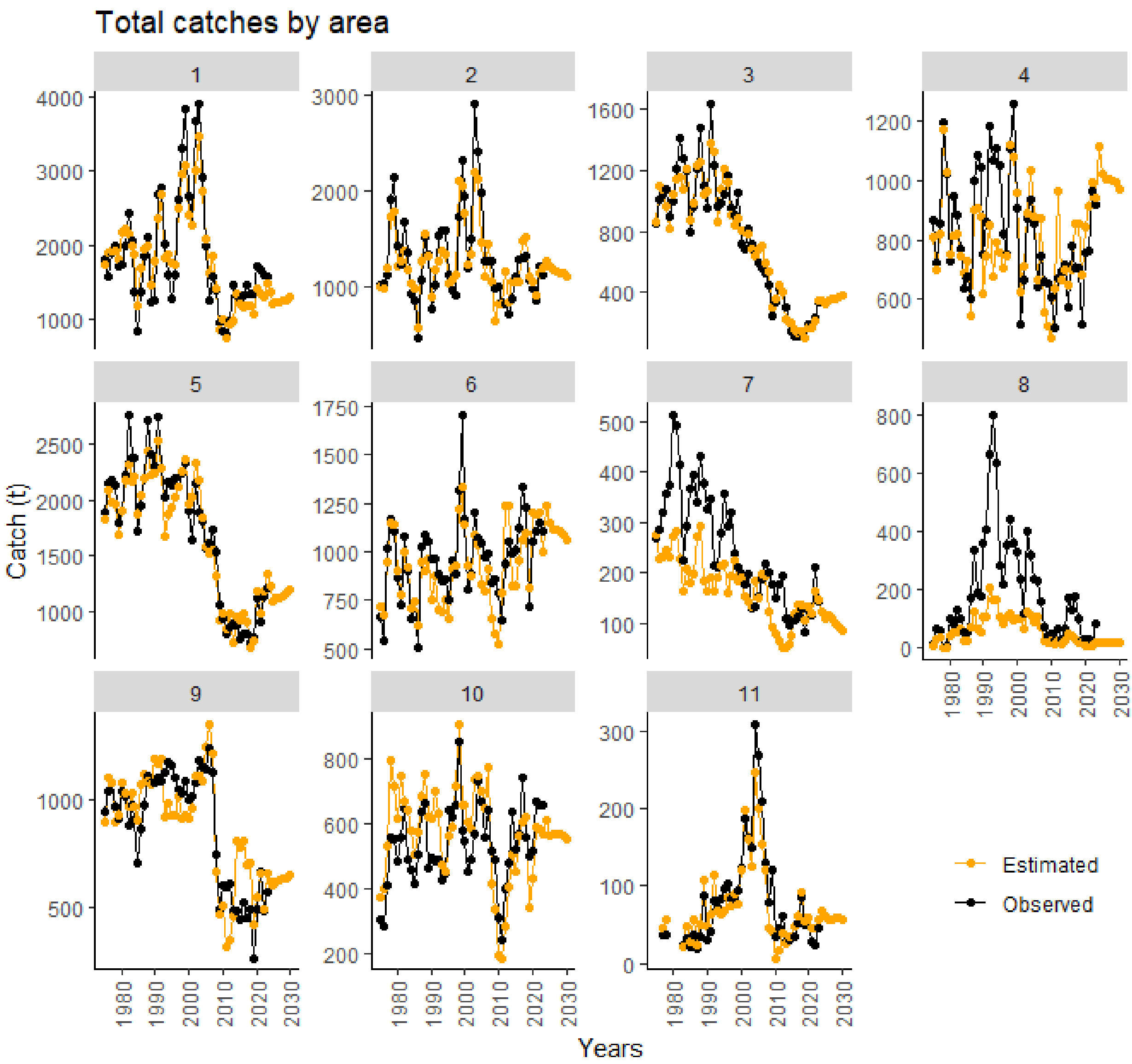

Figure A4-3. Observed and model estimated catches in each model area and year.

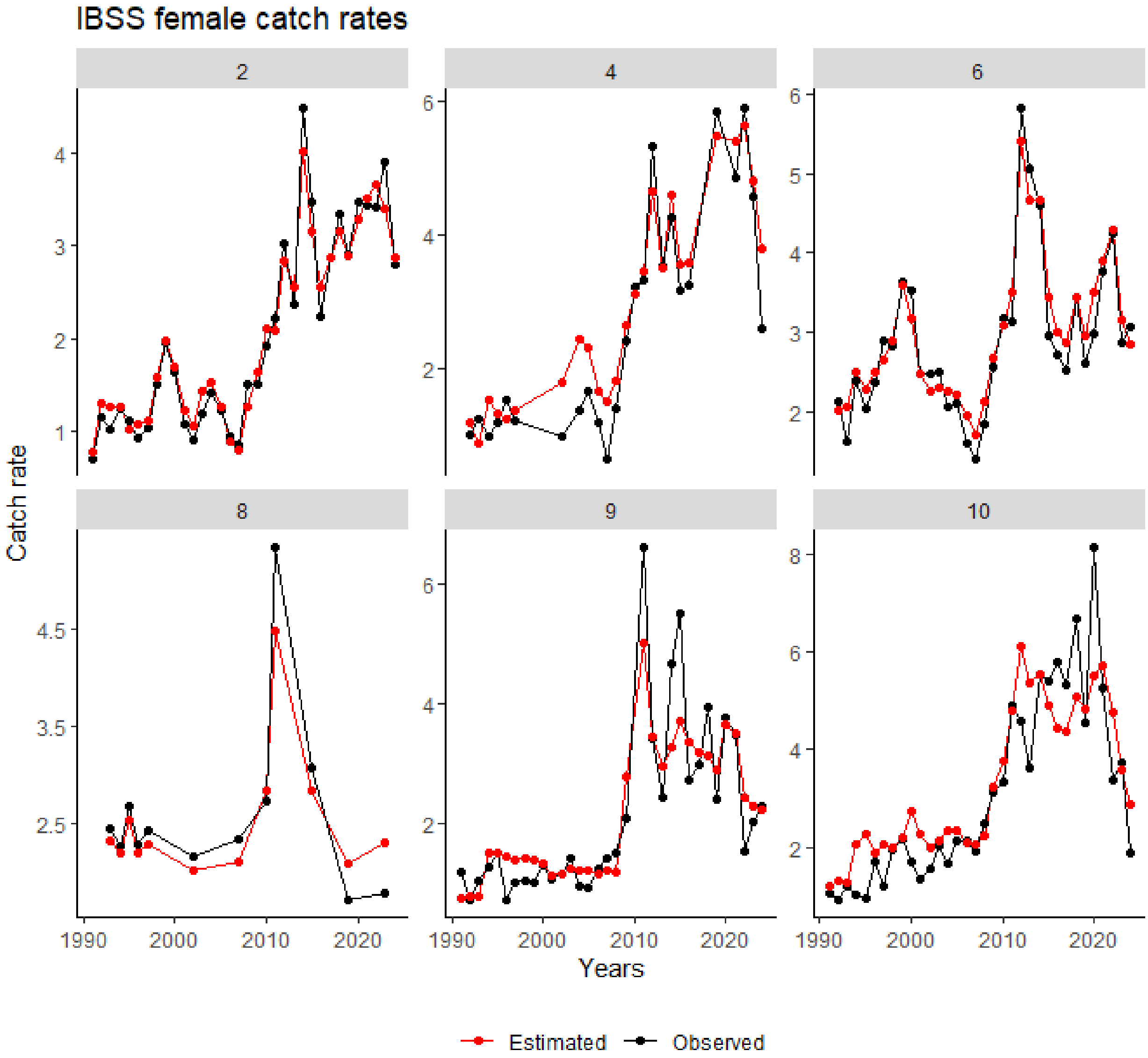

Figure A4-3. Observed and model estimated IBSS female catch rates in each model year for each model area where an IBSS is conducted.

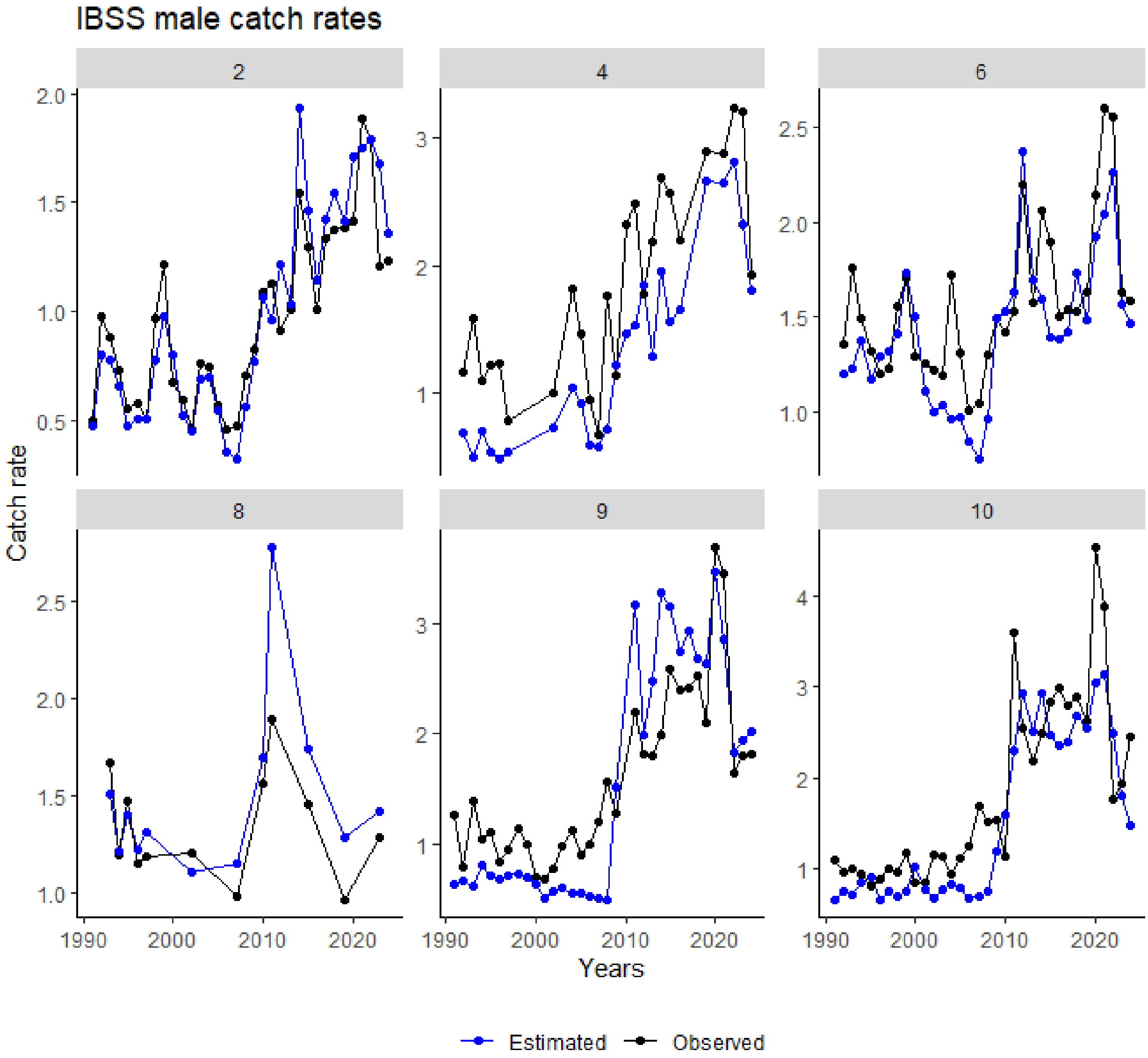

Figure A4-4. Observed and model estimated IBSS male catch rates in each model year for each model area where an IBSS is conducted.

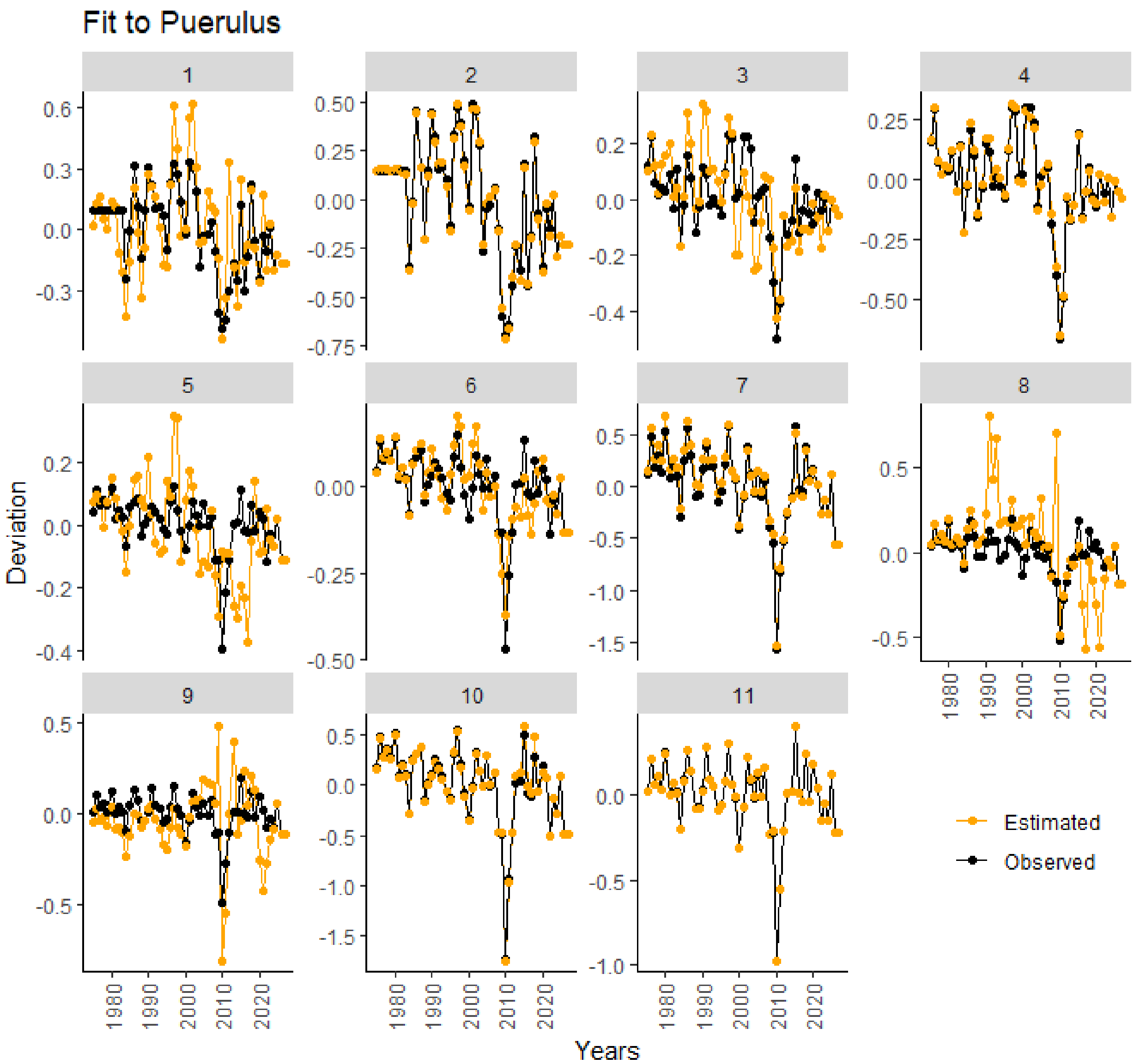

Figure A4-5. Observed and model estimated puerulus catch rates in each model area and year.

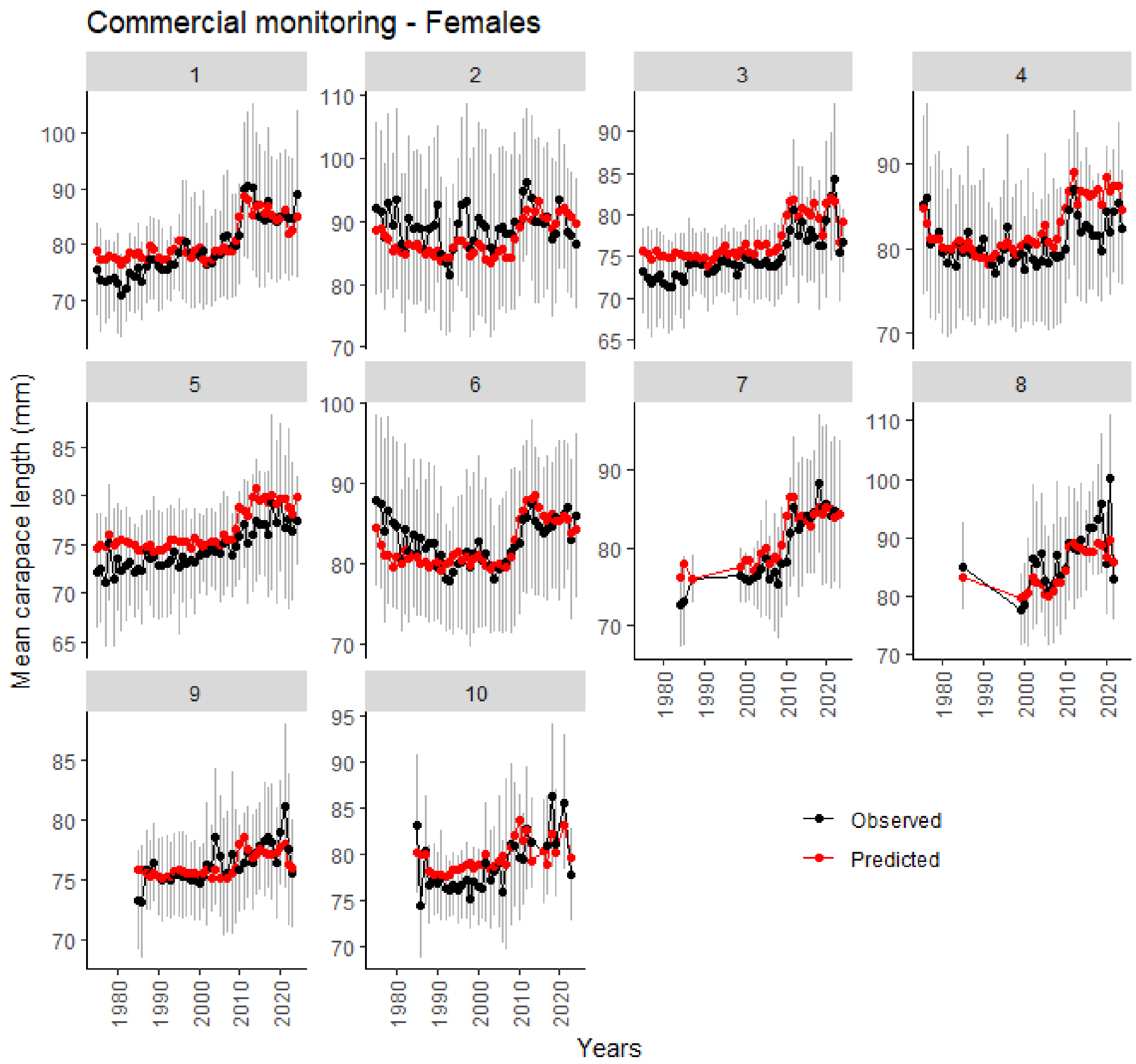

Figure A4-6. Observed (± 95% CI) and model estimated mean carapace length for females in each model area and year.

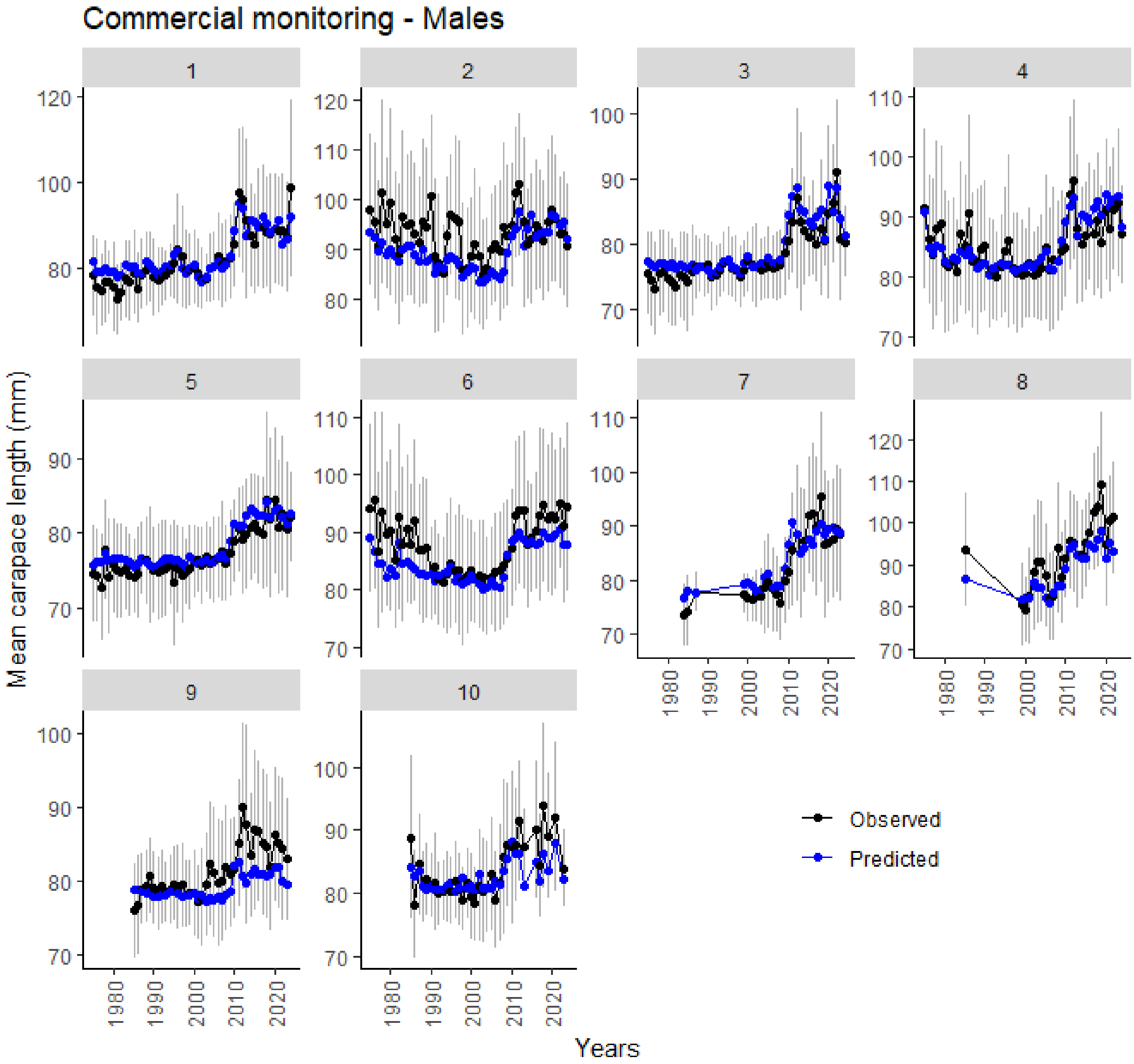

Figure A4-7. Observed (± 95% CI) and model estimated mean carapace length for males in each model area and year.

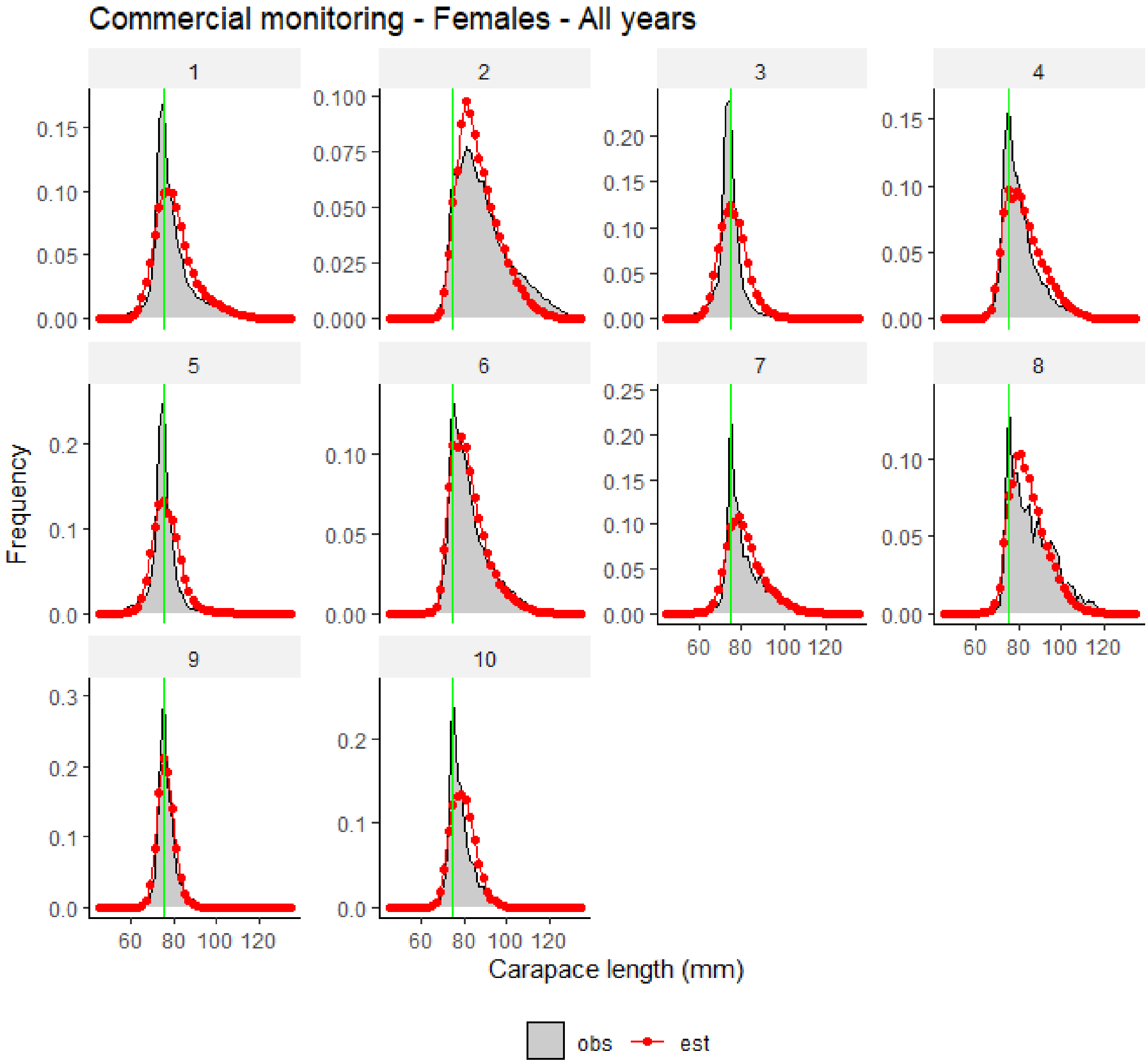

Figure A4-8. Observed and model estimated average size composition mean carapace length for females in each model area. Vertical green line represents the minimum legal-size limit.

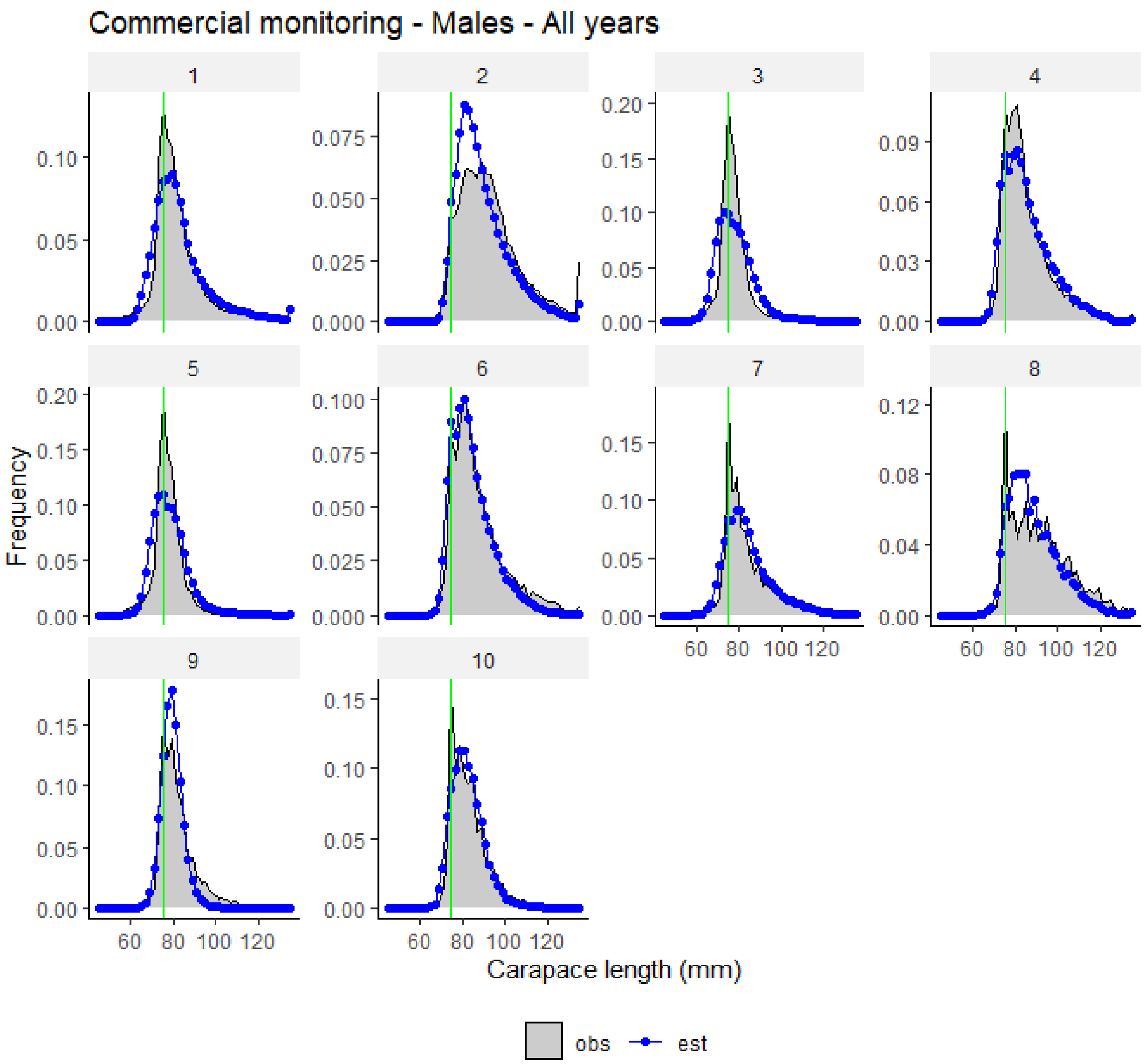

Figure A4-9. Observed and model estimated average size composition mean carapace length for males in each model area. Vertical green line represents the minimum legal-size limit.

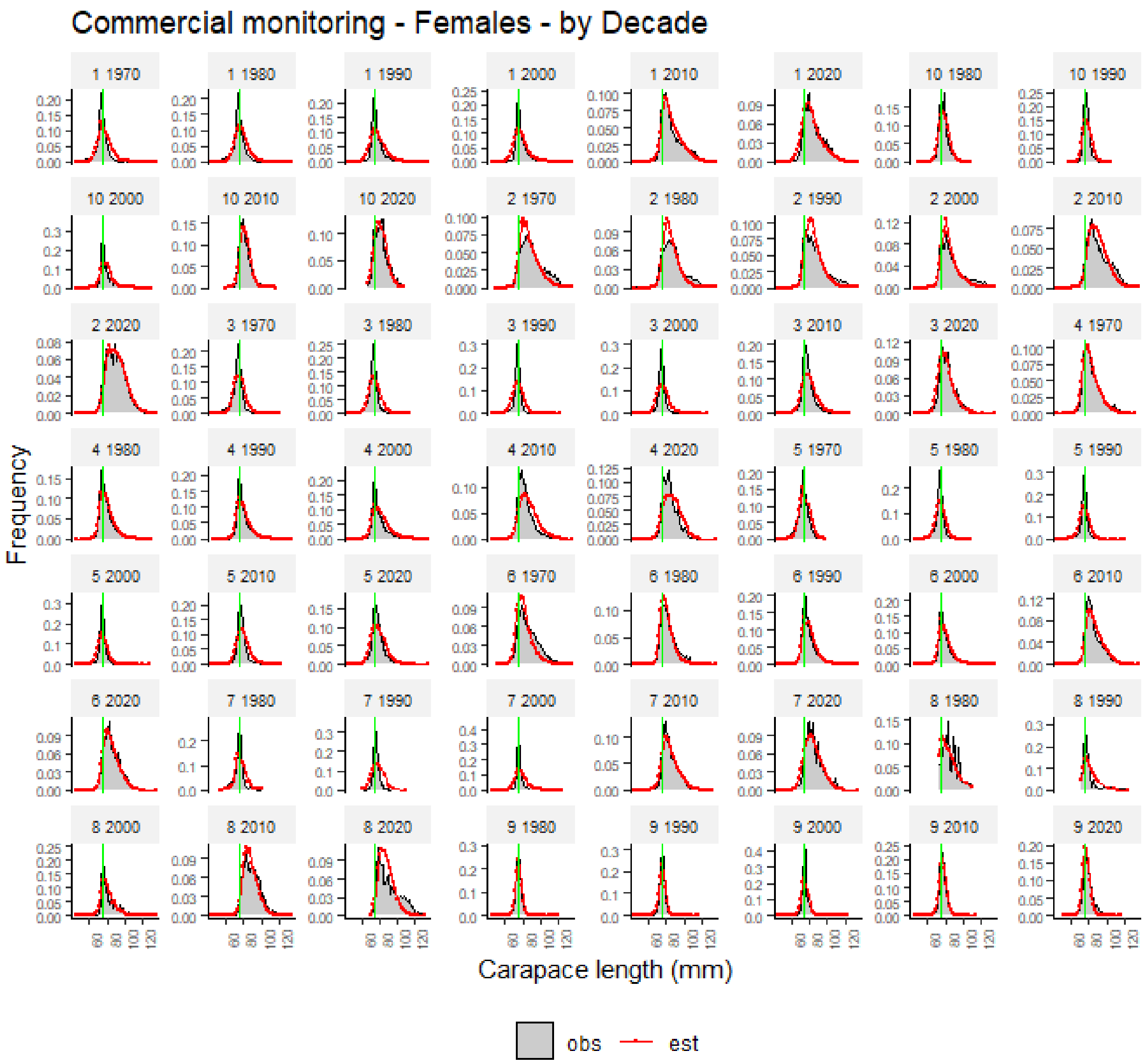

Figure A4-10. Observed and model estimated average size composition mean carapace length for females in each model area and decade. Vertical green line represents the minimum legal-size limit.

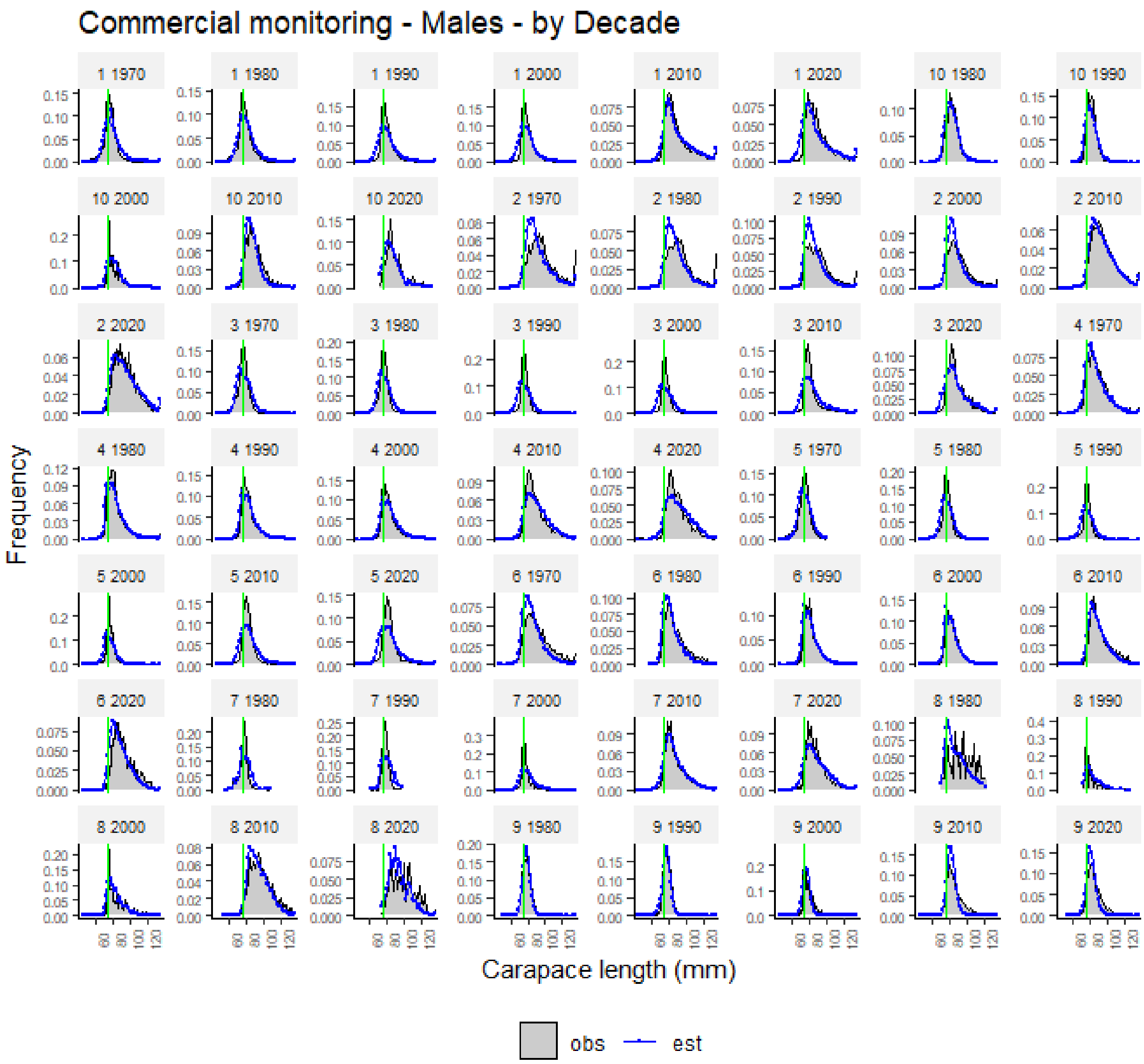

Figure A4-11. Observed and model estimated average size composition mean carapace length for males in each model area and decade. Vertical green line represents the minimum legal-size limit.

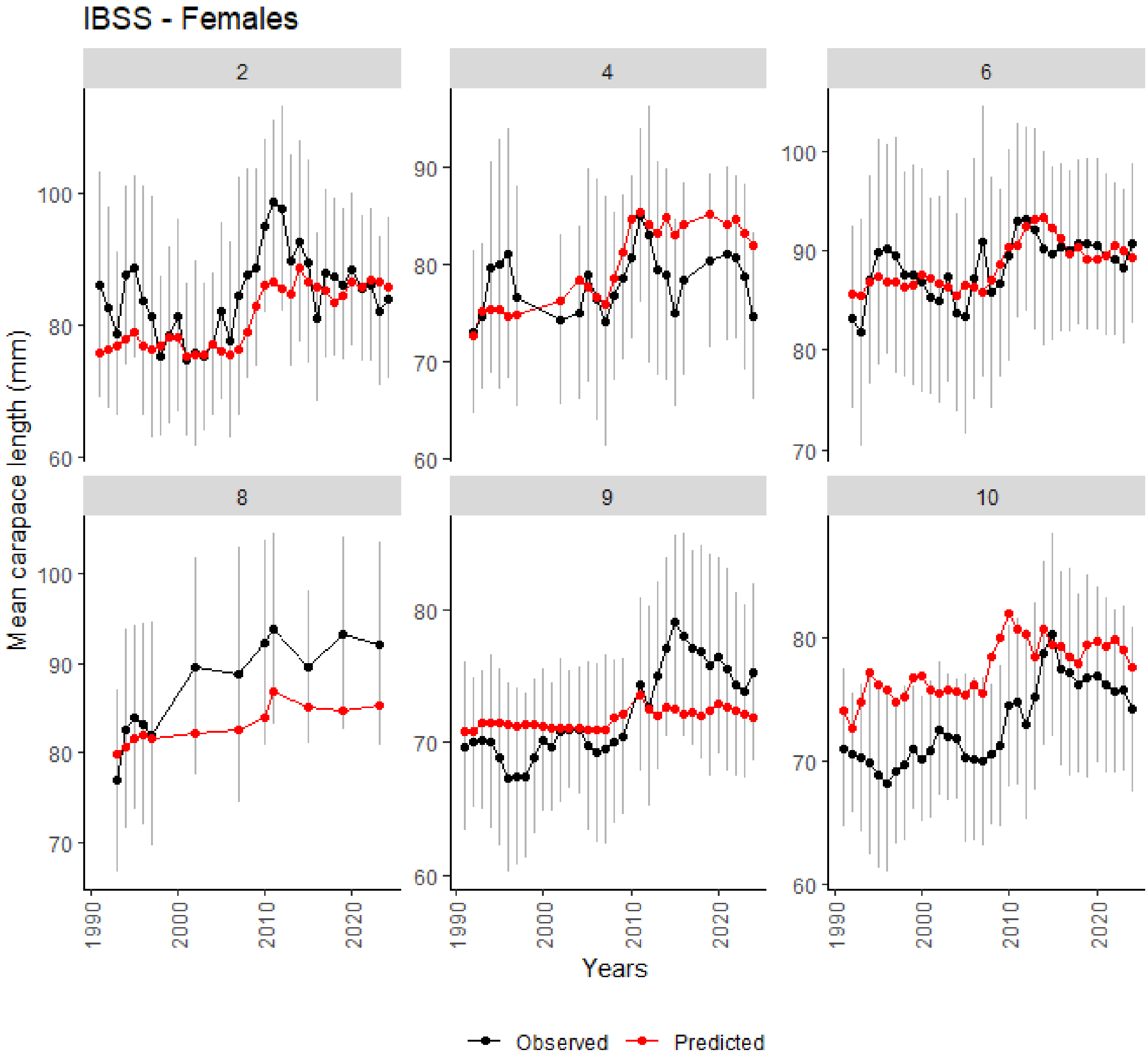

Figure A4-12. Observed (± 95% CI) and model estimated mean carapace length for females in each model area and year when the IBSS is conducted.

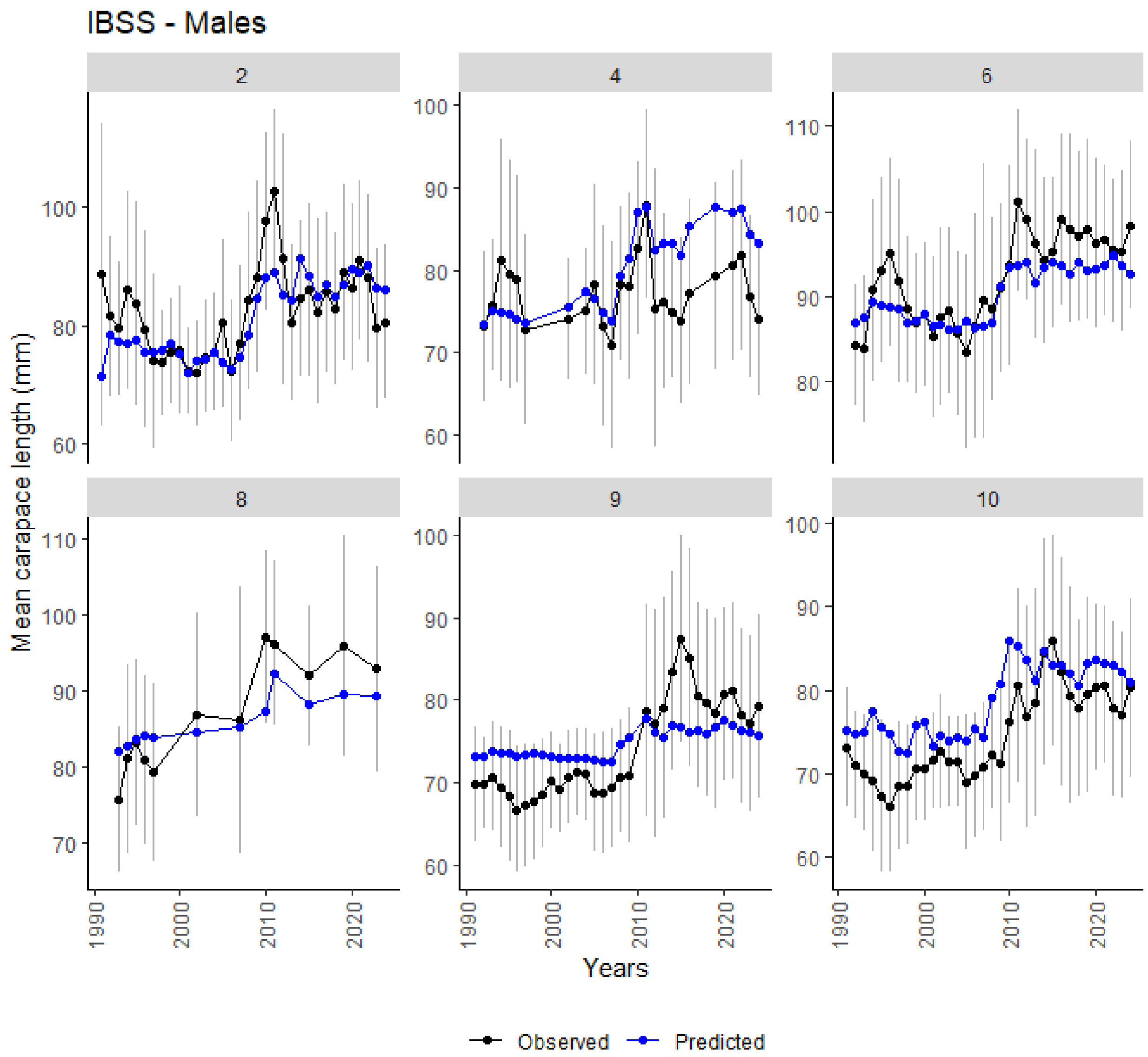

Figure A4-13. Observed (± 95% CI) and model estimated mean carapace length for males in each model area and year when the IBSS is conducted.

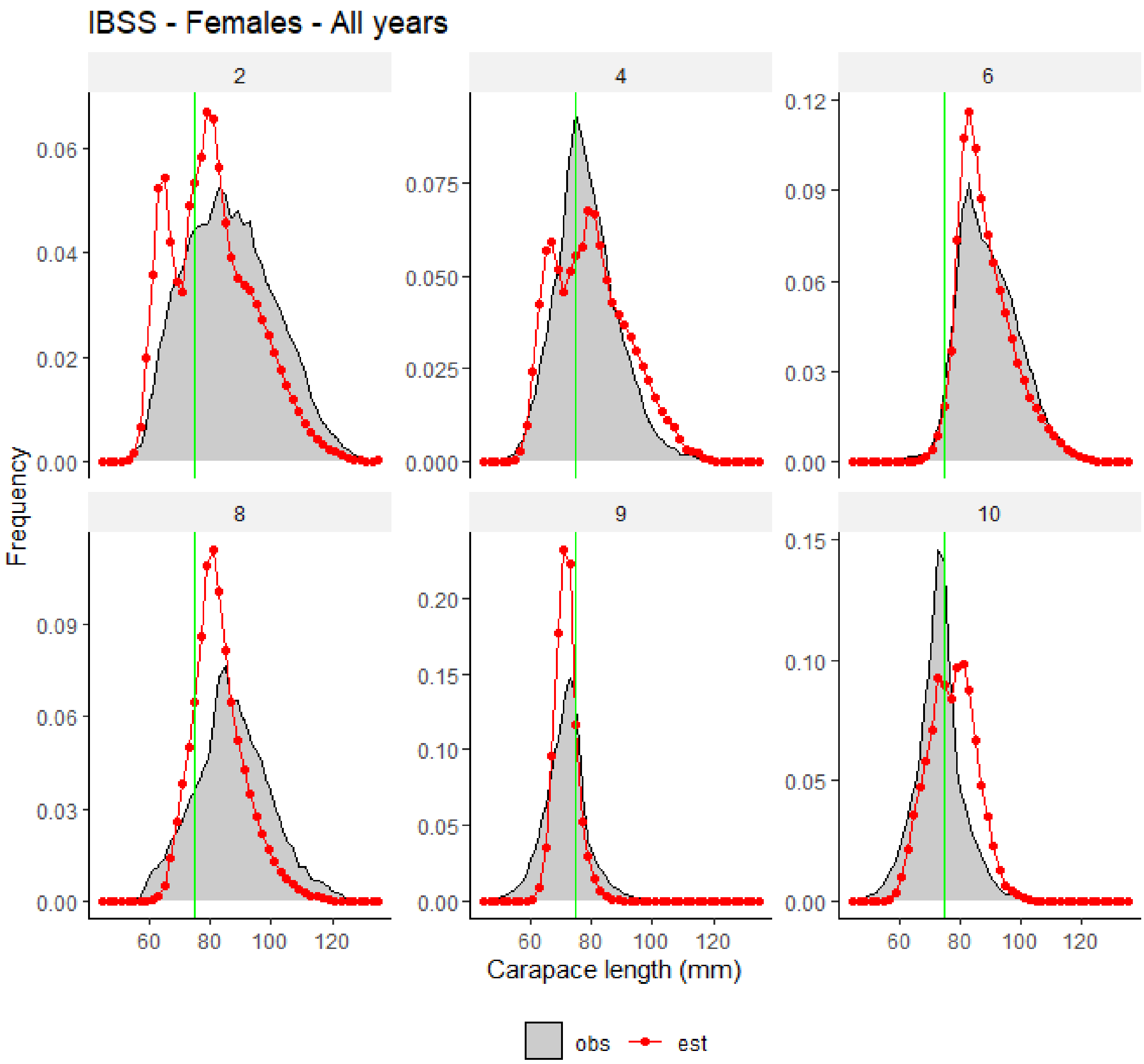

Figure A4-14. Observed and model estimated average size composition mean carapace length for females in each model area where the IBSS is conducted. Vertical green line represents the minimum legal-size limit.

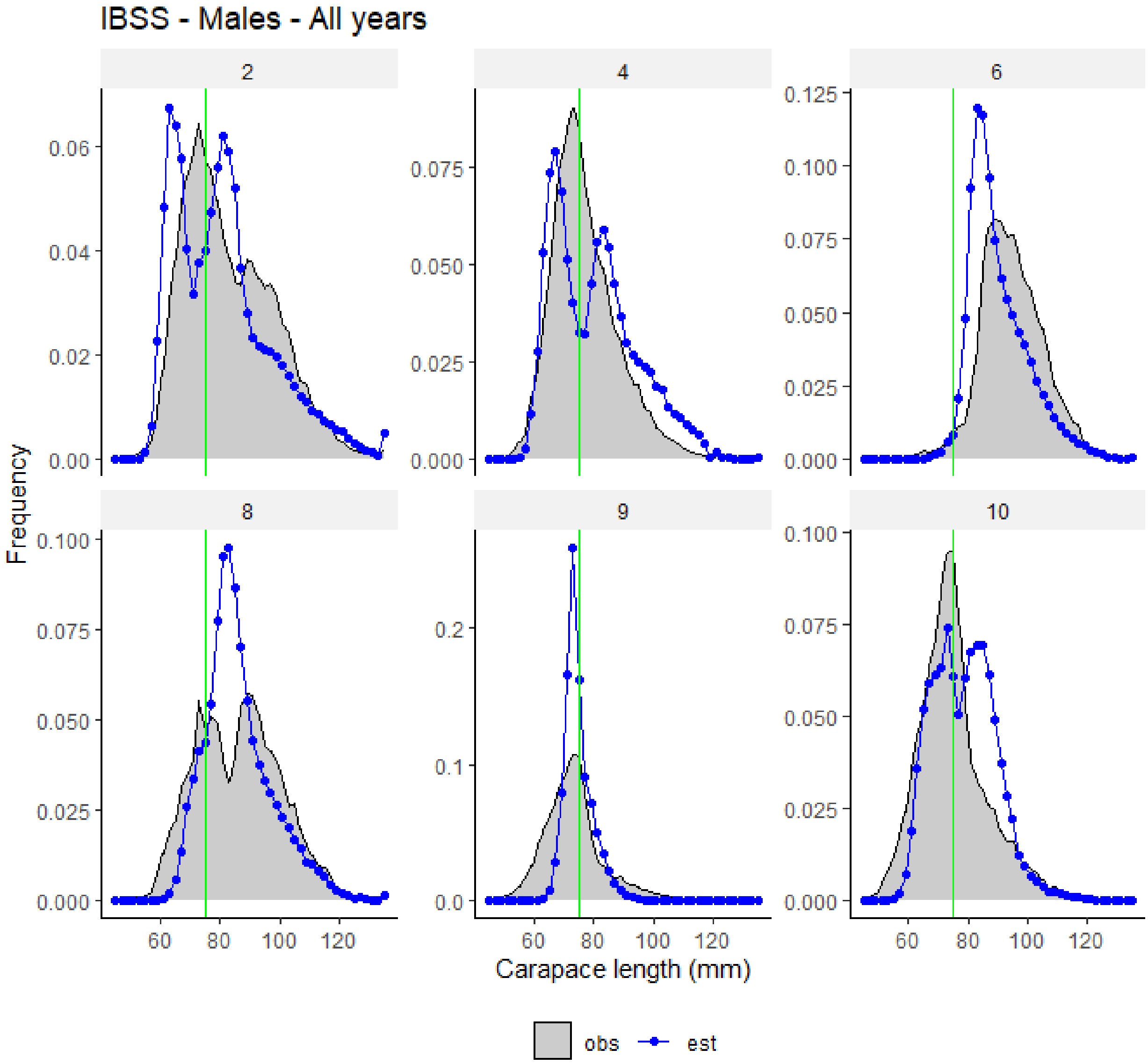

Figure A4-15. Observed and model estimated average size composition mean carapace length for males in each model area where the IBSS is conducted. Vertical green line represents the minimum legal-size limit.

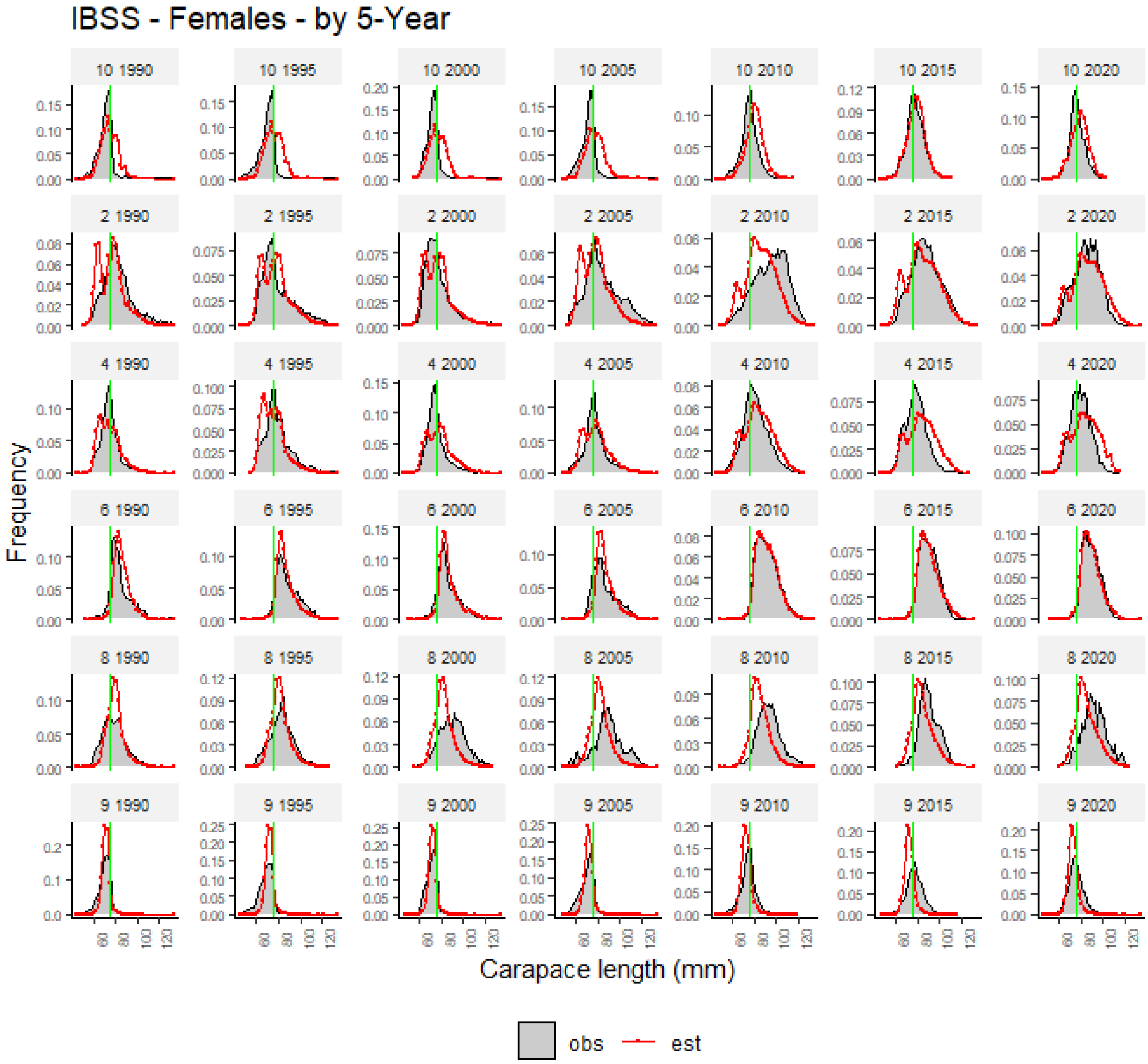

Figure A4-16. Observed and model estimated average size composition mean carapace length for females in each model area and five year period where the IBSS is conducted. Vertical green line represents the minimum legal-size limit.

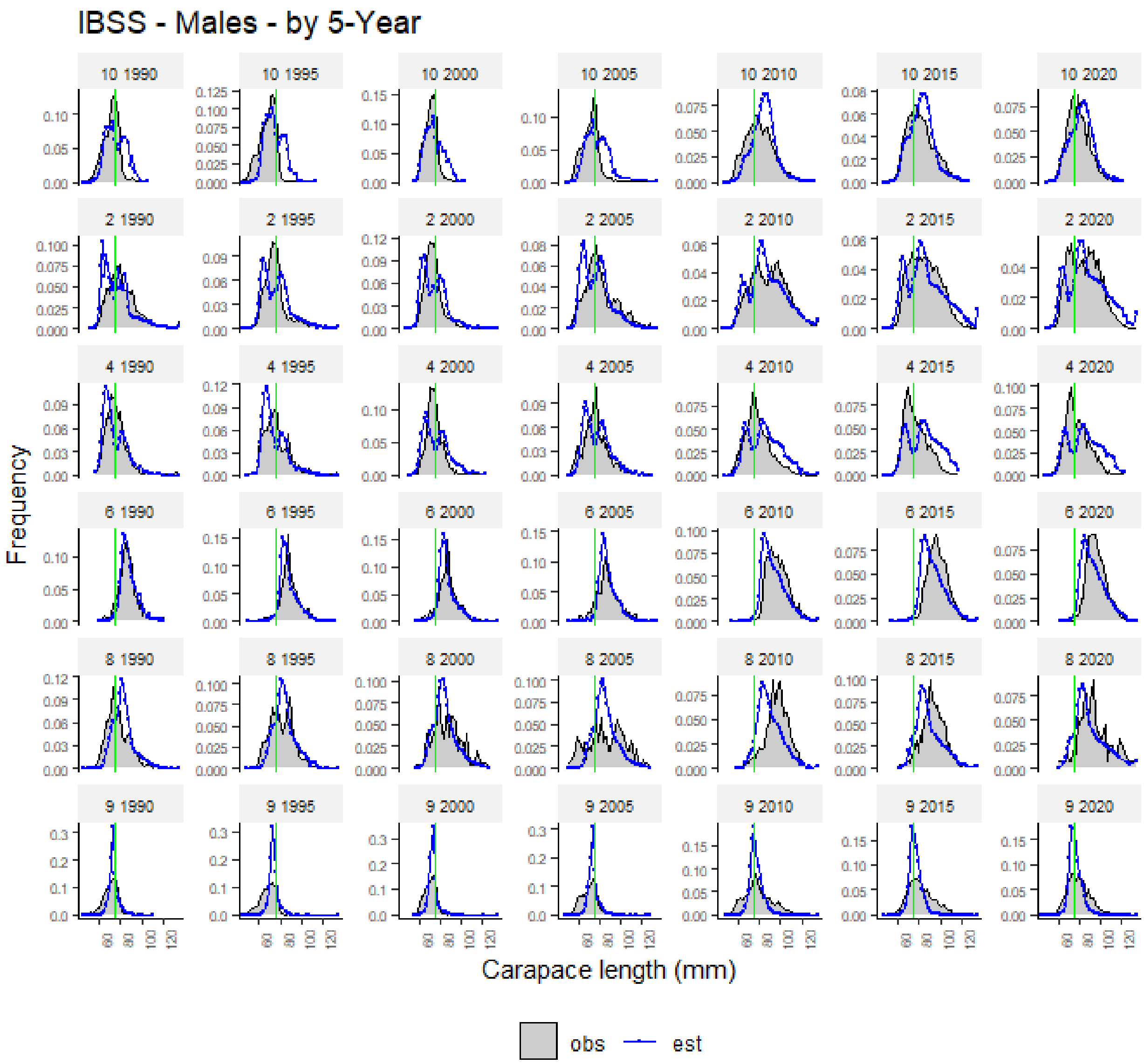

Figure A4-17. Observed and model estimated average size composition mean carapace length for males in each model area and five year period where the IBSS is conducted. Vertical green line represents the minimum legal-size limit.

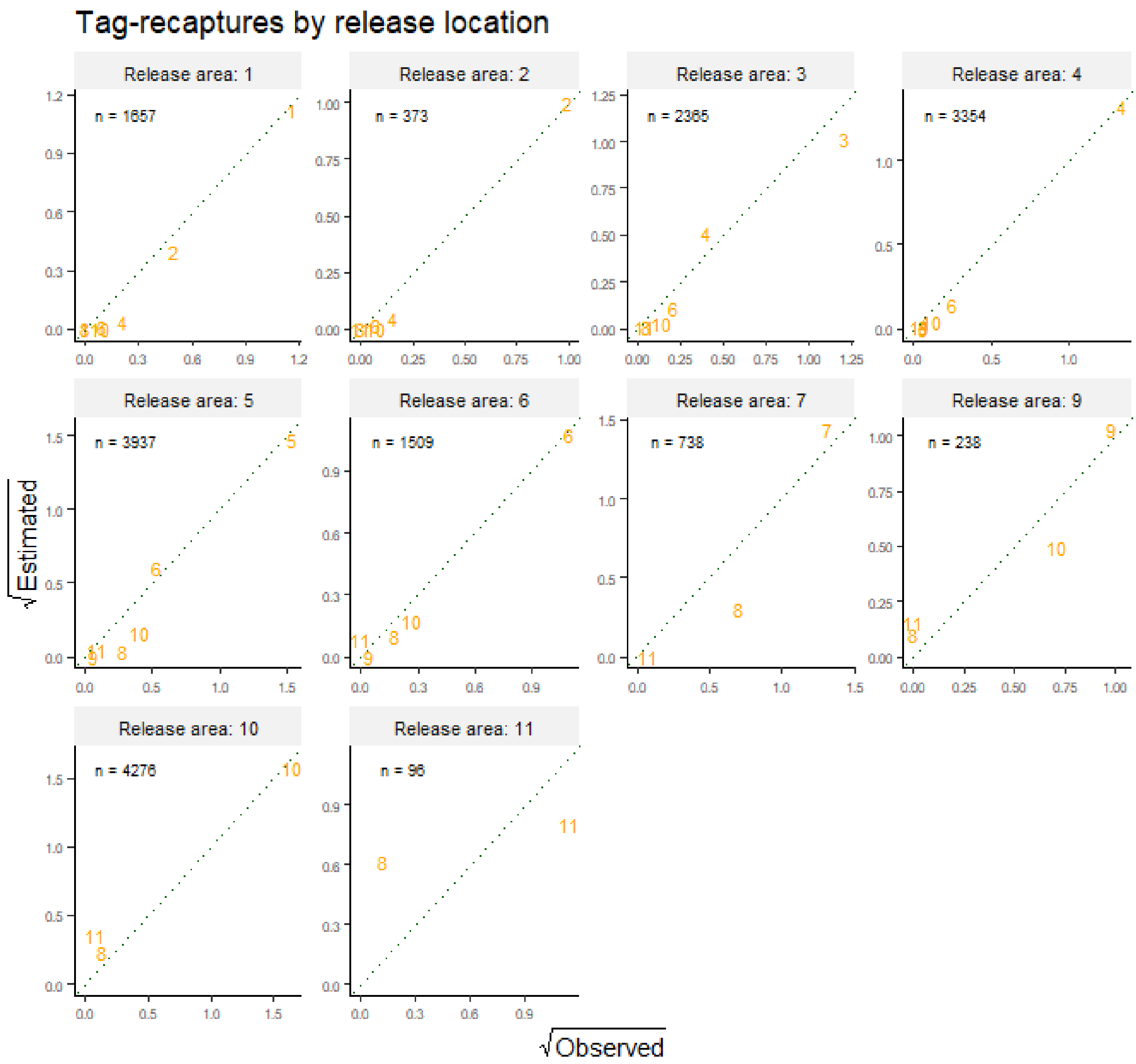

Figure A4-18. Relationship between observed and model estimated recapture locations of lobster released in each of the 11 model areas. "n" denotes sample size of lobster released in an area and recaptured anywhere in the fishery. The orange numbers within each plot identify the area of recapture.

Appendix 5 – Integrated biomass model parameter estimates

Table A5. List of parameters used in the integrated model.

Parameter	Number	Estimated (Y/N)
Fishing efficiency 1 (area, 10=11)	10	Y
Fishing efficiency 2 (area, 10=11)	10	Y
Fishing efficiency 3 (area, 10=11)	10	Y
Fishing efficiency 4 (area, 10=11)	10	Y
Puerulus power (area)	11	Y
Migration (area, no migration out of 8)	10	Y
Migration north (year)	55	Y
Mean CL of white lobster (area, 10=11)	10	Y
SD of white lobster CL (common between areas)	1	Y
Mean recruitment (area)	11	Y
No escape gap select. logistic inflection (area)	11	Y
54 mm escape gap select. logistic inflection (area)	11	Y
55 mm escape gap select. logistic inflection (area)	11	Y
Escape gap selectivity logistic slope	1	Y
Average commercial catchability (area)	11	Y
IBSS catchability (area)	6	Y
IBSS catchability sex scaler	1	Y
Catchability white lobster	1	Y
Recruitment deviations (year x area)	605	Y
Historic recruitment deviations	220	Y
Catchability deviations (year x area)	605	N
Natural mortality (area)	11	N
Natural mortality whites	1	N
Initial fishing mortality (area)	11	N
Temperature catchability relationship	11	N

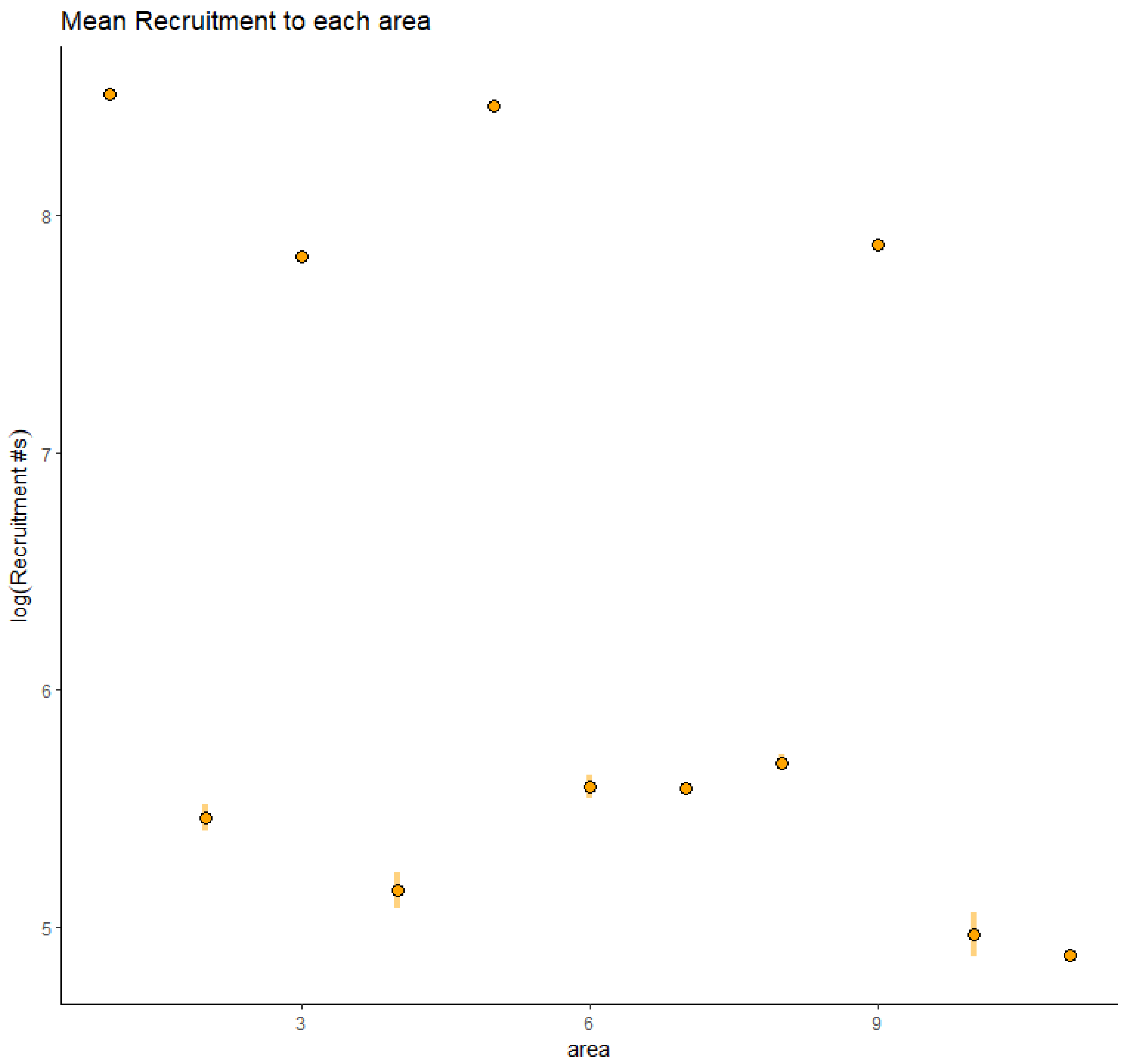

Figure A5-1. Estimated (± 95% CI) log recruitment into each model area.

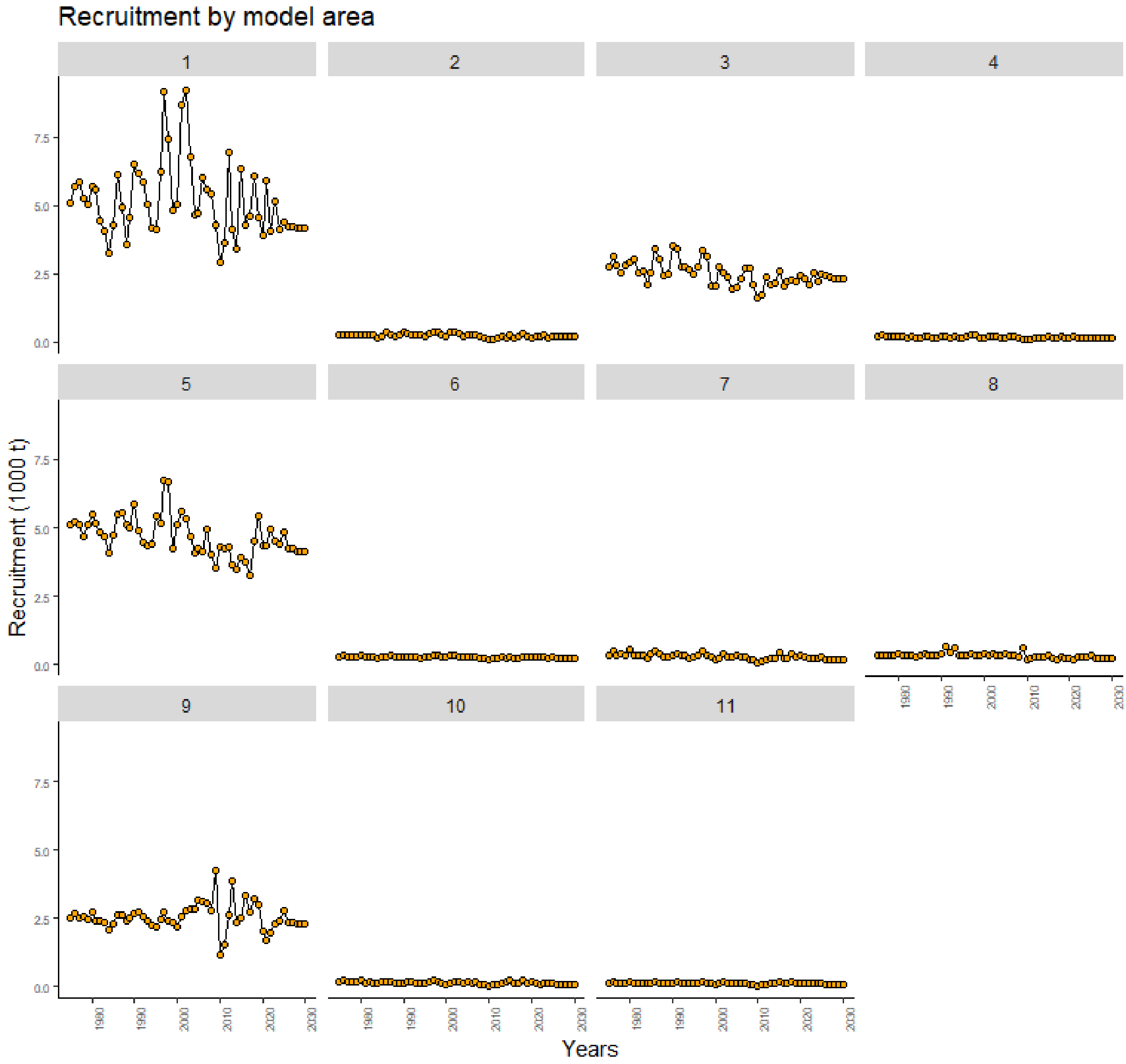

Figure A5-2. Estimated recruitment (t) into each model area.

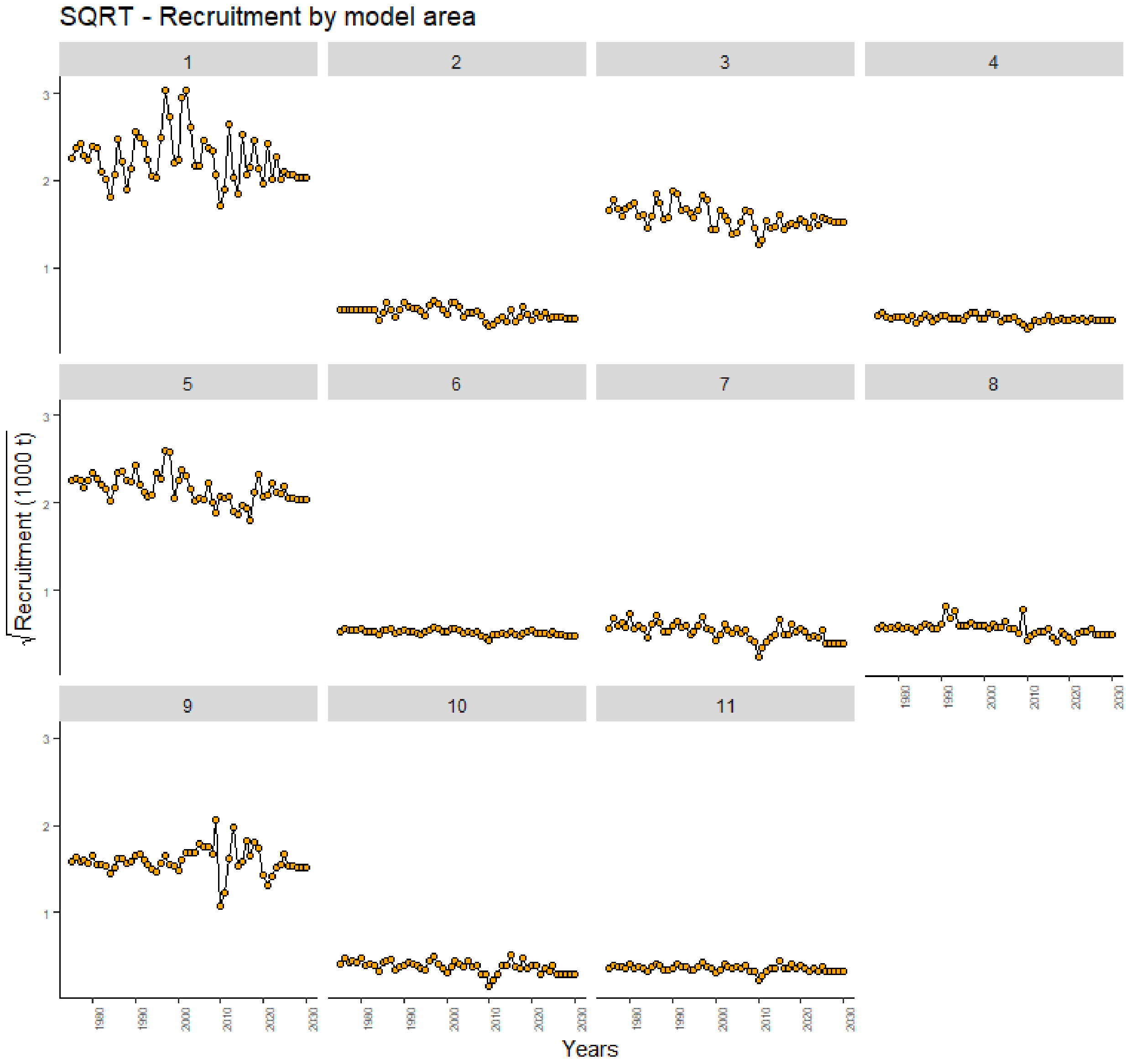

Figure A5-3. Estimated square-root recruitment into each model area to better show annual variation.

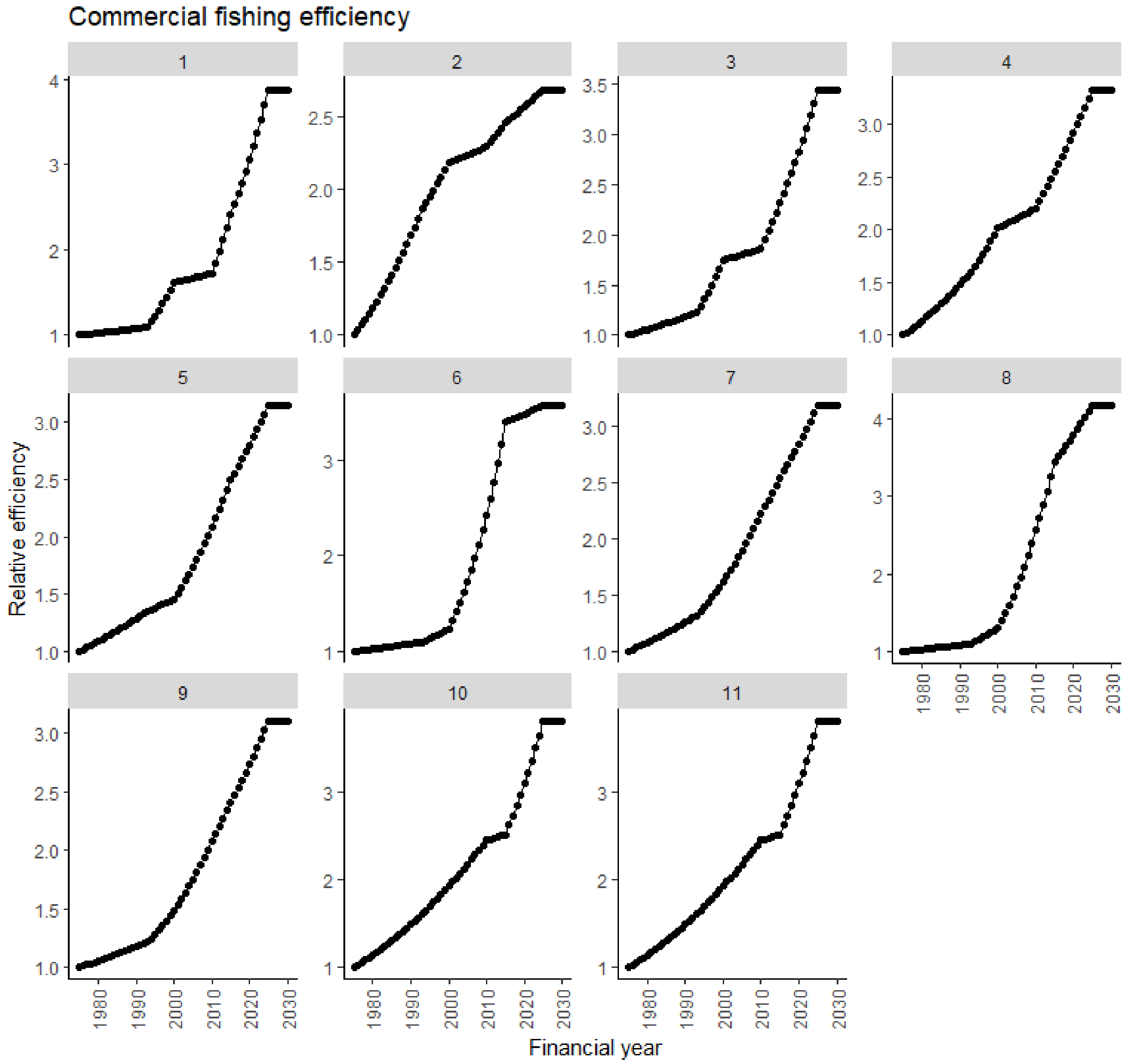

Figure A5-4. Model estimated fishing efficiency in each model area.

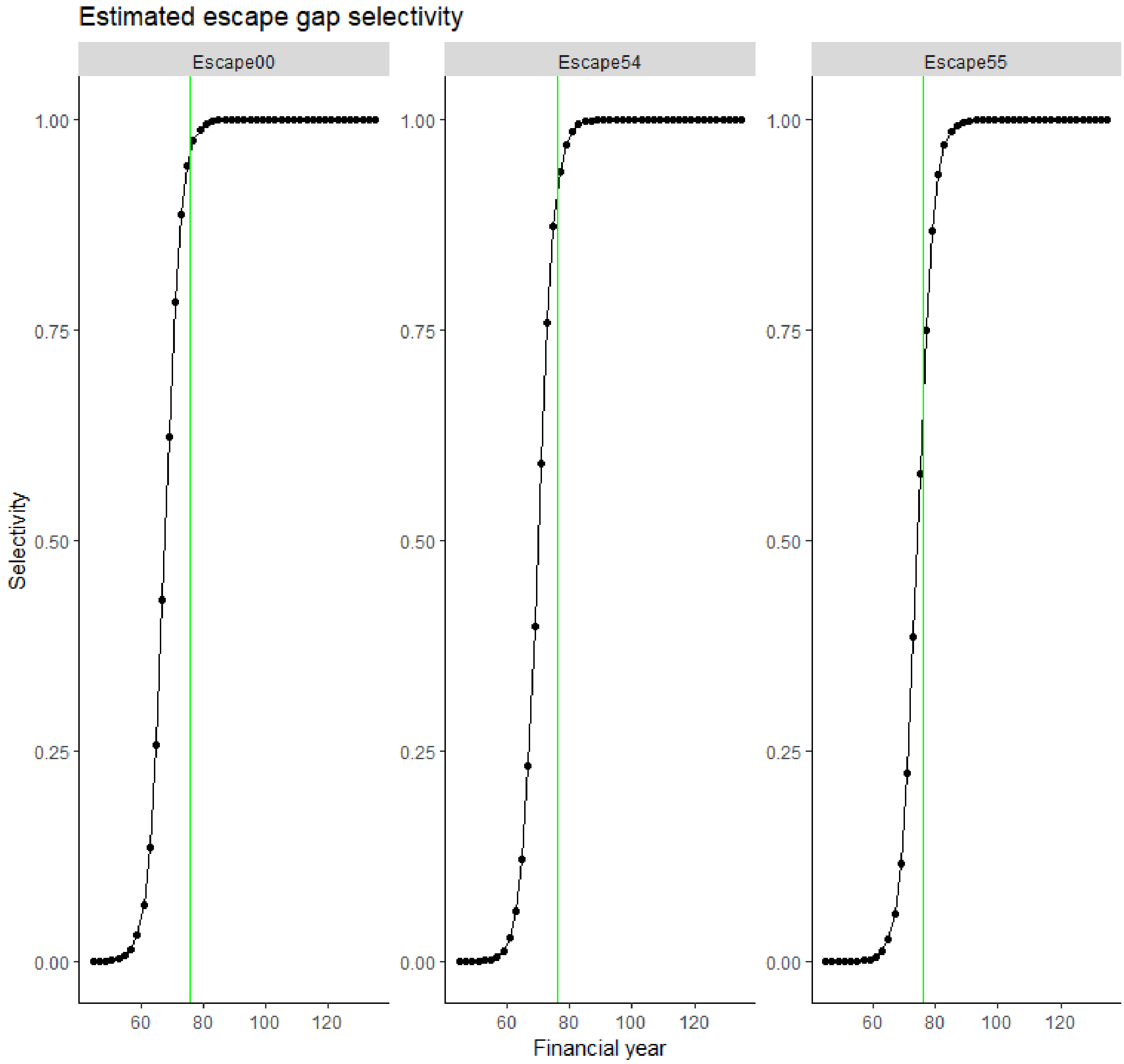

Figure A5-5. Model estimated selectivity for lobster pots with no (Escape00), three 54 (Escape54) and three 55 mm (Escape5) escape gaps, with the minimum legal limit of 76 mm identified by the vertical green line.

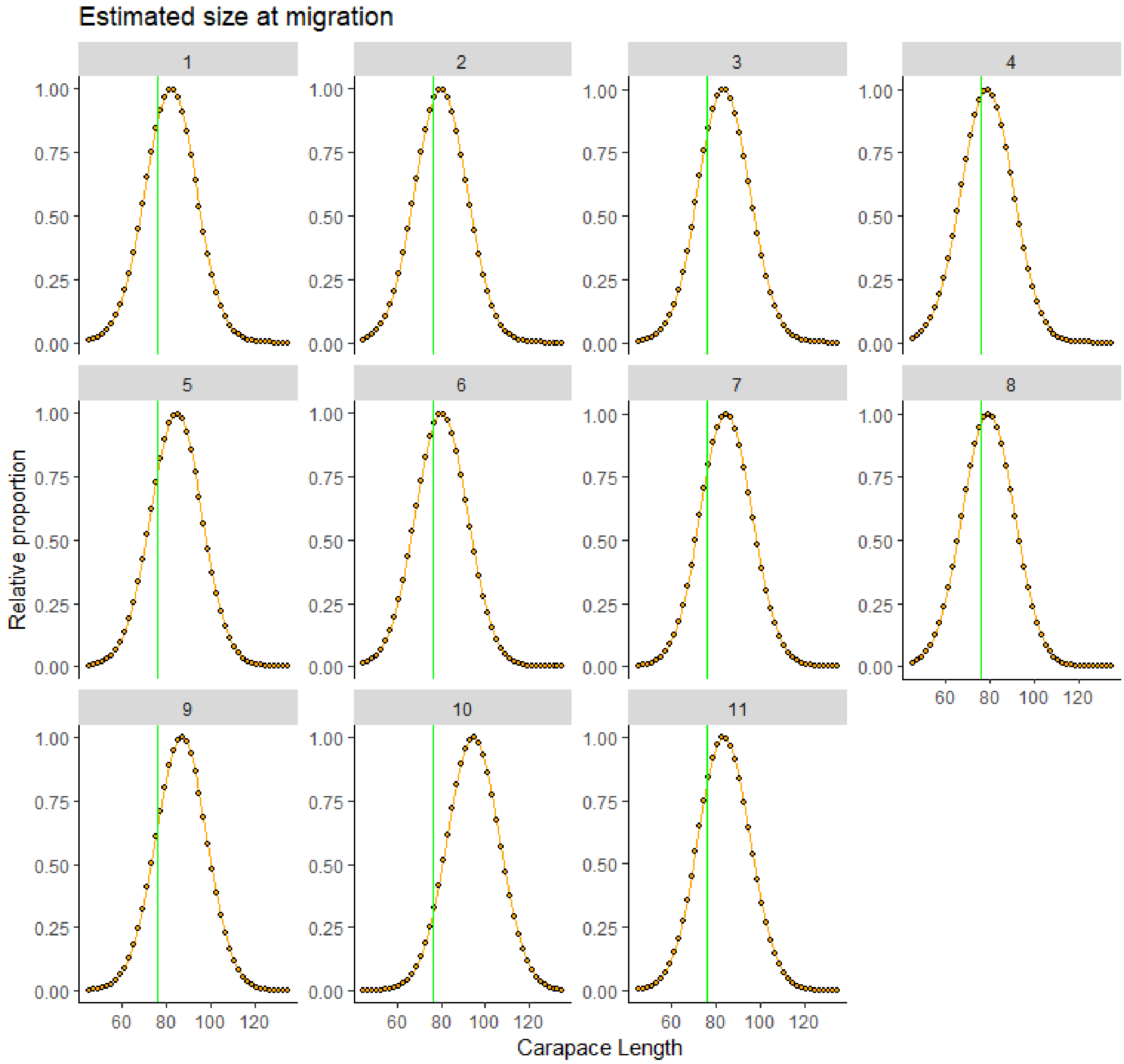

Figure A5-6. Model estimated size at migration in each model area, with the minimum legal limit of 76 mm identified by the vertical green line.

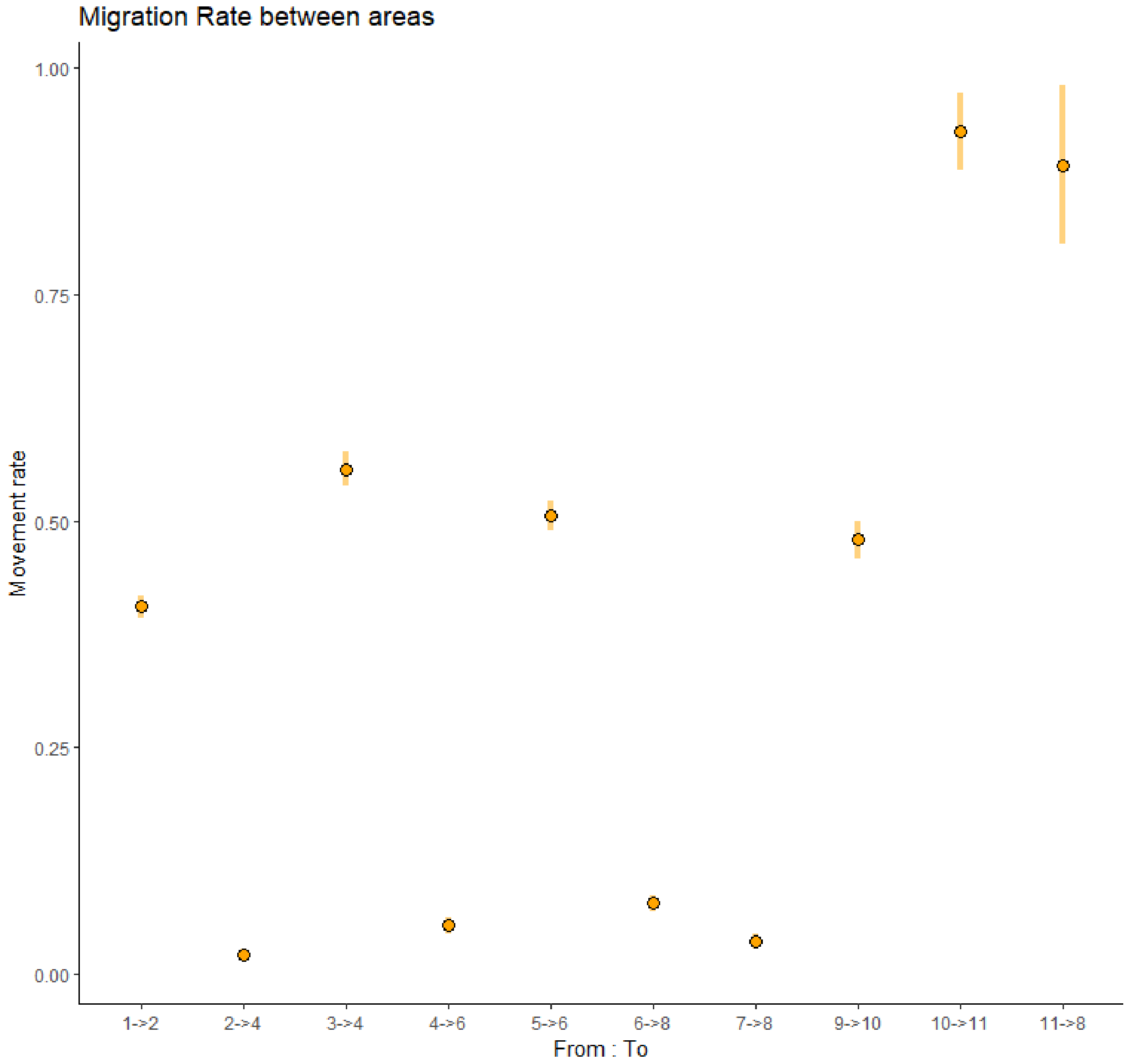

Figure A5-7. Model estimated (± 95% CI) movement rate between model areas.

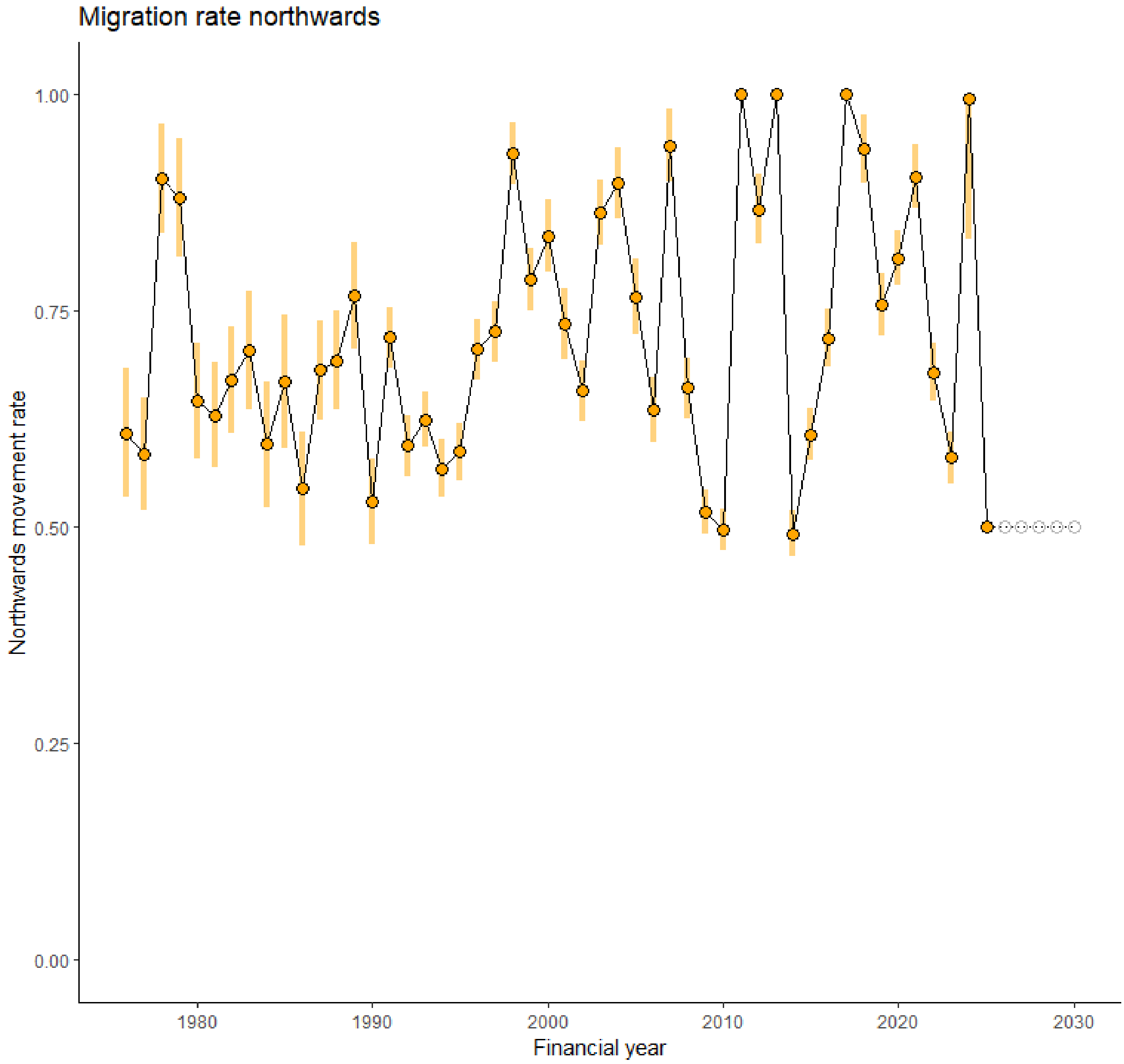

Figure A5-8. Model estimated scaler (± 95% CI) for all northwards movement (from area 2 – 4, 4 – 6, 6 – 10, 10 – 11 and 11 – 8).