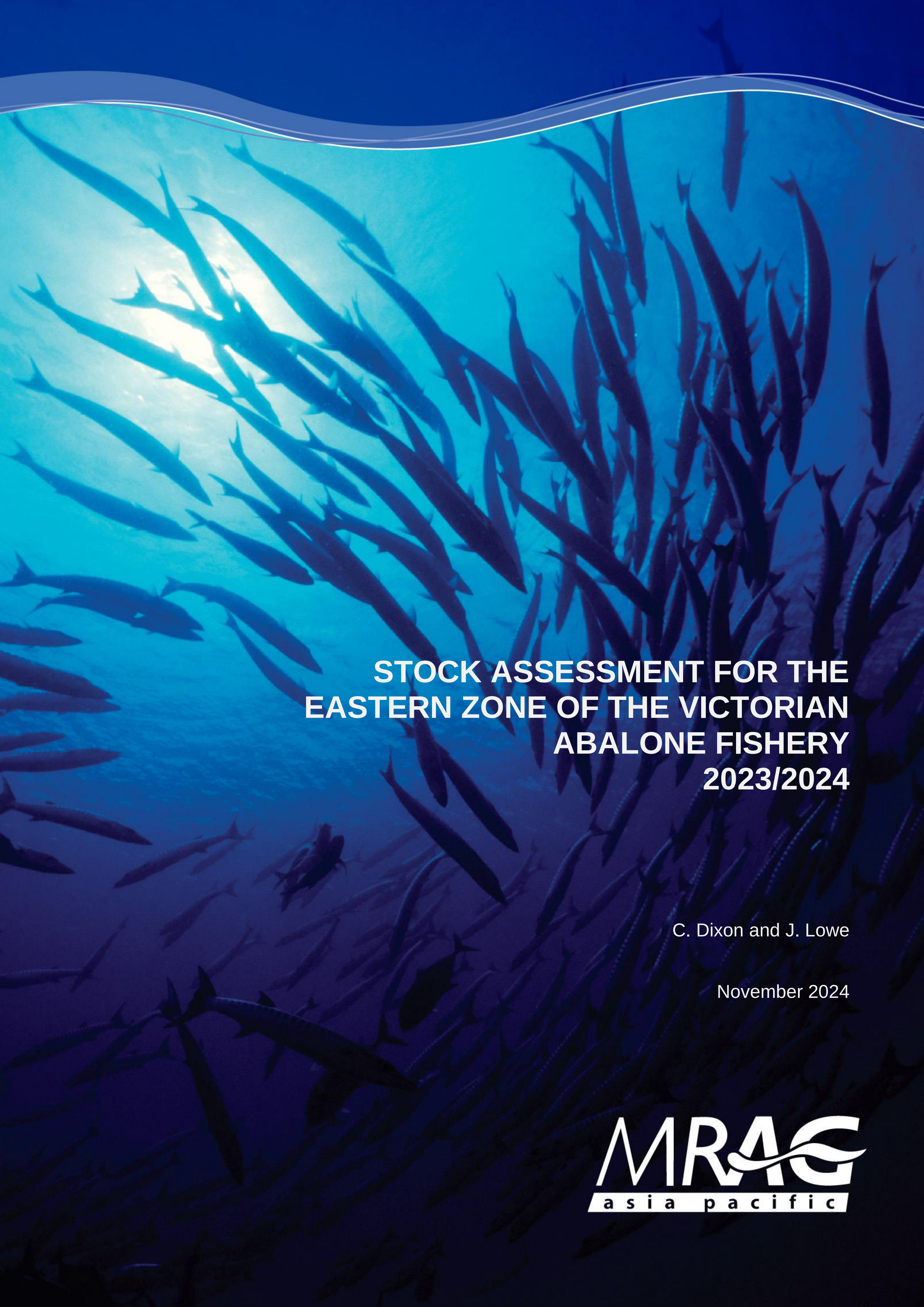


STOCK ASSESSMENT FOR THE EASTERN ZONE OF THE VICTORIAN ABALONE FISHERY 2023/2024

C. Dixon and J. Lowe

November 2024

MRAG asia pacific

About MRAG Asia Pacific

MRAG Asia Pacific is an independent fisheries and aquatic resource consulting company dedicated to the sustainable use of natural resources through sound, integrated management practices and policies. We are part of the global MRAG group with sister companies in Europe, North America and the Asia Pacific.

2/29 Woodstock Rd	PO Box 732	P: +61 7 3371 1500
Toowong Qld 4066	Toowong Qld 4066	F: +61 7 3100 8035
Australia	Australia	E: info@mragasiapacific.com.au

Preferred citation: Dixon, C.D., and Lowe, J. (2024). Stock Assessment for the Eastern Zone of the Victorian Abalone Fishery 2023/24. MRAG Asia Pacific, Brisbane, Australia.

ISBN:

Published: 13 November 2024

Acknowledgements

Funds for this work were obtained through the Victorian Fisheries Authority (VFA), obtained through licence fees. We are grateful to Michael Cleland for his assistance in the provision and interpretation of data. Melissa Schubert and Anthony McGrath from VFA provided constructive reviews of the document. We would like to thank Justin Bell of VFA who provided the figures of abundance for sea urchins.

We would also like to thank the Eastern Zone abalone divers, the Eastern Zone Abalone Industry Association, and the Mallacoota Co-op for gathering commercial size frequency data.

Finally, we would like to thank Dr Duncan Worthington for providing a highly constructive review.

Table of Contents

List of Figures

List of tables

Executive Summary

This report sets out the 2024 stock assessment for the Victorian Eastern Zone Abalone Fishery. Three primary analytical frameworks are used in this assessment of stock status to inform TACC decision making; (i) a weight of evidence assessment, (ii) analysis of trends against Performance Indicators set out in the in the Victorian Wild Harvest Abalone Fishery Management Plan and (iii) performance of the fishery against the Draft Harvest Strategy. Divers' observations and select data from the current season are presented at the Total Allowable Commercial Catch (TACC) setting meeting and approaches to incorporating these data into the formal stock assessment should be considered for future reports.

As discussed in recent Stock Assessment Reports and review documents, there are substantial limitations associated with the two primary sources of data. Catch per unit effort (CPUE) is positively biased due to hyperstability, while Fishery Independent Survey (FIS) data are negatively biased because FIS site locations are not representative of the entire stock, and in particular the current fished stock. As a result, the research and management framework for the fishery is currently undergoing review and further refinement.

In this context, last year's report stated, "*industry's role as stewards of the resource and VFA's obligation to act precautionarily in the face of uncertainty is particularly important until a more robust assessment framework is in place*". Importantly, during the December 2023 TACC setting process, industry voluntarily reduced the TACC from 284.5 t to 208.6 t, which was supported by the Victorian Fisheries Authority (VFA). While it is too soon to determine whether these reductions have been sufficient to slow the decline in biomass, the Eastern Zone Abalone Industry Association (EZAIA) and VFA should be commended for this decision.

In February 2024, an Abalone Scientific Working Group (ASWG) was formed to utilise the experience and expertise of independent scientific personnel, fishery managers and abalone industry members to provide recommendations on how best to assess and monitor the Victorian Abalone Fishery across all three zones. The short-term priorities included changes to the stock assessment reporting framework, and these changes have been included in this report.

The FIS review provided evidence that the decline in abundance at FIS sites from 2003 to around 2010 represents serial depletion of the stocks in the offshore and mid depth reefs. Currently, the fishery is reliant primarily on shallow water reefs that are not surveyed, and accordingly there are no data to assess total or relative biomass for the entire stock. Work has commenced to establish new FIS sites in shallow grounds representative of the fishery, and surveys will begin in 2025.

The available data for the weight of evidence assessment continues to be pessimistic. The total catch of 284.5 t in 2023/24 was close to 100% of the TACC (284.6 t), however it is currently around 60% of the peak historic catch following the introduction of quota in 1988. Standardised CPUE has declined by around 20% since 2019. Mean daily catches are at low levels from an historic perspective, however this appears to have been affected by individual daily catch limits applied by the processor.

In summary, recent trends in available data clearly indicate that the stock has been in decline in recent years and the status of the Eastern Zone stock remains 'declining'. It is not possible to determine how close the stock is to a point where future recruitment may be impaired, however the risk is not negligible. Importantly, industry recommended large reductions in the TACC for the 2024/25 season, which were implemented by VFA. It is too early for any response to be observed in the available data. On this basis, it is recommended that the current TACC and Optimal Targets (Ots) remain stable in the short-term, unless individual diver observations suggest that further reductions in OT are required at some Spatial Management Units (SMUs). Increases in TACC should not be considered until clear evidence of stock recovery over several years is apparent.

1. General Introduction

1.1 Overview

This Stock Assessment Report builds on previous reports for the Eastern Zone Abalone Fishery (e.g. VFA 2018; Dixon and Dichmont 2019; Dixon, Potts and Dichmont 2020; Dixon, Potts and Dichmont 2021, Dixon, Lowe and Potts 2022, Dixon and Lowe 2023). It is the sixth Eastern Zone Stock Assessment Report prepared by MRAG Asia Pacific. The report analyses fishery-dependent catch and effort data (up to 31 March 2024) to assess the blacklip fishery against performance indicators. FIS data were collected from only 10 sites in 2024, and therefore FIS data are not assessed against the Performance Indicators. Catch, effort, CPUE and FIS data are presented in various manners for assessment of stock status in a multiple lines of evidence approach at the Zone level and for each Spatial Management Unit (SMU). Summary results from the Eastern Zone Draft Harvest Strategy 2024 are provided and discussed for each SMU.

1.2 Description of the Eastern Zone Abalone Fishery

The Eastern Zone Abalone Fishery extends along the coast of Victoria from Lakes Entrance to the Victorian / New South Wales border (Figure 1). The fishery is limited entry and the primary method for managing commercial abalone fishing is to set an annual Total Allowable Commercial Catch (TACC) for each management Zone. There are 23 Abalone Fishery Access Licences (AFALs) and 460 quota units in the Eastern Zone fishery. Licences and quota units are transferable (i.e. they can be leased or sold) amongst licence and non-licence holders. A minimum of five quota units must be attached to each AFAL. Fishers may be owner-operators or contract divers.

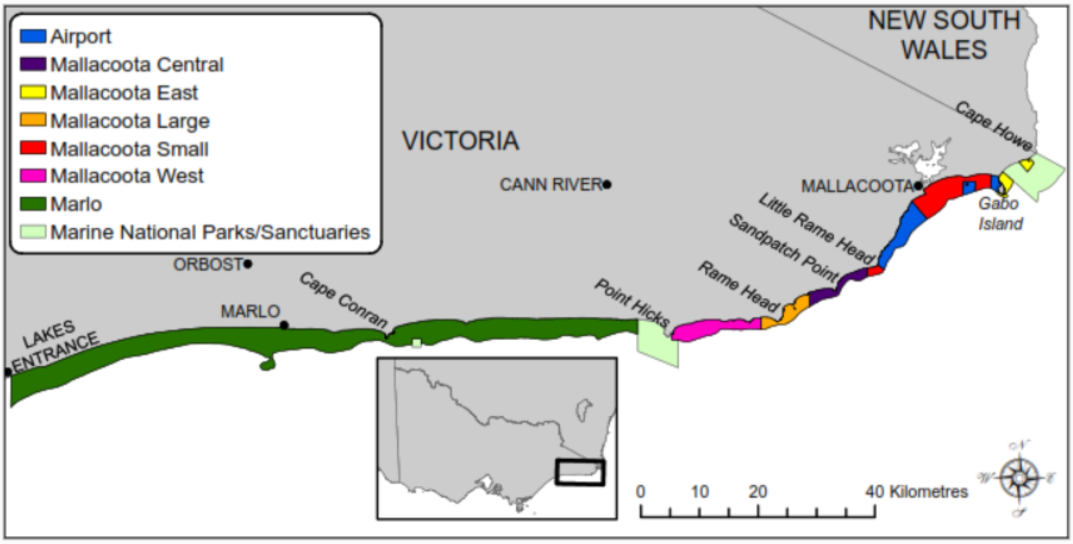


Figure 1: Map of the Eastern Zone Abalone Fishery showing the Spatial Management Units and Marine Protected Areas.

The TACC for the Eastern Zone fishery is set at a Zonal scale, but management of the fishery occurs at a finer spatial scale defined by the seven SMUs (Figure 1). An Optimum Target (OT) catch is set for each SMU based on current quota reference points, catch history and stock assessment outputs. The combined value of all OTs represents the TACC. Total catches for each SMU for the following fishing season are intended to meet the OT for that SMU. During the 2023/24 season, SMUs were closed via a Fisheries Notice once the OT upper limit had been reached or exceeded, and reef codes were closed when the specified upper limit had been reached. Further details regarding the history of the fishery and current management goals and arrangements are described in the *Victorian Wild Harvest Abalone Fishery Management Plan* (DEDJTR 2015) (the Management Plan).

1.3 Objectives

The Victorian Government's overarching policy objective is to optimise the commercial, social and cultural value to Victoria derived from the use of fisheries resources and associated ecosystems. This objective is pursued within the context of the broader policies and instruments applicable to fisheries including: the *Fisheries Act 1995* and subordinate legislation; Offshore Constitutional Settlements; commitments made by all Australian governments to manage fisheries according to the principles of ecologically sustainable development; and Victorian Government policies to facilitate economic productivity (including reducing regulatory burden) and to conserve environmental assets.

A TACC is set for each management Zone which aims: *"To obtain optimum harvests from the fishery, whilst conserving sufficient reproductive capacity to maintain or rebuild population recruitment and ensuring that sufficient aggregations remain on reefs to preclude habitat loss"* (DEDJTR 2015). A reference to habitat is included in the context of evidence indicating that the presence of abalone on reefs helps to ensure that the habitat remains suitable for post-larval settlement and survival, and this means that more abalone may need to be retained on reefs than the minimum required to maintain levels of reproduction (Miner et al. 2006; Mundy and Jones 2017).

The Management Plan specifies the objectives, strategies and actions for managing the fishery for at least five years from the declaration of the plan. Objectives include:

- Objective 1: Rebuild or maintain abalone stocks
- Objective 2: Secure access to the resource
- Objective 3: Enable improvements in economic productivity
- Objective 4: Empower effective industry representation, organisation and funding
- Objective 5: Ensure fisheries compliance
- Objective 6: Ongoing monitoring and targeted research.

1.4 Abalone Fishery Scientific Working Group

In February 2024, an Abalone Scientific Working Group (ASWG) was established by VFA to utilise the experience and expertise of independent scientific personnel, fishery managers and abalone industry members to provide recommendations on how best to assess and monitor the Victorian Abalone Fishery across all three zones. The short-term priorities identified by the ASWG were focussed on improvements to the stock assessment process, specifically changes to the filters applied to the CPUE dataset, and changes to the CPUE standardisation modelling. The recommended changes have been applied to this report.

2. Methods

2.1 Data sources and uncertainties in the assessment

2.1.1 Catch, effort, and CPUE

The Eastern Zone fishery began around 1966, however commercial logbook data were only gathered from 1 January 1969. Catch and effort logbook data were sourced from three different datasets provided by VFA. These data were merged and validated, with the final dataset comprised of the following subsets of data:

- 1 January 1969 to 31 May 1978
- 1 June 1978 to 31 March 2004

- 1 April 2004 to 31 March 2024

Catch per unit effort, referred to as CPUE, is a commonly used index of abundance for fisheries stock assessment. However, recent Stock Assessment Reports (Dixon et al 2020, 2021, 2022; Dixon and Lowe 2023) and a review of the CPUE standardisation approach (Dichmont et al 2022) have discussed in detail the limitations of CPUE data as an index of abundance for the Eastern Zone abalone fishery. The key issues include:

- hyperstability due to their cryptic nature and aggregating behaviour,
- changes in the spatial or temporal distribution of the catch,
- effort creep due to improvements in technology,
- reliability of reporting,
- environmental conditions, market forces.

In summary, because abalone aggregate and divers generally target the densest visible aggregations, CPUE can be maintained even if overall population abundance is declining. As a result of these circumstances, stable or increasing trends in CPUE may not be reflective of trends in stock abundance. Declines in CPUE are generally considered to reflect declining abundance, however they are also unlikely to be linear, with rates of decline potentially more severe than CPUE data would suggest. Complicating these issues, declines in CPUE in the short-term may also be attributed to other influencing factors such as an increase in size limit, or changes in market forces. Other factors such as diver experience can also affect abalone CPUE trends.

In addition to these factors, Dichmont et al (2022) identified that the quality of logbook data was poor, stating "*There are many issues with the accuracy of the logbook data. The spatial location of divers at the local scale is missing and we were unable to untangle important small-scale changes over time such as moving inshore or discovering new reefs within a reefcode. Given the extent of outliers in the linear models, it is possible that the data may include periods where some divers may not have recorded catch, effort and location information with the accuracy needed to use this data as a reliable index of abundance*".

To partially address the issue of data outliers, the ASWG examined catch, effort and CPUE data in detail from 2003 onward to remove data that appeared unrealistic. As a result, the following set of filters were applied to the CPUE datasets before standardisation was undertaken:

- Removed CPUE <25 kg/h and >250 kg/h at the reefcode/day scale
- Removed daily catches <20 kg/day and >800 kg/day
- Removed daily effort <20 minutes/day and >9 hours/day
- Removed the first 50 days of each divers records (learning period)

The CPUE data in previous reports were standardised following Giri and Gorfine (2018). However, the approach did little to improve the index of abundance as there was little difference between nominal and standardised trends at all spatial and temporal scales. Several alternative standardisation models were tested by Dichmont et al (2022), and during 2024 a revised standardisation model was agreed upon through the ASWG. The revised model removed some of the interaction terms and included a "quarter" term (Qtr) to replace the "month" term.

The linear mixed-effects model at the Zone level was specified as follows:

log(Blacklip) = 0 + offset(log(Effort)) + QuotaYear + (1|Diver) + SMU + (1|SMU:Year.Qtr) + ReefCode + (1|ReefCode/QuotaYear) + (1|ReefCode:Year.Qtr)

The linear mixed-effects model at the SMU level was specified as follows:

(log(Blacklip) ~ 0 + offset(log(Effort)) + QuotaYear + (1|Diver) + ReefCode + (1|ReefCode/QuotaYear) + (1|ReefCode:Year.Qtr)

While approaches to improving the information base for the fishery continue to evolve, this assessment remains heavily reliant on CPUE as its primary source of information. Thus, there is substantial uncertainty in the interpretation of the data that drive the stock status assessment and Draft Harvest Strategy outcomes.

In addition to catch, effort and CPUE trends, this report also examines trends in mean daily catch. This measure only includes days when divers fished a single SMU and more than 50 kg of abalone was recorded. Currently these data are not standardised, however it is planned to develop a standardisation model for mean catch per day through the ASWG in 2025.

2.1.2 Fishery-independent survey abundance

Several fishery-independent survey (FIS) approaches have been developed for abalone fisheries in Australia. Commencing in 1992, the Victorian FIS provides a long-term, annual dataset measuring recruit and pre-recruit abundance (standardised using GLMM following VFA 2019), along with size structure data. The Victorian FIS is currently being improved, with new sites being established in shallow water reefs representative of the fishery from 2025.

Of greatest importance, both commercial fishing effort and FIS locations were mapped using GIS software to obtain an understanding of how well (or otherwise) FIS sites represented the biomass upon which the Eastern Zone fishery is currently based. In general, the results of this analysis suggested that FIS sites are a very poor representation of the current fishing grounds. As hypothesized in previous Stock Assessment Reports, declines in FIS abundance observed over a decade from around 2003 represented declines in abundance on intermediate and deeper water reefs. During this period, CPUE actually increased as fishing became concentrated in the shallower, more productive reefs where FIS sites were not located (due to logistic reasons). On this basis, the declines in abundance during this period do reflect a reduction in biomass from intermediate and deeper reefs, however the rate of decline in abundance is much greater than the rate of decline in total biomass because the FIS sites are negatively biased.

With declines in FIS abundance providing overly pessimistic trends and CPUE providing overly optimistic trends, the contrasting signals from these data sources have caused substantial uncertainty in the assessment of stock status for many years. The relationship between these measures has been studied in detail in previous reports and has been included as an appendix in this report. To address these issues, the FIS review process identified an urgent need to establish new FIS locations in shallow reefs that are representative of the current fishing grounds. The first of these sites will be in place during 2025.

The FIS review process also resulted in a reduction in the number of historic FIS sites surveyed in the Eastern Zone. While no FIS was conducted in 2022, data were gathered from 15 old FIS sites referred to as the “Top 15” (Dixon 2023). While these sites are not representative of the primary fishing grounds, they were selected as they maintained reasonable levels of abalone abundance, and they were generally adjacent to areas of more intense fishing effort. In 2024, only a subset of ten of the Top 15 sites were surveyed in the Eastern Zone, with new fixed transects established within the existing area of the radial transect area. This provides direct comparisons between survey types, however in 2024 this further diluted the strength of the survey data as a measure of annual abundance.

While data from these Top 15 sites are not considered to be representative of trends in biomass for the fishery, they contribute some useful information toward the assessment of stock status. Recruit and pre-recruit abundance as well as size frequency data are presented at the SMU scale, however the number of Top 15 FIS sites at this scale varies between 1 and 4 for 6 of the 7 SMUs, and there are no Top 15 sites for the Mallacoota Large SMU. Thus, interpretation of these trends should be treated with caution. Analyses from Dixon (2023) suggest that trends for the Top 15 sites at the zone scale are similarly precise to previous years when around 60 sites were surveyed.

2.1.3 Size structure data

Fishery-independent survey

Size structure data from FIS are available from 1992. However, the approach to collecting length frequency data changed in 2003 when abalone were removed after the transect survey counts from areas immediately outside of the site radius in a "timed swim" approach, rather than removing all abalone encountered on the transects themselves.

Data are weighted by the standardised abundance at each site to ensure that the size distribution is representative of the sampled population, rather than the samples measured, which reduces bias. Length frequency samples from each site were converted from counts to percentage frequency and were then scaled by the total count at each site to determine the percentage length frequency at the SMU scale. The percent frequency was then multiplied by the standardised total abundance (i.e. standardised pre-recruit abundance + standardised recruit abundance) for each year. These data are then presented graphically with associated statistics and reported in Appendix 3. Data from all FIS sites are presented at the SMU level from 2003 to 2021, and data from the Top 15 FIS sites are presented at the SMU level from 2003 to 2023, except for Mallacoota Large where there are no Top 15 sites. Interpretations of the data are included in the summary assessment for each SMU.

FIS length frequency data also enable abundance measures to be split into pre-recruit indices for the harvest strategy. Interpretation of size data is difficult as small changes can be quite influential in size-structured models. Thus, only crude changes can be investigated with the broad statistics obtained from these data, so when there are clear trends these should be considered important.

To examine the effect of the change in the method of length-frequency data collection, Dixon (2023) compared the ratio of recruit to pre-recruit abundances on transects versus timed collections and found that length frequency gathered since 2003 was strongly biased toward the collection of larger abalone. The results from this analysis are presented in Appendix 3. It is considered unlikely that bias in size structure would result from the in situ transect counts as abalone are encountered in a systematic manner. This view is supported by Gorfine (1998) who states "*Because the application of radial transacts avoids targeting some emergent abalone to the exclusion of others, there is less potential for divers to bias their sample towards larger abalone as may occur with time searches…. Time searches do not necessarily permit this separation of pre recruits from post recruits because of the potential for divers to collect larger, more accessible abalone at the expense of smaller abalone*".

Therefore, there are two sources of bias that have recently been identified in the FIS length-frequency data. Firstly, as previously described, FIS site locations are not representative of the entire stock. And secondly, changes in the approach to collecting length frequency data has biased the size data towards larger abalone. On this basis, the length-frequency data presented in this report are not representative of the abalone population and trends in FIS length frequency should be given little weight in the assessment. All length-frequency data are presented in Appendices.

Commercial length frequency

Data on size structure of the commercial catch are a very important data source to monitor changes in the fished population. While interpretation of these data can be affected by changes in size limits or changes in market demands, a shift towards "knife-edge fishing", where more abalone are being caught closer to the size limit, can reflect higher levels of fishing mortality on a stock.

Commercial length frequency data were gathered by the Mallacoota Co-op from 2010/11 to 2013/14 and 2015/16 to 2018/19, and these data are presented in this report. Unfortunately, the Mallacoota Co-op was lost in the 2020 bushfires and the sampling program was discontinued. The data that were gathered provided some useful insights into commercial size structure, however inconsistent sampling and low sample size numbers in later years complicate their interpretation.

There remains an urgent need to gather size structure data that are representative of the commercial catch.

2.1.4 Size limits

Spatial and temporal changes in size limits impacts fishing selectivity (availability) which makes it difficult to interpret temporal trends in CPUE and the impact that changes in TACCs have on exploitable biomass. For example, a decrease in the LML generally allows access to a larger biomass of smaller abalone and may result in a consequent increase in fishery CPUE over a short time frame and a reduction in mean length of the catch. Changes in LML need to be factored into the interpretation of all data, particularly trends in CPUE over time. Examples of LML changes are the LML at the Mallacoota Large SMU which was progressively increased from 120 mm to 138 mm from 2009/10 to 2016/17 because of the exceptionally high growth and large size at maturity among many of its abalone populations (VFA 2018). The LML was reduced at Mallacoota Large to 135 mm for 2019/20.

While size limits have been stable since 2019/20, there were numerous size limit changes, regulated and voluntary, within the Eastern Zone during the previous decade. These changes were often applied at the reef code scale; however, more recently changes have been applied at SMU scale recognising the practical implications for enforcement and administrative burden. A table representing the history of LML changes is provided in Appendix 2. Compliance levels with voluntary size limit changes are relatively unknown.

The regulatory changes to LML have included both increases and decreases. Size limits have been increased due to stakeholder and government concern about the state of the resource, but they have also been decreased to manage fishing effort more sustainably across SMUs (VFA 2018).

2.2 Approaches to assessment of stock status

Performance Indicators

The first approach for assessing stock status is assessment against the Performance Indicators (PIs) and associated reference points described in the Management Plan (Table 1). The primary PIs are standardised CPUE and FIS recruit and pre-recruit abundance and are intended to be used as indicators of biomass and fishing mortality to infer stock status at Zone and SMU scales. The *2016 Victorian Abalone Science - Methods Used for Fishery Assessment* report (VFA 2019) describes how the different data types are acquired, processed, and analysed.

The primary PIs are assessed across two spatial scales (Zone and SMU) and two temporal scales (long-term: 2003/04 to current, and short-term: 2009/10 to current). In 2023/24, there were no new data to inform the FIS PIs. As described above, there are many issues with these measures that result in substantial uncertainty in the interpretation of the PIs. On this basis, recent Stock Assessment Reports have recommended that the PIs be reviewed (Dixon et al 2021, 2022, 2023).

Table 1: Performance indicators used in the assessment of the Eastern Zone abalone fishery. LML = Legal Minimum Length.

Performance Indicator	Description	Units	Source and time series
Catch	Commercial catch reported at Zonal and SMU scale	Tonnes	FA Commercial catch returns 1992 – current
Catch per unit effort (CPUE)	Catch / Effort for individual fishers. Average and standard error (nominal only) calculated at Zonal and SMU scale Used as a proxy indicator of legal biomass Primary and secondary indicator in draft HS	Nominal kg/hr Standardised kg/hr	VFA Commercial catch returns 1979 - current
Short and long-term trend analysis of CPUE	Objective statistical method used to determine if a change in trend occurs and if the trend is positive, negative, or statistically non-significant	Significant or non-significant trend Positive or negative percentage change	VFA Commercial catch returns 1992 – current
Pre-recruit abundance	Used as an indication of the strength of recruitment. Tertiary indicator in draft HS	Average number of abalone per 30 m transect. Nominal and Standardised	VFA FIS 1992-current
Recruit abundance	Used as an indicator of adult abundance	Average number of abalone per 30 m transect. Nominal and Standardised	VFA FIS 1992-current
Short and long-term trend analysis of pre-recruit and recruit abundance	Objective statistical method used to determine if a change in trend occurs and if the trend is positive, negative, or statistically non-significant	Significant or non-significant trend Positive or negative percentage change	VFA FIS 1992-current
Length frequency statistics (FIS)	Used to show changes in size composition of the abalone populations at Zone/ SMU relative to the LML from survey data	%<LML Median calculated as the mid-point of the length distribution	VFA FIS 2003-current

Weight of evidence

The second approach used to assess stock status is the weight of evidence approach that considers all sources of available scientific data. For the Eastern Zone these data sources include catch, effort, CPUE data, FIS abundance and size-structure, as well as size structure of the commercial catch. Note that formal weightings to each of these data sources has not been agreed, thus trends in all these data sources are considered subjectively in an overall manner to determine a likely stock status. Future assessments need to integrate additional data sources into the weight of evidence approach, in particular data collected from new FIS sites and data collected through the commercial data logger programs (VMS, length-frequency and depth data).

Draft Harvest Strategy

A Draft Harvest Strategy has been developed for the Victorian Abalone Fishery (Central and Eastern Zones) and a summary of the 2023/24 results is provided in Section 3.2.3. It comprises operational objectives, performance indicators, reference levels and decision (or control) rules which directly link to TACC setting. The Draft Harvest Strategy requires further validation before it is formally integrated into the TACC setting process. In this report, we compare the independent weight of evidence assessment of stock status at the SMU scale with the outcomes of the Draft Harvest Strategy.

Both the stock assessment and Draft Harvest Strategy results are presented at the annual TACC setting workshop. The TACC will continue to be set this year based upon a 'bottom up' multiple lines of evidence approach as detailed in the Management Plan. Catch targets for each SMU are to be reviewed during the annual workshops and these will directly influence the recommended TACC for the following season.

2.3 Quality Control

Raw catch effort and CPUE data were received by MRAG Asia Pacific on 10 September 2024. Data were provided by VFA in a validated form.

Raw FIS data were provided on 16 August 2024 for the Mallacoota region, and 4 November 2024 for the Marlo region.

The new CPUE standardisation model was developed by Jake Lowe (MRAG) and Duncan Worthington (AMBRAD) and was coded into the R Script by Jake Lowe.

MRAG AP manages all data under an ISO 9001 certified Quality Management System (QMS).

3. Results

3.1 Eastern Zone Blacklip Assessment

3.1.1 Catch and effort

The Eastern Zone fishery commenced in 1962 (Gorfine et al 2008), however daily logbooks were not introduced until January 1969. As a result, figure 2 shows a catch of only 200 t in 1968 (i.e. 1968/69 quota year) because it included only catches from 1 January to 30 March 1969. Catches exceeded 700 t in 1969, 1970 and 1972 before declining rapidly to below 400 t in 1977. An increase to around 550 t in 1979 was immediately followed by another decline to around 400 t in 1982. Catches remained around 550 t from 1983 to 1987 before the introduction of quota in 1988. Catches remained relatively stable until 2002 before an increase in quota led to higher catches until 2008. Thereafter, catches (and quotas) have generally declined. Currently, reported catch is around 40% of the 1970 peak. The total catch in 2023/24 was 284.5 t, which was almost 100% the TACC of 284.6 t. This was a decrease of 14% compared to the previous years' catch (330 t).

Dive effort peaked around 600,000 minutes in the early part of the fishery (1969 to 1973) and fluctuated thereafter until the introduction of quota in 1988. Thereafter, effort has generally declined, reaching a historic low in 2019 and 2020 due primarily to impacts from Covid-19 on markets. Currently, reported effort is around 30% of the historic peak.

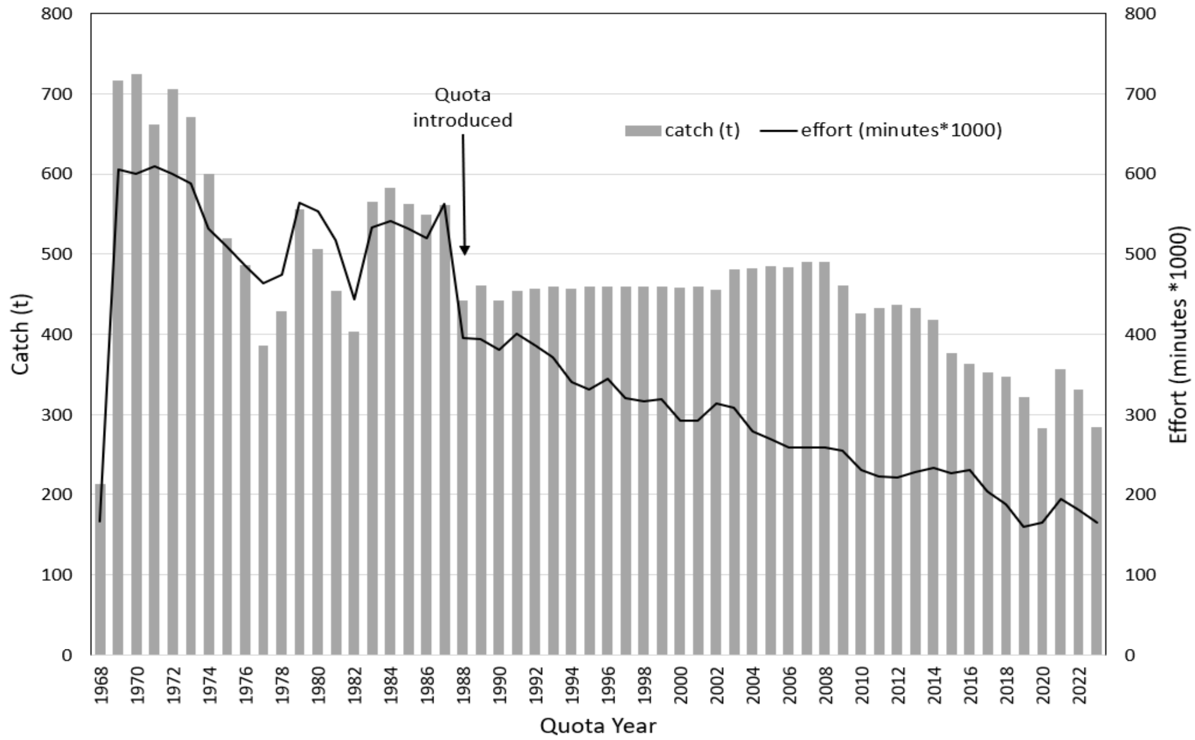


Figure 2: Historic catch (t) and effort (minutes) from 1968 to 2023. Quota was introduced in 1988 with the quota year running from April to March. Data are reported in quota years.

Mean daily catch ranged from 300-350 kg per day from 1979 to the introduction of quota in 1988 before increasing to a peak of around 470 kg per day in 1996 (Figure 3). Mean daily catches were relatively stable for the next 16 years but declined from 450 kg per day in 2012 to 380 kg per day in 2015 before recovering again from 2017 to 2019 at around 440 kg per day. Section 4 includes discussion on the impacts of market forces on mean daily catch. Impacts from Covid-19 on the market have resulted in daily catch limits being imposed that influence the interpretation of mean daily catch estimates from 2020 onward.

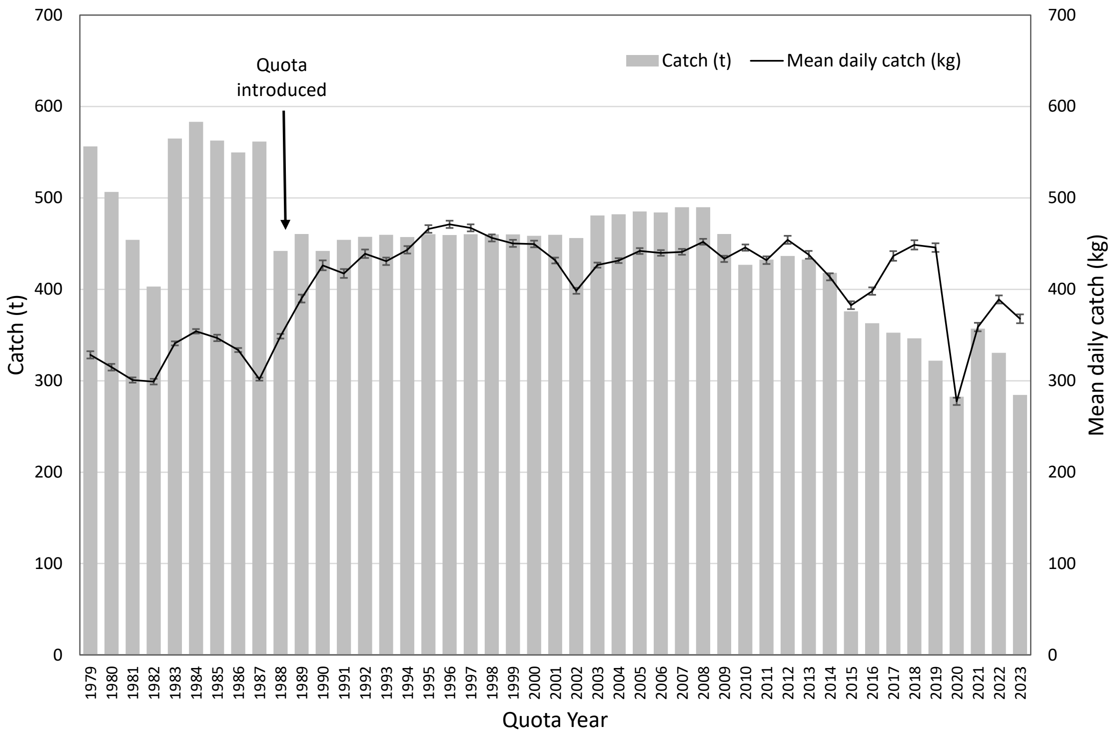


Figure 3: Historic catch (t) and mean daily catch (kg per fishing day +/- SE) from 1979 to 2023. Quota was introduced in 1988 with the quota year running from April to March. Data are reported in quota years.

3.1.2 Catch per unit effort (CPUE)

Nominal CPUE generally increased from 1992 to 2012, declined from 2012 to 2016, increased again from 2016 to 2019, and generally declined thereafter (Figure 4). The new CPUE standardisation model shows a slight decline in CPUE relative to nominal trends over time, particularly in the last three years.

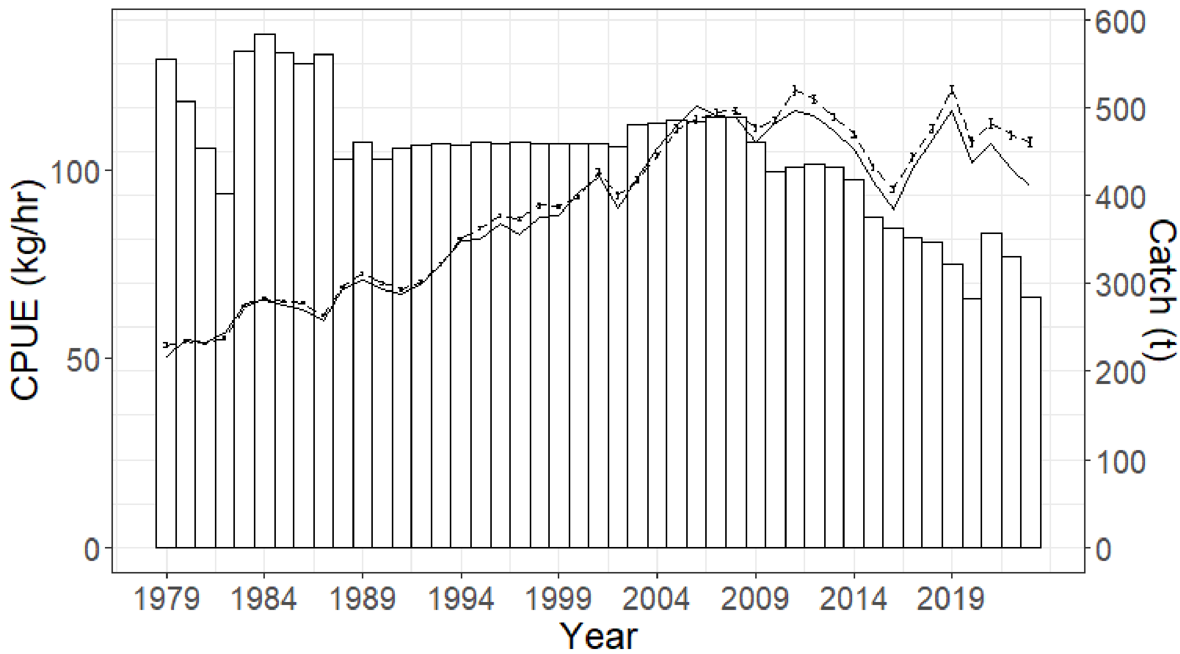


Figure 4: Eastern Zone catch and CPUE (nominal and standardised) from 1992/1993 – 2023/24. Catch = bars, nominal CPUE = grey series (+/- SE), standardised series = black. MPs = int79duction of Marine Parks.

3.1.3 FIS abundance

Recruit abundance

Figure 5 plots recruit abundance from FIS sites from 1992 to 2023. The grey line is the nominal data from all FIS sites surveyed, with the black lines representing the nominal (dashed) and standardised (solid line) values for the Top 15 sites only. There was little difference between nominal and standardised trends. Recruit abundance at the Top 15 sites declined substantially from 2003 to 2008 before increasing the following two years. Thereafter recruit abundance has generally declined. Recruit abundance in 2023 was the lowest recorded, declining by 20% from 2021 levels.

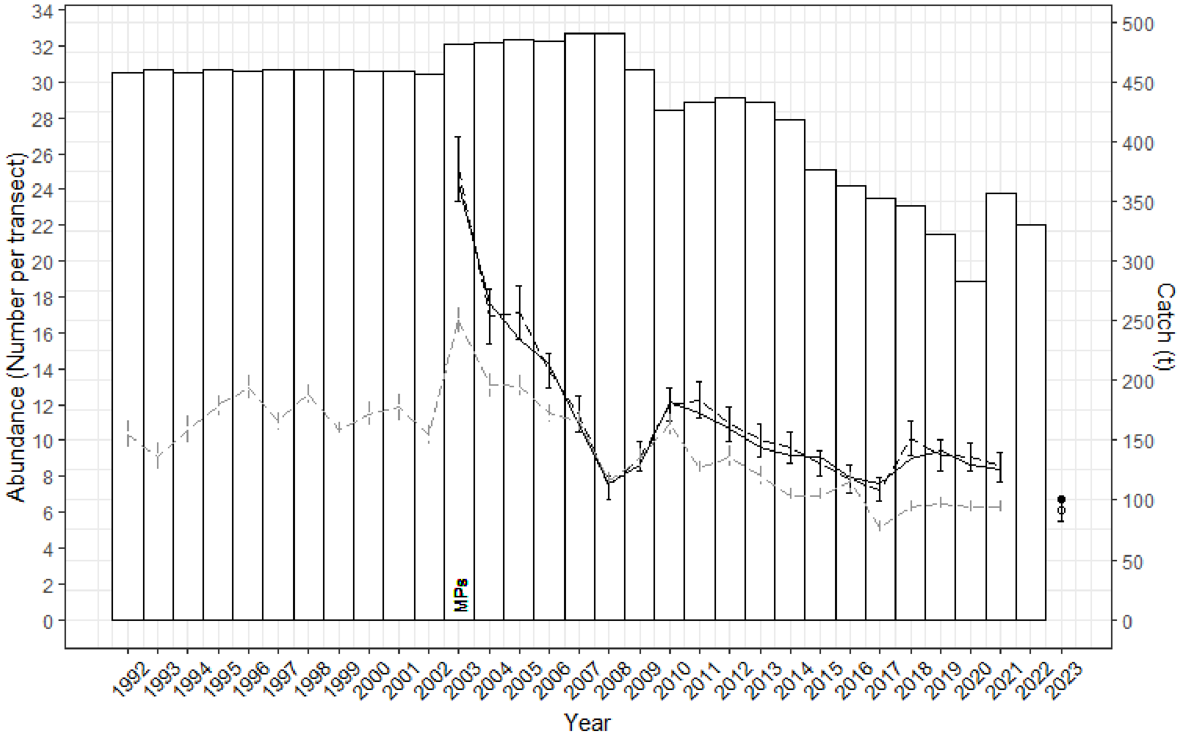


Figure 5: FIS recruit abundance (1992-2023) and catch (1992/93 – 2022/23) for the Eastern Zone. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line, open datapoint in 2023; +/- SE) and standardised (solid line, solid datapoint in 2023) abundance across the Top 15 sites only.

Pre-recruit abundance

Figure 6 shows pre-recruit abundance from FIS sites. As for Figure 5, the grey line is the nominal data from all FIS sites surveyed, with the black lines representing the nominal (dashed) and standardised (solid line) values for the Top 15 sites only. There was little difference between nominal and standardised trends. Pre-recruit abundance at the Top 15 sites declined consistently from 2003 to 2021. Pre-recruit abundance increased by 27% in 2023 and was the highest observed since 2017.

2024 FIS surveys

During 2024, a modified FIS was completed that included six of the Top 15 sites from the Mallacoota East, Mallacoota Small and Mallacoota Central SMUs, and four sites from the Marlo SMU. Figure 7 shows trends in total abundance for these ten sites in years when all ten sites have been surveyed. During 2024, the abundance at Marlo sites decreased compared to 2023 while the abundance at Mallacoota sites increased relative to 2023.

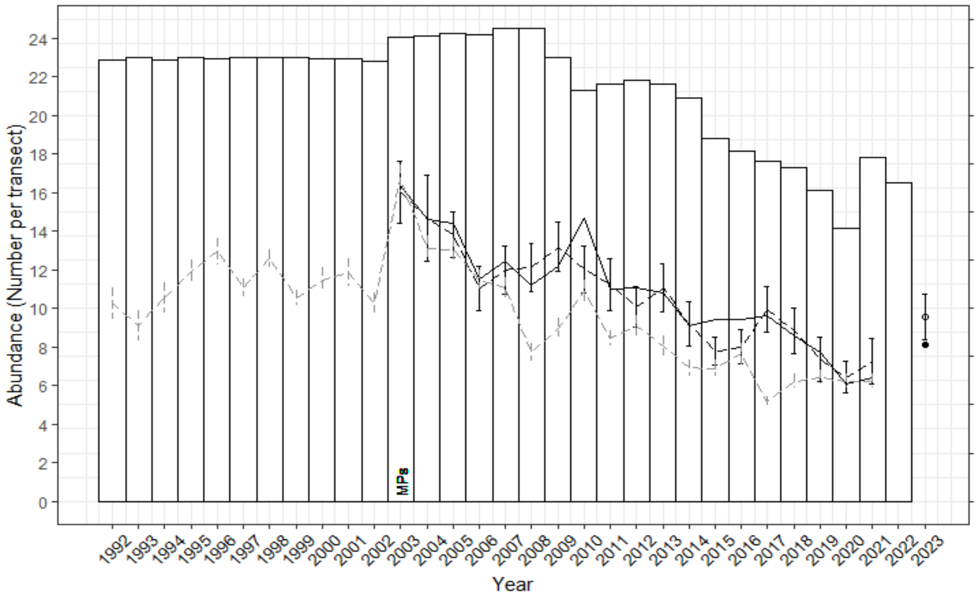


Figure 6: Pre-recruit abundance (1992-2023) and catch (1992/93 – 2022/23) for the Eastern Zone. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line, open datapoint in 2023; +/- SE) and standardised (solid line, solid datapoint in 2023) abundance across the Top 15 sites only.

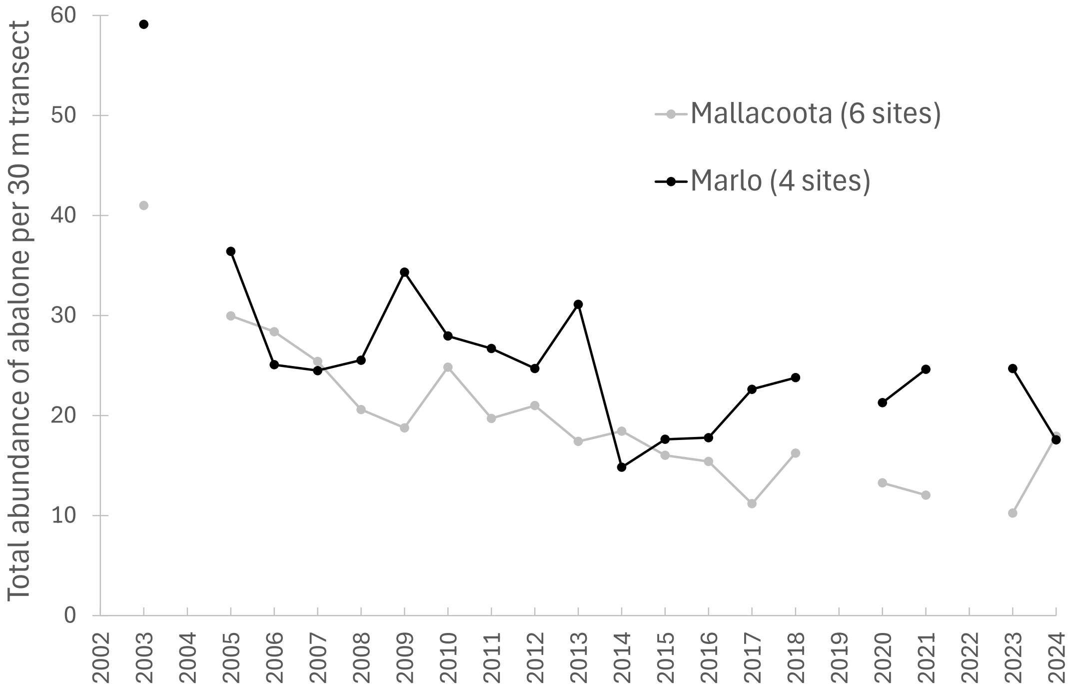


Figure 7: Mean total abundance (2003-2024) for 6 sites surveyed consistently at Mallacoota and 4 sites surveyed consistently at Marlo. Only years when all 10 sites were surveyed are shown.

3.1.4 Eastern Zone Performance Measures

The catch in 2023/24 was 284.5 t, which was almost 100% of the TACC (284.6 t, Table 2). Catch has declined by 41% since 2003/04, 38% since 2009/10 and was similar to 2020/21. Mean daily catch in 2023/24 was 367.8 kg/h, which was 14% lower than 2003/04, 15% lower than 2009/10, and 33% higher than 4 years ago. Nominal CPUE in 2023/24 was 107.5 kg/h, which was 10% higher than

2003/04, 4% lower than 2009/10, and similar to 4 years ago. Standardised CPUE in 2023/24 was 95.8 kg/h, which was 3% lower than 2003/04, 11% lower than 2009/10, and 6% lower than 4 years ago.

Recruit and pre-recruit abundance comparisons weren't available for 2023/24. In 2022/23, recruit abundance at the Top 15 sites had declined by 62% since 2003/04, 45% since 2009/10 and 23% in the previous 4 years. Pre-recruit abundance had declined by 44% since 2003/04, 45% since 2009/10 and had increased by 34% from the previous 4 years.

*Table 2: Performance measures used in the assessment of the Eastern Zone abalone fishery. * FIS data from 2022/23.*

Measure	2023/24	Long term (since 2003/04)	Short term (since 2009/10)	Last 4 years (since 2020/21)
Nominal CPUE (kg/hr)	107.5	97.7 (↑10%)	111.4 (↓4%)	107.6 (0%)
Standardised CPUE (kg/h)	95.8	98.6 (↓3%)	107.7 (↓11%)	102.2 (↓6%)
Recruit abundance (Top 15 n/transect)	6.7*	17.7 (↓62%)	12.2 (↓45%)	8.6 (↓23%)
Mean daily catch (kg/day)	367.8	426.5 (↓14%)	433.3 (↓15%)	277.5 (↑33%)
Pre-recruit abundance (Top 15 n/transect)	8.1*	14.6 (↓44%)	14.7 (↓45%)	6.1 (↑34%)
Catch (t)	284.5	480.7 (↓41%)	460.4 (↓38%)	282.5 (↑1%)
2023/24 TACC t, (% TACC)	284.6 t, (100%)			

3.2 Spatial management unit (SMU) blacklip assessment

3.2.1 SMU Performance Measures

Assessing SMUs on an individual basis provides a more detailed picture of spatial patterns of performance measures and distributions of effort and catch within the Zone. In 2023/24, the distribution of catches generally did not reflect the OTs established for several SMUs (Table 3). As for other recent years, the catch at Marlo (48.0 t) was 33% below the OT (71.5 t). Catches from Mallacoota West (18.1 t) were 16% below the OT (21.5 t). Catches were 14-17% above the respective OT's at the Airport, Mallacoota Central, Mallacoota East and Mallacoota Small SMU's.

Declines in standardised CPUE were seen at all temporal scales for the Eastern Zone (Table 3). The Marlo SMU showed the greatest declines in CPUE at each of the three temporal scales. Declines in CPUE were seen at all SMUs in the last 4 years except for Mallacoota Large.

Table 3 also defines SMUs by their size defined by their contribution to the catch (VFA 2018). Large SMUs are defined as those where total catches accounted for > 15% of the TACC, medium SMUs are defined as those where total catches accounted for 10-15% of the TACC, and small SMUs are defined as those where total catches accounted for <10% of the TACC.

In 2023/24, the Airport contributed 34.2% of the total catch, which was the highest proportional contribution of any SMU in the fishery's history. Mallacoota Central was the second highest contributor (19.1%) followed by Marlo (16.9%) which continues to decline in its contribution. Mallacoota East (10.7%) was the only Medium SMU. Mallacoota West joined Mallacoota Large and Mallacoota Small as Small SMU's in 2023/24, with each producing similar catch levels. The following sections of the report present data and assessments of each SMU, ranked in order from the largest to the smallest contributors to catch.

Table 3: Performance measures used in the assessment of the Eastern Zone abalone fishery at the SMU scale (Zone totals repeated for reference).

Spatial Management Unit (SMU)	Catch				Standardised CPUE		
	Total Catch 2023/24		OT (t)	SMU Category	Long-term (2003/04)	Short-term (2009/10)	4 years (2019/20)
	(t)	(%) TACC					
Airport	97.3	34.2	85	Large	15	9	-1
Mallacoota Central	54.3	19.1	46.4	Large	3	-10	-2
Marlo	48.0	16.9	71.5	Large	-18	-27	-18
Mallacoota East	30.5	10.7	26.2	Medium	1	-13	-9
Mallacoota Large	18.8	6.6	18.5	Small	9	-5	7
Mallacoota West	18.1	6.4	21.5	Small	-3	-14	-1
Mallacoota Small	17.7	6.2	15.5	Small	-5	-11	-13
Eastern Zone	284.5	100.0	284.6		-3	-11	-6

Notes: Coloured shading indicates whether catch has been caught within the OT, Threshold or exceeded the Limit. Green (within OT range) indicates catch was <±15% of the OT, Yellow (within threshold range) indicates catch was ±15-30% OT, Red (exceeding limit range) indicates catch was >±30% of the OT for the 2018/19 quota year. SMU catch categories (% of zone catch): Large ≥ 15%, Medium 10-15%, Small < 10%.

3.2.2 Distribution of the catch

The distribution of catch by SMU in the Eastern Zone has been relatively stable since 2003 (Figure 8). The greatest contributions have traditionally come from the Airport and Marlo SMUs, which have both been consistently high in annual catch. Mallacoota Central and Mallacoota West were both significant contributors to total catch during the 2000s, with recent catches higher from Mallacoota Central. The Mallacoota Large and Mallacoota Small SMUs have always been the lowest contributors, with total catches variable over time.

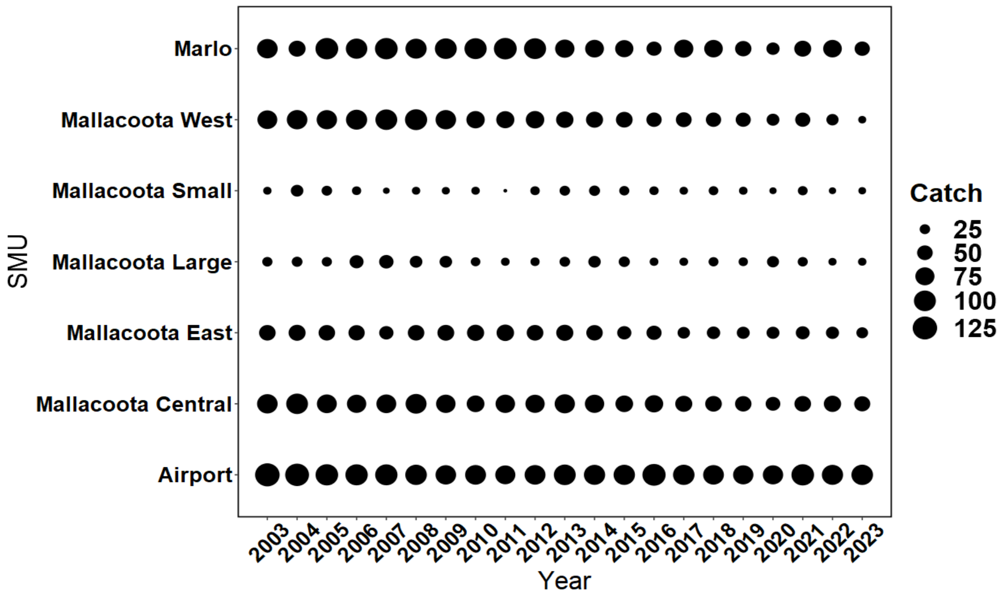


Figure 8: Relative distribution of catch at each SMU in the Eastern Zone by quota year.

3.2.3 Draft Harvest Strategy outputs

The full Draft Harvest Strategy results are published in a separate report for the Eastern Zone fishery. Tables 4 and 5 provide a summary of results to inform the TACC setting process. Current CPUE is above the Target at the Airport SMU, and between the Threshold and Target levels at all other SMUs (Table 4). CPUE has been above the Threshold level at all SMUs for at least 31 years, meaning that following the harvest strategy, an "Increasing" SMU result could allow an increase in catch up to 25%. Catch Control Rule (CCR) 1 applies for all SMUs.

As in previous reports, these results use reference points based on standardised CPUE, whereas the original reference points were based on nominal CPUE. The nominal CPUE reference points are more conservative, however the only difference that results would be that the Airport SMU reduces from "Above Target" to "Above Threshold". This makes no material difference to the outcomes.

Table 4: Reference points for Eastern Zone SMUs, mean annual CPUE from 2018 - 2023 and applicable catch control rules (CCR).

SMU	Limit RP	Threshold RP	Target RP	2018	2019	2020	2021	2022	2023	Current Status	Years above Threshold	CCR
Airport	50	70	100	105.8	118.2	110.9	104.8	105.0	109.9	Above Target	31	1
Mallacoota Central	50	70	100	101.1	109.5	91.8	98.6	92.5	90.1	Above Threshold	31	1
Mallacoota East	40	60	110	101.2	106.7	98.9	107.4	98.7	90.4	Above Threshold	35	1
Mallacoota Large	40	60	100	90.8	100.3	87.5	93.0	86.1	93.2	Above Threshold	36	1
Mallacoota Small	50	70	100	105.7	110.7	101.6	106.5	91.6	88.9	Above Threshold	31	1
Mallacoota West	50	70	110	103.8	119.8	91.6	99.5	90.3	90.7	Above Threshold	32	1
Marlo	50	70	130	127.5	126.4	110.4	117.2	109.3	90.8	Above Threshold	33	1

The Final Category for the Airport, Mallacoota Central, Mallacoota Large and Mallacoota West SMUs were assessed as Stable (Table 5). The Mallacoota East, Mallacoota Small and Marlo SMUs were assessed as decreasing. While the 4-year gradient was negative at all SMUs, only the Mallacoota Small and Marlo SMU's had a decreasing Primary Indicator. There were no FIS data to inform the Tertiary Indicator. The suggested total catch range for the Eastern Zone was 191.8 t to 212.6 t.

Table 5: Harvest Strategy results for Eastern Zone SMUs, with suggested target catch ranges.

SMU	4yr gradient	Primary Indicator	2yr ratio (% change)	Secondary Indicator	Primary Category	Tertiary Indicator	Final Category	2024/25 Target Catch (OT, t)	Total catch, Lower (t)	Total catch, Upper (t)
Airport	-0.27	Stable	4.6	Stable	Stable	NA	Stable	80.0	76.0	84.0
Mallacoota Central	-1.21	Stable	-2.6	Stable	Stable	NA	Stable	34.8	33.1	36.5
Mallacoota East	-3.31	Stable	-8.4	Decreasing	Decreasing	NA	Decreasing	19.7	16.7	18.7
Mallacoota Large	1.18	Stable	8.3	Increasing	Stable	NA	Stable	18.5	17.6	19.4
Mallacoota Small	-5.06	Decreasing	-3.0	Stable	Decreasing	NA	Decreasing	7.8	6.6	7.4
Mallacoota West	-1.26	Stable	0.4	Stable	Stable	NA	Stable	12.0	11.4	12.6
Marlo	-5.72	Decreasing	-17.0	Decreasing	Decreasing	NA	Decreasing	35.8	30.4	34.0
Total								208.6	191.8	212.6

3.2.4 Airport SMU (Large SMU)

The Airport SMU continued to be the most important Eastern Zone SMU in terms of total catch with 97.3 t harvested in 2023/24 representing 34.2% of the TACC (Table 3) and 34.2% of the zone catch (Table 6). The total catch for 2023/24 was 14.5% above the OT. Standardised CPUE in 2023/24 was 15% higher than 2003/04 and 9% higher than 2009/10.

Table 6: Summary of Catch, Optimum Targets and Performance Indicators for the Airport SMU.

Catch					Long-term indicators CPUE 2003/04 – 2023/24 Abundance 2003-2023			Short-term indicators CPUE 2009/10 – 2023/24 Abundance 2009-2023		
2023/24		OT (t)			CPUE	Pre-recruits	Recruits	CPUE	Pre-recruits	Recruits
(t)	(%)	22/23	23/24	24/25						
97.3	34.2	85.0	85.0	80.0	15	NA	NA	9	NA	NA
LML = 110/120 mm			Mean daily catch=406 kg							

The Airport is an important contributor to the Eastern Zone TACC, with an average catch of 93 t since 1979 and 95 t since 1988 and a peak catch of 126 t taken during 2003 when Marine Parks were first implemented (Figure 8). Since the introduction of quota, catches have been generally stable from this SMU, with a low catch of 76 t in 1998. The 2023/24 catch of 97.3 t was around the long-term average. The catch of 106.6 t in 2021/22 was the second highest catch since 2004/05 and was the fourth highest catch for the Airport SMU in the last 30 years. The OT for 2024/25 was reduced by 5 t to 80.0 t.

Mean daily catch ranged from 400 to 500 kg/day from 1979 to 2019 (Figure 9). Mean daily catch, which is impacted by market forces, reached a historic low in 2020 but has increased thereafter.

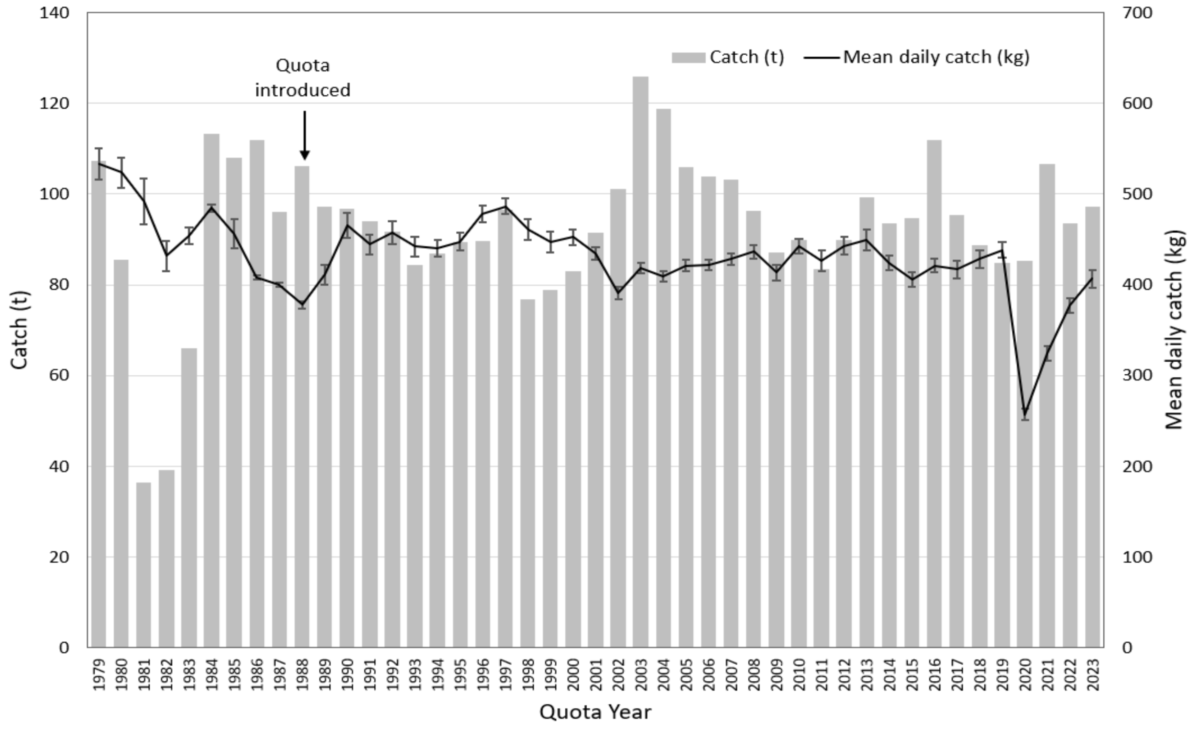


Figure 9: Total catch and mean daily catch for the Airport SMU from 1979 to 2023.

Nominal CPUE generally increased from 1992 to 2012, declined to 2017 before increasing to a historic peak of 125 kg/hr in 2019 (Figure 10). Standardised CPUE has shown similar annual trends between years, but has reduced over time relative to nominal CPUE.

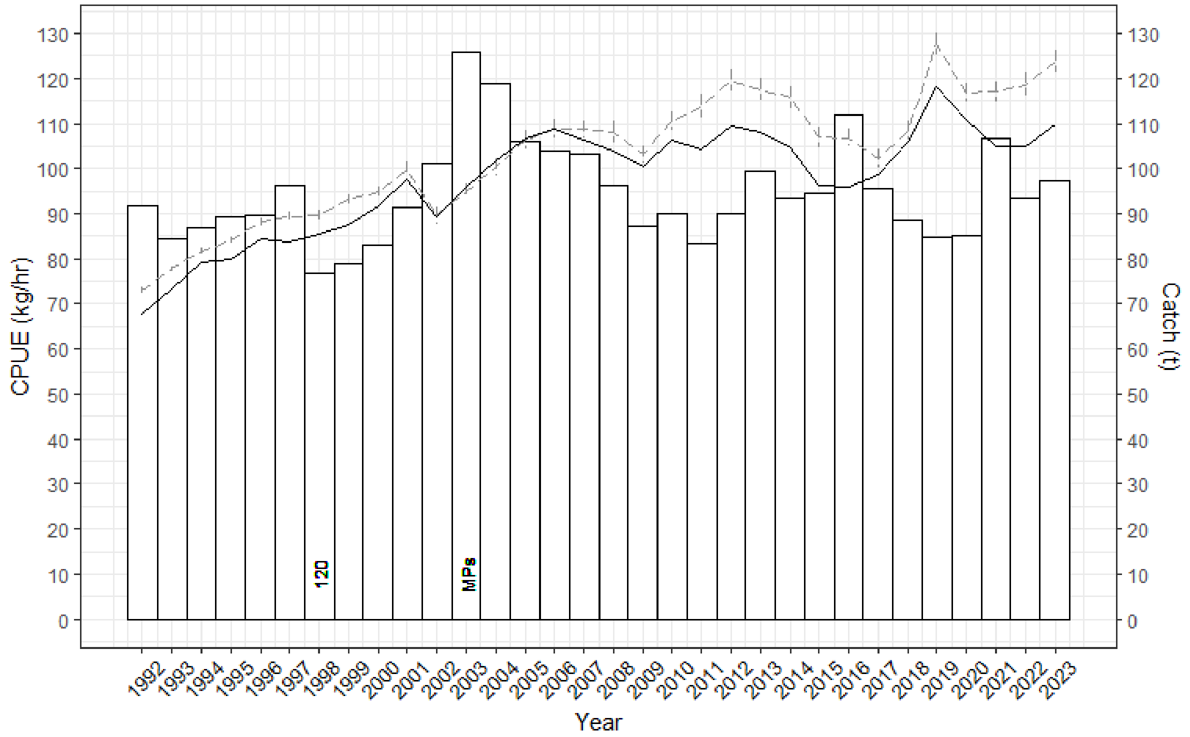


Figure 10: Airport SMU catch, and CPUE (nominal and standardised) from 1992/93 – 2023/24. Catch = bars, nominal CPUE = grey series (+/- SE), unadjusted standardised series = black. Numbers in bars indicate changes to LMLs. MPs = introduction of Marine Parks.

Table 7: Catches (kg) by reefcode for the Airport SMU from 2018/19 to 2023/24, the five-year average catch from 2018/19 to 2022/23, and the OT for 2023/24.

Reefcode	2018/19	2019/20	2020/21	2021/22	2022/23	5-yr average	2023/24	OT	Difference (kg)
24.21 Quarry Beach / Betka	40319	38550	24373	40805	43676	37545	48186	37000	11186
24.10 Little Rame Lee	21643	25434	19142	22988	18483	21538	29639	23000	6639
24.16 Gabo Harbour	11087	9343	18415	17235	13629	13942	7761	13000	-5239
24.15 Tullaberga	9173	4274	11457	13037	11956	9979	6108	6000	108
24.11 Shipwreck	6557	7184	11797	12540	5809	8777	5556	6000	-444

The Airport SMU comprises five reefcodes each of which have contributed substantially to the Airport SMU catch in the last six years (Table 7). Catches in 2023/24 were above the previous 5-year average at Quarry Beach / Betka and Little Rame Lee reefcodes and well below the previous 5-year average at all other reefcodes. The catch from Quarry Beach / Betka and Little Rame Lee reefcodes was 30% and 29% above the suggested OT, respectively, while the catch from Gabo Harbour was 40% below the suggested OT.

FIS data were not collected during 2022. The trends from the “all sites” data series (grey dashed) are difficult to interpret because of changes in sites over time. The standardised abundance of recruit sized abalone at the two Airport SMU Top 15 sites declined substantially from 2003 to 2007 (Figure 11). Standardised abundance generally increased from 2007 to 2020 but has declined thereafter and was at its lowest levels in 2023.

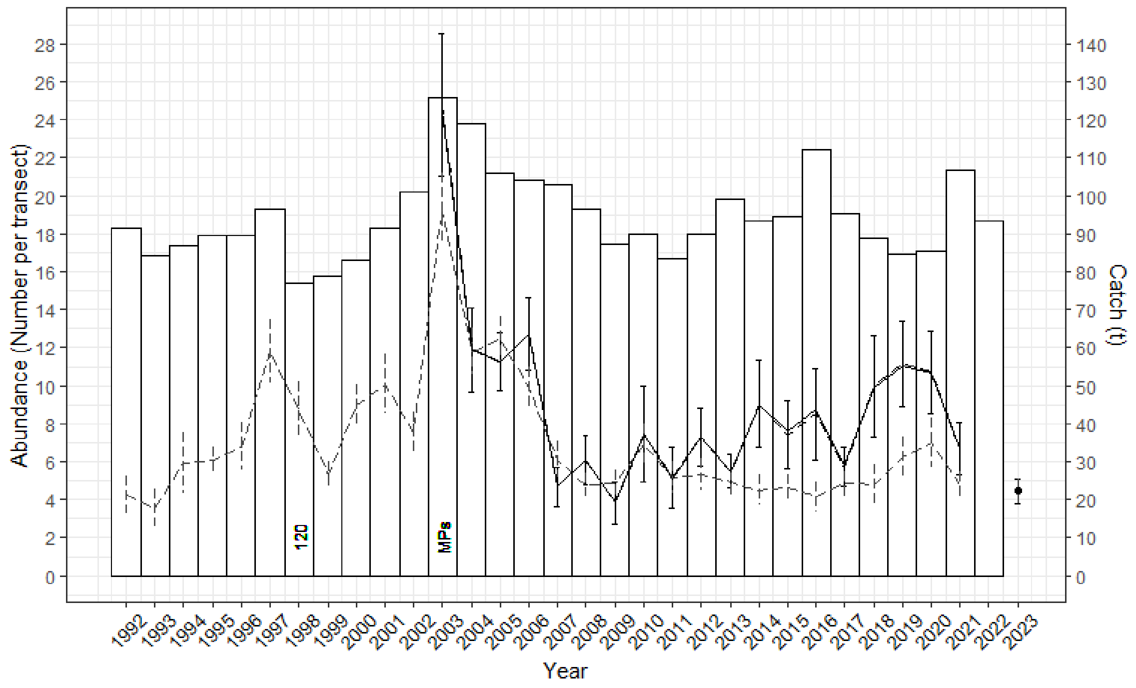


Figure 11: Recruit abundance and catch from 1992/93 – 2022/23 for the Airport SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the two Top 15 sites located within the Airport SMU.

Standardised pre-recruit abundance at the two Top 15 sites declined from 2003 to 2021 before increasing slightly in 2023 to the levels observed in 2011 and 2013 (Figure 12).

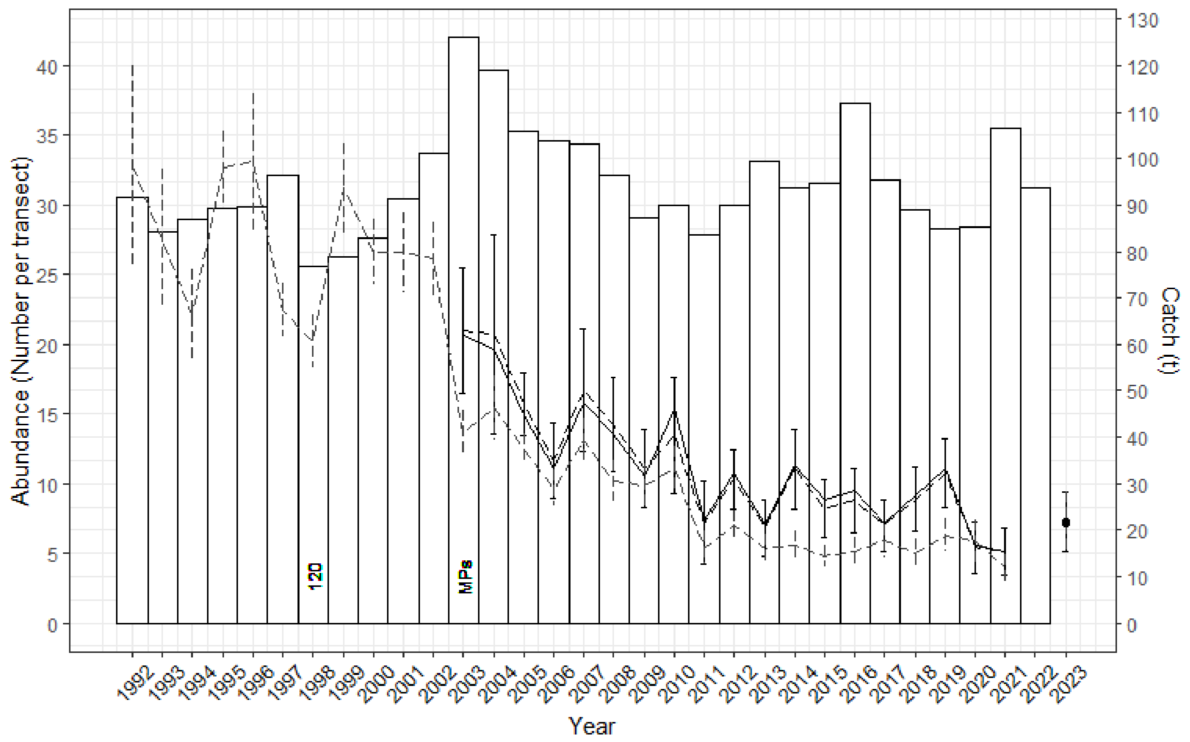


Figure 12: Pre-recruit abundance and catch from 1992/93 – 2022/23 for the Airport SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the two Top 15 sites located within the Airport SMU.

FIS length frequency data

As described in 2.1.3, length-frequency data gathered during FIS from collections at the end of each transect are biased toward the collection of larger abalone relative to the data gathered on transects within pre-recruit and recruit categories. Length frequency distributions and associated statistics are provided in Appendix 4 for (a) all sites and (b) Top 15 sites. The following summary (and for all other SMUs) is based on the “all data” time series.

As FIS abundance has declined at the Airport SMU, the size structure of the surveyed population remained relatively stable. Modal size was 105-109 or 110-114 in most years, although this more variable as FIS abundance declined. Mean size ranged from 104 to 110 mm without clear trends. The percentage of abalone above the LML (LML) of 120 mm has ranged from 14% to 28%. This is a low proportion of the population above the 120 mm LML compared to other SMUs however it must be noted that some areas of the Airport are fished at 110 mm LML (but here we have analysed the statistics against the more conservative size limit for comparison with other SMUs).

Commercial length frequency data

Commercial length frequency distributions are provided in Appendix 5.

The size structure of the commercial catch at the Airport SMU has also remained relatively stable since 2010/11. Mean size has been relatively consistent, ranging from 121 – 124 mm. The modal size was 120-124 mm in all years except 2010/11 and 2018/19 where the modal size was 115-119 mm. The interpretation of these data is complicated by a mixture of size limits applicable in this SMU (110 and 120 mm). Samples sizes were above 1000 shells measured in all years except 2015/16 (251 measured). There were no data available from 2019/20.

Summary

The Airport SMU has maintained high catches since 1984 and remains the highest producing SMU in the Eastern Zone. The 2023/24 catch (97.3 t) was above the historic average (93 t). The catch was 14.5% above the OT. Catches in 2023/24 were above the previous 5-year average at Quarry Beach / Betka and Little Rame Lee reefcodes and well below the previous 5-year average at all other reefcodes. The catch from Quarry Beach / Betka and Little Rame Lee reefcodes was 30% and 29% above the suggested OT, respectively, while the catch from Gabo Harbour was 40% below the suggested OT. Mean daily catch has increased in the last three years after the low in 2020. Standardised CPUE has slightly increased in the last three years as well. The OT was reduced for 2024/25 from 85 to 80 t.

Recruit abundance from all sites peaked in the early 2000s, while pre-recruit abundance was high in the early 1990s and has declined over time. While both measures are currently low relative to historic levels, both measures were relatively stable between 2011 and 2021. Size frequency data from FIS and commercial catch sampling indicate stability in the size structure of the population.

Harvest Strategy outcomes in 2023 were driven only by trends in the last four years of commercial CPUE. For the Airport SMU, mean CPUE was above the Target level in the Draft Harvest Strategy and has been above the Threshold level for 30 consecutive years (Table 4). The Primary Indicator (4-year gradient) was Stable and the Secondary Indicator (ratio between years) was Stable, which gave a Stable Primary Category (Table 5). The Tertiary Indicator was not available, resulting in a Stable Final Category for the Airport SMU. The OT for 2023/24 was 80 t, and the results of the Harvest Strategy suggested an OT ranging from 76 to 84 t.

Catches in recent years remain high in an historic context, which differs to all other parts of the fishery that have shown declines in biomass and catch. Despite these relatively high catches, CPUE has increased in recent years. Notably, the OT was reduced from 85 to 80 t for the 2023/24 season. While there is no direct evidence from the data that further reductions are required, diver observations will be critical in determining the OT for the Airport SMU.

3.2.5 Mallacoota Central (Large SMU)

The Mallacoota Central SMU was the second highest SMU in terms of total catch with 54.3 t harvested in 2023/24 representing 19.1% of the TACC (Table 3) and 19.1% of the zone catch (Table 8). The 2023/24 catch was 17% above the Optimum Target of 46.4 t. Standardised CPUE in 2023/24 was 3% higher than in 2003/04 and 10% lower than 2009/10.

Table 8: Summary of Catch, Optimum Targets and Performance Indicators for the Mallacoota Central SMU.

Catch					Long-term indicators CPUE 2003/04 – 2023/24 Abundance 2003-2023			Short-term indicators CPUE 2009/10 – 2023/24 Abundance 2009-2023		
2023/24		OT (t)			CPUE	Pre-recruits	Recruits	CPUE	Pre-recruits	Recruits
(t)	(%)	22/23	23/24	24/25						
54.3	19.1	57.0	46.4	34.8	3	NA	NA	-10	NA	NA
LML = 125 mm			Mean daily catch=351 kg							

The Mallacoota Central SMU is an important contributor to the Eastern Zone TACC with an average catch of 80 t since 1979 and 78 t since 1988, and a peak catch of 104 t taken during 1985 (Figure 13). Catches generally ranged from 60 to 100 t per year from 1979 to 2016 before declining to 44 to 59 t since 2017. Notably, the OT for 2024/25 has been reduced to 34.8 t.

Since the introduction of quota, mean daily catch has ranged from 267 to 473 kg/day with an average of 417 kg/day. Mean daily catch has been affected by market forces since 2020.

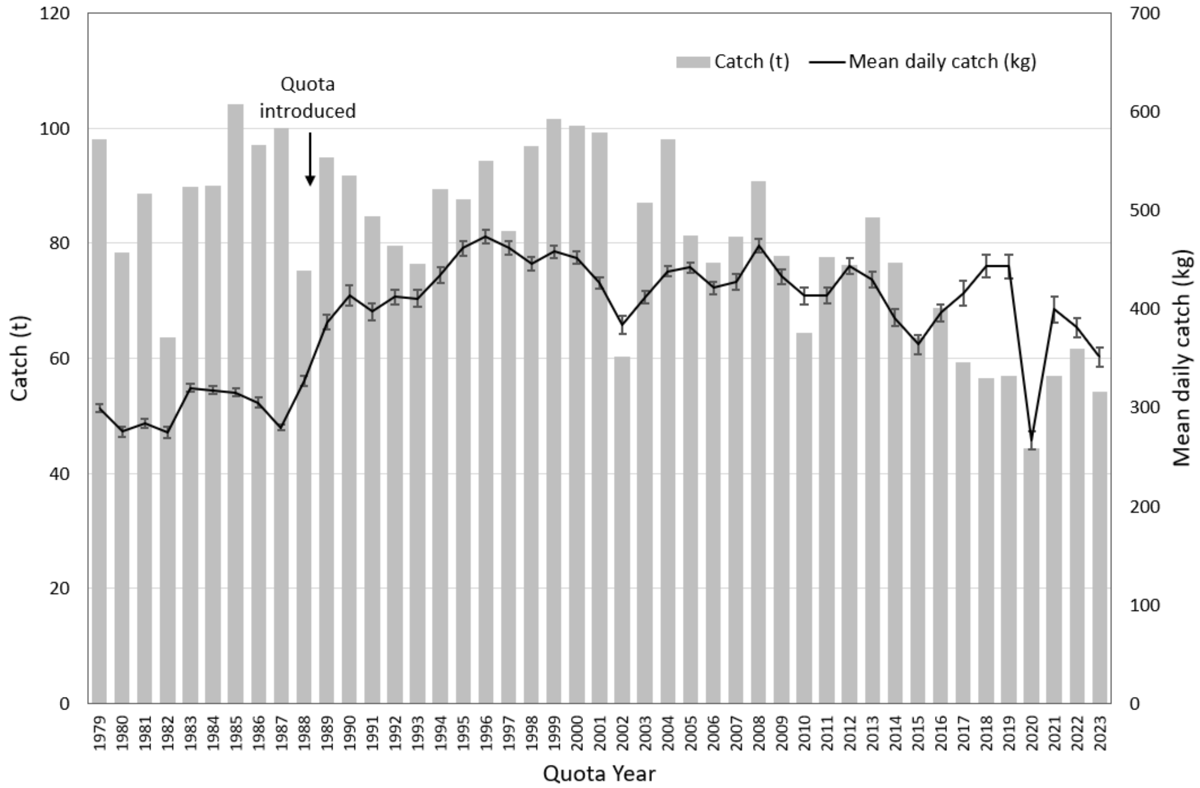


Figure 13: Total catch and mean daily catch for the Mallacoota Central SMU from 1979 to 2023.

Nominal CPUE generally increased from 1992 to reach a peak of 119 kg/hr in 2012 before declining to 90 kg/h in 2016 (Figure 14). Nominal CPUE ranged from 98 to 107 kg/h thereafter and has been stable the last three years. Albeit slightly lower, standardised CPUE has followed similar trends to nominal CPUE, however in the last three years the departure between the two measures has increased.

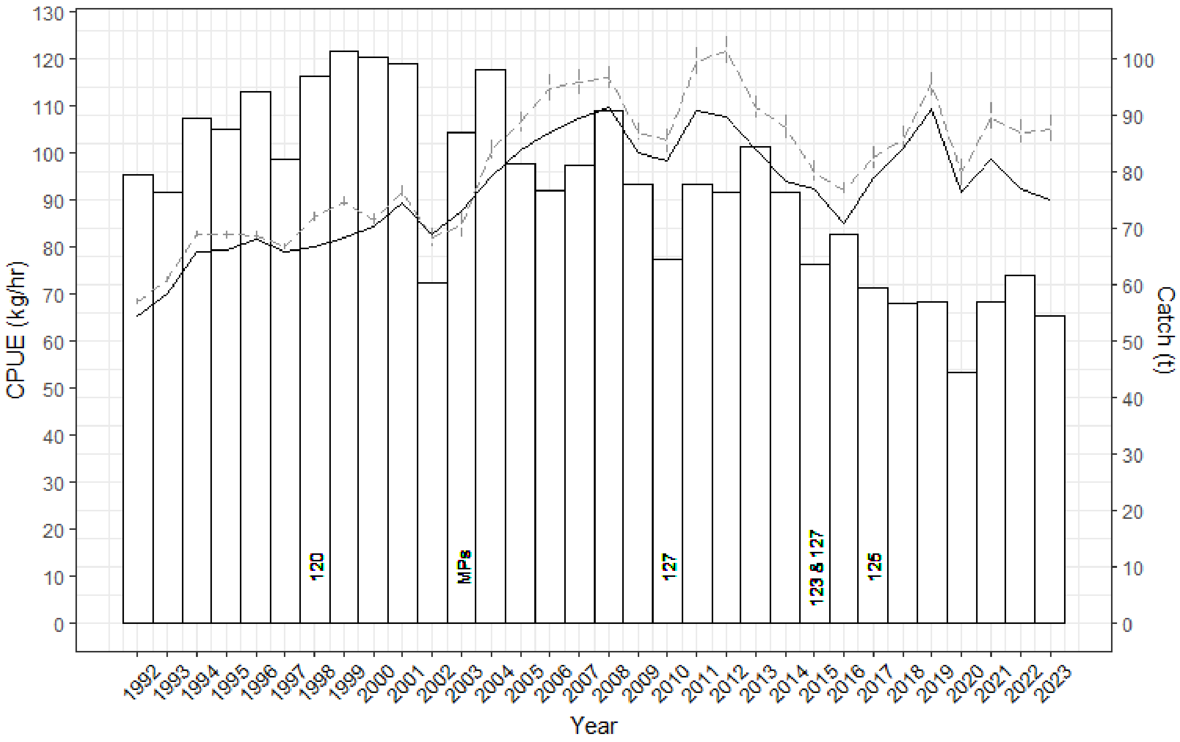


Figure 14: Mallacoota Central SMU catch, and CPUE (nominal and standardised) from 1992/93 – 2023/24. Catch = bars, nominal CPUE = grey series (+/- SE), standardised series = black. Numbers in bars indicate changes to LMLs. MPs = introduction of Marine Parks.

Table 9: Catches by reefcode for the Mallacoota Central SMU from 2018/19 to 2023/24, the five-year average catch from 2018/19 to 2022/23, and the OT for 2023/24.

Reefcode	2018/19	2019/20	2020/21	2021/22	2022/23	5-yr average	2023/24	OT	Difference (kg)
24.07 Sandpatch Lee	32420	31395	25025	25403	28375	28524	29259	24000	5259
24.06 Sandpatch Point	16809	15844	10524	20367	22806	17270	16253	14400	1853
24.08 Benedore	6508	8453	8283	10327	9486	8611	8204	7000	1204
24.04 Red River	837	1325	616	912	1074	953	598	1000	-402
24.05 Secret Reef	0	0	0	0	0	0	0	0	0

The Mallacoota Central SMU comprises five reefcodes however only three reefcodes contribute substantially to the annual catch (Table 9). Sandpatch Lee produces the highest catch, with Sandpatch Point around half of that catch and Benedore half of that catch again. In 2023/24, catches were around 5 t (22%) above the OT at Sandpatch Lee.

The FIS trends from the “all sites” data series (grey dashed) are difficult to interpret because of changes in sites over time. The standardised abundance of recruits at the three Top 15 sites has been highly variable since 2003 displaying a general decline (Figure 15). The standardised abundance in 2023 was the lowest recorded.

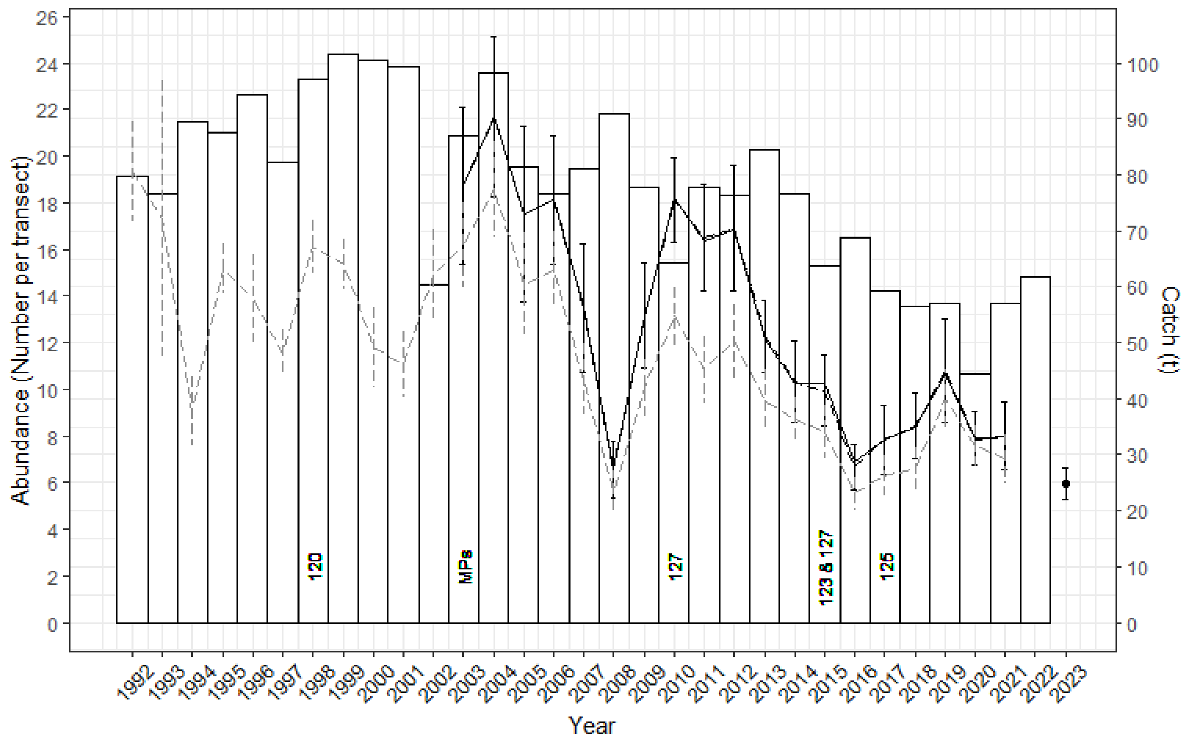


Figure 15: Recruit abundance and catch from 1992/93 – 2022/23 for the Mallacoota Central SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the three Top 15 sites located within the Mallacoota Central SMU.

Standardised pre-recruit abundance at the three Top 15 sites generally declined from 2003 to 2011 and has remained relatively stable thereafter (Figure 16).

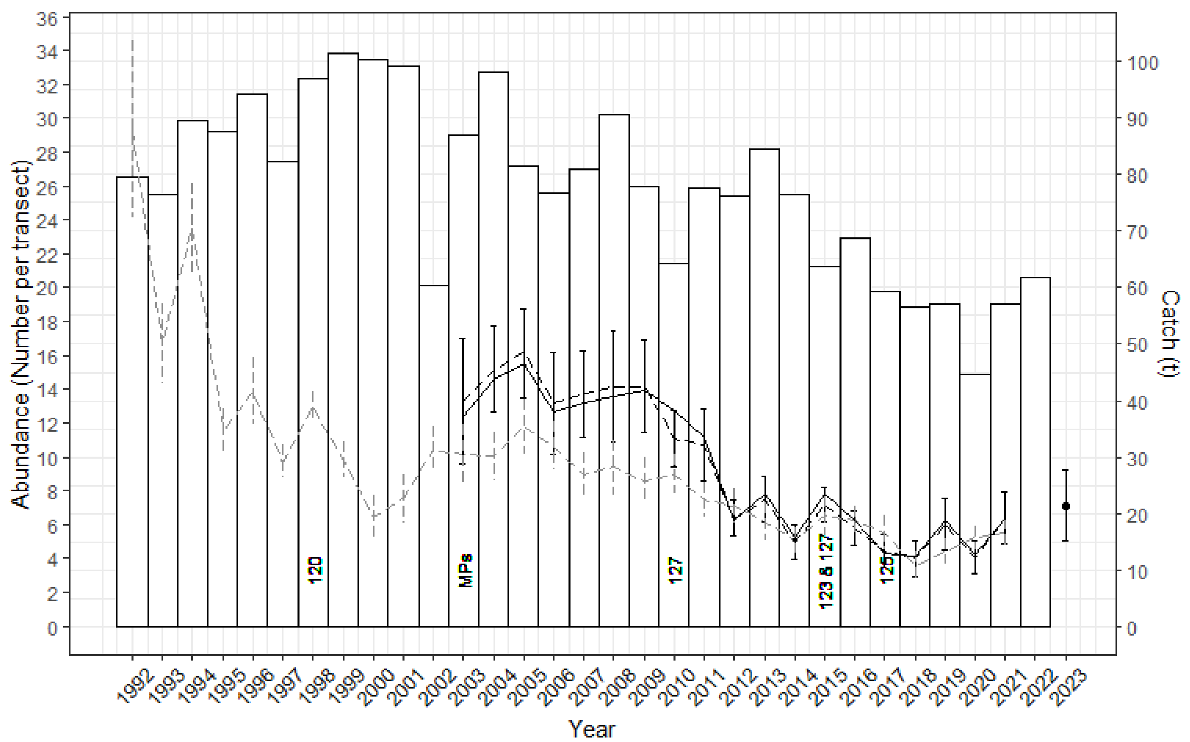


Figure 16: Pre-recruit abundance and catch from 1992/93 – 2022/23 for the Mallacoota Central SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the three Top 15 sites located within the Mallacoota Central SMU.

FIS length frequency data

The size structure of the population at Mallacoota Central has been variable since 2003 (Appendix 4). From 2003 to 2010 the mean size was generally stable from 117 to 118 mm, with the proportion above the LML being 37 to 40%. From 2011 to 2014, mean size increased to 120 to 123 mm and the proportion above LML ranged from 43 to 55%, before declining rapidly to 114 mm and 32% above LML in 2016. In the last five years the mean size (range 119 to 124 mm) and the proportion above LML (range 48 to 59%) have been variable.

Commercial length frequency data

From 2010/11 to 2016/17 a strong modal size class of 130-134 mm was present in the sampled commercial catch in all years (Appendix 5). From 2010/11 to 2013/14, the proportion of abalone just above the size limit (i.e. 125-129 mm size class) was generally around half of the modal size class. However, in 2016/17 22% of the catch was in the 125-129 mm size class compared to 28% in the 130-134 mm size class, and in 2018/19 the proportions in the sampled catch were equal (both 25%). It is unclear how reductions in size limits in 2014/15 and 2016/17 have affected these samples. No data are available from 2019/20. Higher numbers of shells sampled would increase the certainty in this measure in future years.

Summary

The Mallacoota Central SMU has contributed an average of 79 t to the Eastern Zone TACC since the introduction of quota. Following a peak catch of 102 t taken during 1999, catches have generally declined thereafter. Catches in the last 7 years have been among the lowest observed despite size limit reductions in 2015 and 2017. Three of the five reefcodes in the Mallacoota Central SMU produce most of the SMU catch. In 2023/24, catches were around 5 t (22%) above the OT at Sandpatch Lee. CPUE has declined since 2019. The OT in 2023/24 was reduced by around 10 t, however the total catch exceeded the OT by 8 t. It is noted that the OT was further reduced for 2024/25 from 46.4 to 34.8 t.

Recruit and pre-recruit abundances from all sites declined substantially from 2003 to 2021. Recruit abundance from the two Top 15 sites was the lowest observed in 2023, while pre-recruit abundance increased slightly at these sites. Despite declines in abundance, the length frequency distributions from FIS showed no clear trends over time. Commercial catch sampling data up to 2018/19 suggested that a higher proportion of abalone were being harvested close to the LML, however this may have been affected by reductions in size limit.

For the Mallacoota Central SMU, mean CPUE was above the Threshold level in the Draft Harvest Strategy, and it has been above the Threshold level for 31 consecutive years (Table 4). The Primary Indicator was Stable and the Secondary Indicator was Stable, which gave a Stable Primary Category (Table 5). The Tertiary Indicator was not available, resulting in a Stable Final Category for the SMU. The OT for 2023/24 was 34.8 t, and the results of the Harvest Strategy suggest an OT from 33.1 to 36.5 t.

CPUE has declined since 2019. While abundance at FIS sites has declined substantially from an historic perspective, recruit and pre-recruit abundance appear to have stabilized in recent years. **While the OT was reduced by around 10 t for 2023/24, catches were 8 t (17%) over the OT. The OT was further reduced by around 11 t for 2024/25. While there is no clear evidence to suggest that the OT needs further reductions, diver observations will be critical in determining the status of the Mallacoota Central SMU.**

3.2.6 Marlo (Large SMU)

The Marlo SMU was the third highest contributor to the Eastern Zone total catch with 48.0 t harvested in 2023/24 representing 16.9% of the TACC (Table 3) and 16.9% of the zone catch (Table 10). The catch was 33% below the Optimal Target of 71.5 t. In 2023/24, standardised CPUE was 18% lower than 2003/04 and 27% lower than 2009/10.

Table 10: Summary of Catch, Optimum Targets and Performance Indicators for the Marlo SMU.

Catch					Long-term indicators CPUE 2003/04 – 2023/24 Abundance 2003-2023			Short-term indicators CPUE 2009/10 – 2023/24 Abundance 2009-2023		
2023/24		OT + carryover* (t)			CPUE	Pre-recruits	Recruits	CPUE	Pre-recruits	Recruits
(t)	(%)	22/23	23/24	24/25						
48.0	16.9	91.0*	71.5	35.8	-18	NA	NA	-27	NA	NA
LML = 125 mm			Mean daily catch=370 kg							

The Marlo SMU has been a historically important contributor to the Eastern Zone TACC, with an average catch of 68 t since 1979 and 67 t since 1988 (Figure 17). Since the introduction of quota, catches increased from 1990 to 2005 and from 2005 to 2012 catches averaged 102 t per year, with a peak catch of 109 t taken during 2011. Catch declined steadily thereafter, reaching 47 t in 2016. Following a decrease in LML in 2017, catches returned to around 70 t in 2017 and 2018 before reducing again in 2019. The 2020/21 catch of 36 t was the lowest recorded, with catch increasing to 58.7 t in 2021/22 and 72.6 t in 2023/24 before decreasing to 48.0 t in 2023/24. Notably, the OT for 2024/25 has been halved to 35.8 t.

Mean daily catch ranged from 417 to 499 kg/day between 1990 and 2019 before dropping to 269 kg/day in 2020. Mean daily catch has been affected by market forces since 2020.

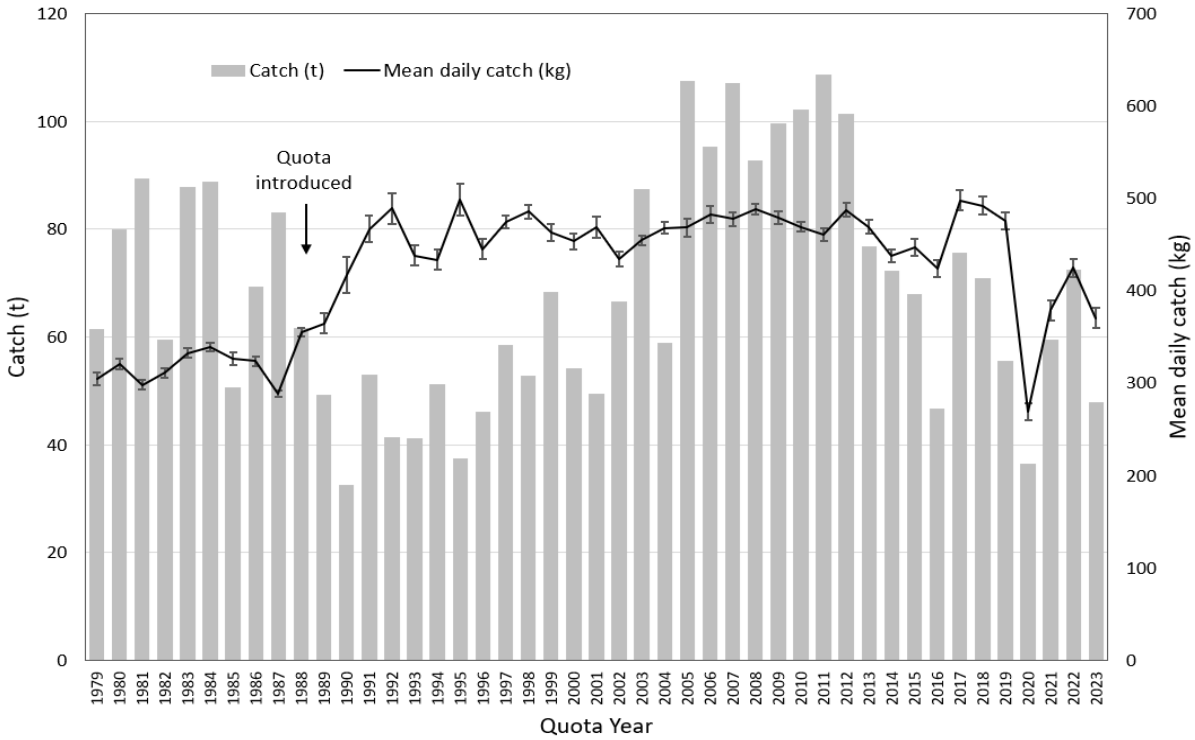


Figure 17: Total catch and mean daily catch for the Marlo SMU from 1979 to 2023.

Nominal CPUE generally increased from 1992 to 2011, reaching a peak of 131 kg/hr before declining to 100 kg/h in 2016 and increasing again until 2018 (Figure 18). Nominal CPUE has declined substantially thereafter, decreasing by 28% in the last 5 years. Standardised CPUE has followed the nominal trends since 2011.

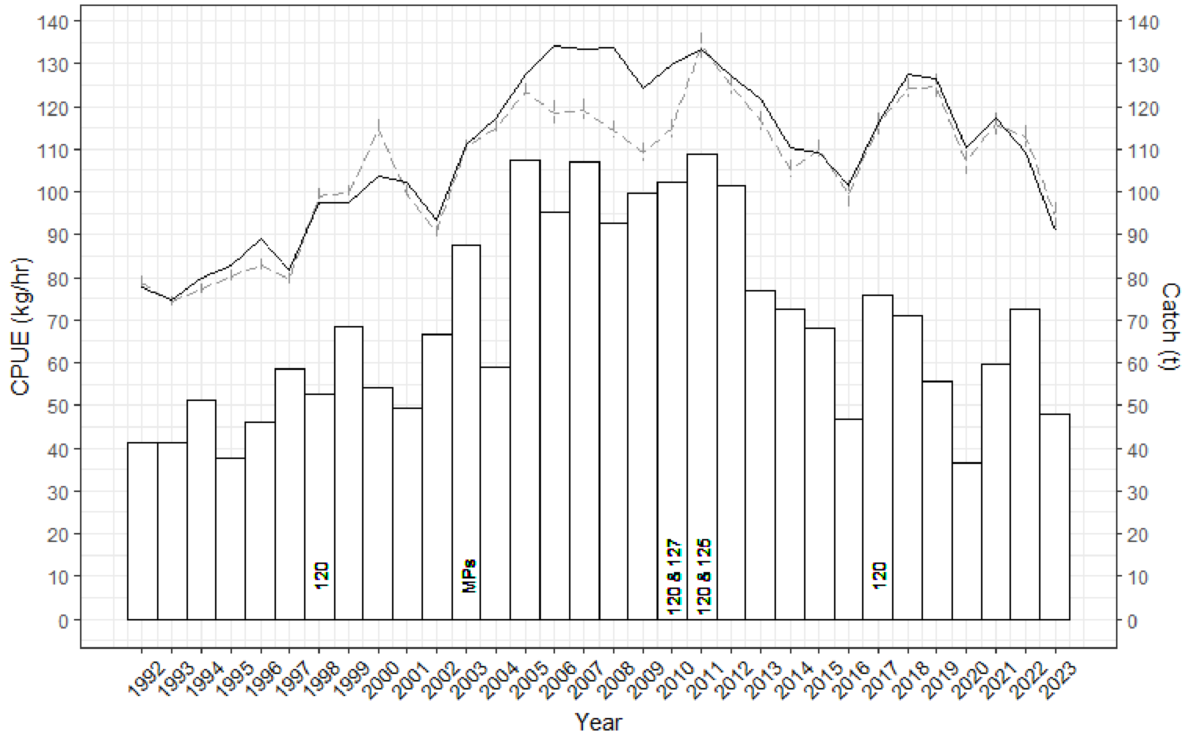


Figure 18: Marlo SMU catch, and CPUE (nominal and standardised) from 1992/93 – 2023/24. Catch = bars, nominal CPUE = grey series (+/- SE), standardised series = black. Numbers in bars indicate changes to LMLs. MPs = introduction of Marine Parks.

Table 11: Catches by reefcode for the Marlo SMU from 2018/19 to 2023/24, the five-year average catch from 2018/19 to 2022/23, and the OT for 2023/24.

Reefcode	2018/19	2019/20	2020/21	2021/22	2022/23	5-yr average	2023/24	OT	Difference (kg)
22.08 Pearl Point	15580	13072	8453	21288	16607	15000	15449	20000	-4551
22.04 Cape Conran	20501	14859	9312	15116	14906	14939	13385	15000	-1615
22.05 East Cape	13794	11033	11845	13877	23516	13052	8459	17000	-8541
22.03 Point Ricardo	5700	5889	1877	3402	6836	4741	6528	5000	1528
22.06 Yeerung Reef	8032	7475	3578	4129	5351	5713	3011	8000	-4989
22.02 Frenches	7285	3329	1316	1687	4761	3676	946	6500	-5554
22.10 Clinton Rocks	0	0	0	0	352	70	191	0	191
22.09 Tamboon	0	0	0	0	113	23	0	0	0
23.01 Point Hicks	0	0	49	0	110	32	0	0	0
22.01 Marlo	0	0	0	0	0	0	0	0	0

The Marlo SMU comprises ten reefcodes however only six reefcodes contribute meaningful annual catches (Table 11). The overall Marlo SMU catch was well below the OT, and this was reflected at all reefcodes except Cape Conron and Point Ricardo. Catches were particularly low at East Cape (50% of the OT), Yeerung Reef (62% below the OT) and Frenches (85% below the OT).

The FIS trends from the "all sites" data series (grey dashed) are difficult to interpret because of changes in sites over time. Standardised abundance from the four Top 15 sites declined substantially from 2003 to 2006 and have been generally stable thereafter.

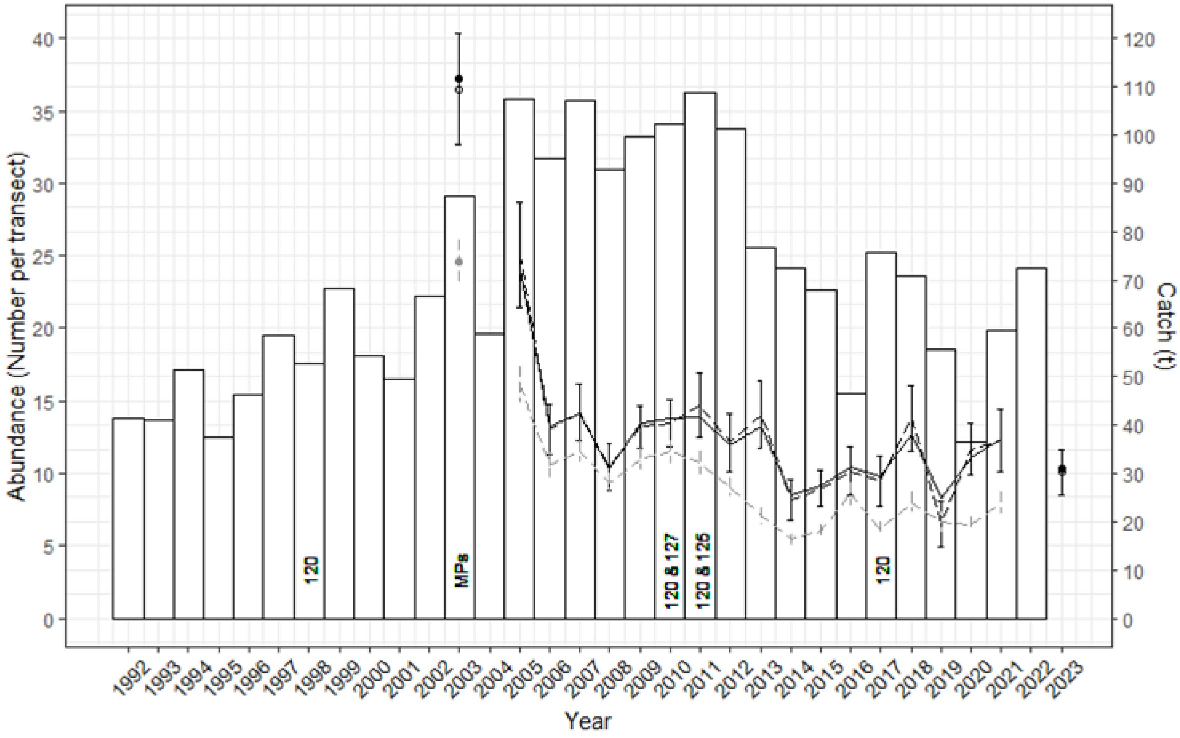


Figure 19: Recruit abundance and catch from 1992/93 – 2022/23 for the Marlo SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the four Top 15 sites located within the Marlo SMU.

The standardised abundance of pre-recruits at the four Top 15 sites has been highly variable since 2003. The standardised abundance in 2023 was around 15 abalone per transect, which was above the long-term average of 12 abalone per transect.

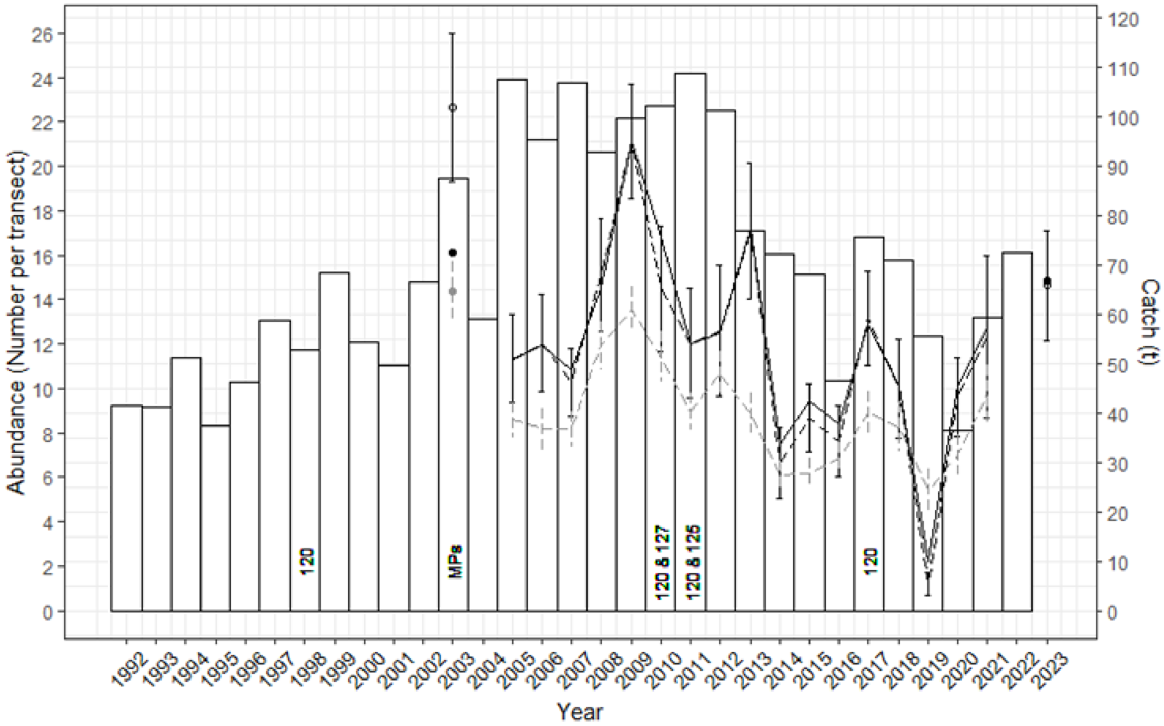


Figure 20: Pre-recruit abundance and catch from 1992/93 – 2022/23 for the Marlo SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the four Top 15 sites located within the Marlo SMU.

FIS length frequency data

From 2005 to 2007, the Marlo SMU surveyed population contained a high proportion of large abalone, with mean size ranging from 120 to 122 mm, modal size of 125-129 mm and a proportion above the LML of 61 to 64% (Appendix 4). While densities remained high until 2012, mean size declined (115 to 119 mm) and the proportion above the LML also decreased (range 50 to 55%). Since 2013 total abundance has declined, mean size has ranged from 115 to 119 mm, modal size has been 120-124 mm or below in all years and the proportion above the LML has ranged from 45 to 57%. While there appeared to be a relatively high proportion of abalone <70 mm in 2019, this did not appear to result in a distinct cohort in 2020 reflective of a strong recruitment pulse nor was there a substantial increase in pre-recruit abundance.

Commercial length frequency data

In 2010/11 and 2011/12, the size structure of the commercial catch primarily comprised abalone in the 125-129 mm and 130-134 mm size classes, well above the size limit of 120 mm (Appendix 5). However, in 2017/18 and 2018/19, a much higher proportion of abalone sampled were in the 120-124 mm size class, immediately above the LML, resulting in a decline in the mean size to 131 and 129 mm, respectively. It is not clear whether these trends were affected by changes in size limits in recent years, or whether this pattern reflects more knife-edge selection. It should be noted that the sample sizes were smaller from these years and higher numbers of shells sampled would increase the certainty in this measure in the future. No data are available from 2018/19.

Summary

The Marlo SMU is an important contributor to the Eastern Zone TACC. The 2023/24 catch of 48.0 t was well below the OT, and this was reflected at all reefcodes except Cape Conron and Point Ricardo. Catches were particularly low at East Cape (50% of the OT), Yeerung Reef (62% below the OT) and Frenches (85% below the OT). The mean daily catch has been low in the last three years but is affected by market conditions. CPUE has declined since 2018.

The abundance of recruits has not varied significantly, and from 2013 to 2021 abundances ranged (without trend) from 5.5 to 8.5 abalone per transect. Pre-recruit abundance has fluctuated without any clear trends since 2003. At the Top 15 sites, recruit abundance was similar to recent years and on a positive note, pre-recruit abundance in 2023 was the highest observed since 2013.

Size structure from all FIS sites suggested that the mean and modal size of the population, as well as the proportion of abalone above the size limit, has declined since 2010/11. Similarly, commercial catch sampling data up to 2018/19 suggest that the mean size of the catch had also declined to that time, however this was likely affected by changes in LML.

Mean CPUE was above the Threshold level in the Draft Harvest Strategy and has been above the Threshold level for 33 consecutive years (Table 4). The Primary Indicator was Decreasing and the Secondary Indicator was Decreasing, which gave a Decreasing Primary Category. The Tertiary Indicator was not available (Table 5). The base OT (i.e. without carryover) for 2024/25 was 35.8 t. The Decreasing result of the Harvest Strategy suggests that the OT should be reduced, with a range of 30.4 to 34.0 t.

Industry strongly suggests that environmental factors have affected both the fishing activity and productivity of the Marlo stocks in recent years. During this time, average catches have been low in an historic sense, so it is plausible that flood conditions experienced in recent years may have influenced productivity. As a result, CPUE has declined substantially since 2018 and is currently at low historic levels. **In response to poor stock status, the OT was halved for 2024/25. More time is required to determine whether these cuts were sufficient to improve stock status. Diver observations will be critical in determining whether the reductions were sufficient in the short-term.**

3.2.7 Mallacoota East (Medium SMU)

The Mallacoota East SMU contributed 30.5 t in 2023/24 representing 10.7% of the TACC (Table 3) and 10.7% of the zone catch (Table 12). The 2023/24 catch was 16% over the OT of 26.2 t. Standardised CPUE in 2023/24 was 1% higher than in 2003/04 and 13% lower than 2009/10.

Table 12: Summary of Catch, Optimum Targets and Performance Indicators for the Mallacoota East SMU.

Catch					Long-term indicators CPUE 2003/04 – 2023/24 Abundance 2003-2023			Short-term indicators CPUE 2009/10 – 2023/24 Abundance 2009-2023		
2023/24		OT (t)			CPUE	Pre-recruits	Recruits	CPUE	Pre-recruits	Recruits
(t)	(%)	22/23	23/24	24/25						
30.5	10.7	32.5	26.2	19.7	1	NA	NA	-13	NA	NA
LML = 120 mm		Mean daily catch=358 kg								

The Mallacoota East SMU has contributed an average catch of 59 t since 1979 and 56 t since 1988 (Figure 21). The peak catch of 83 t was taken the year before quota was introduced. From 2003 to 2014 catches were relatively stable averaging 56 t (range 42-63 t), however in the last nine years catches have declined averaging only 37 t (range 30-47 t), with 2023/24 the lowest catch recorded. Notably, the OT for 2024/25 has been reduced to 19.7 t.

Since the introduction of quota, mean daily catch has ranged from 258 to 504 kg/day with an average of 407 kg/day. Mean daily catches in the last three years has been stable and similar to those from 2014 to 2019 despite changes in market conditions.

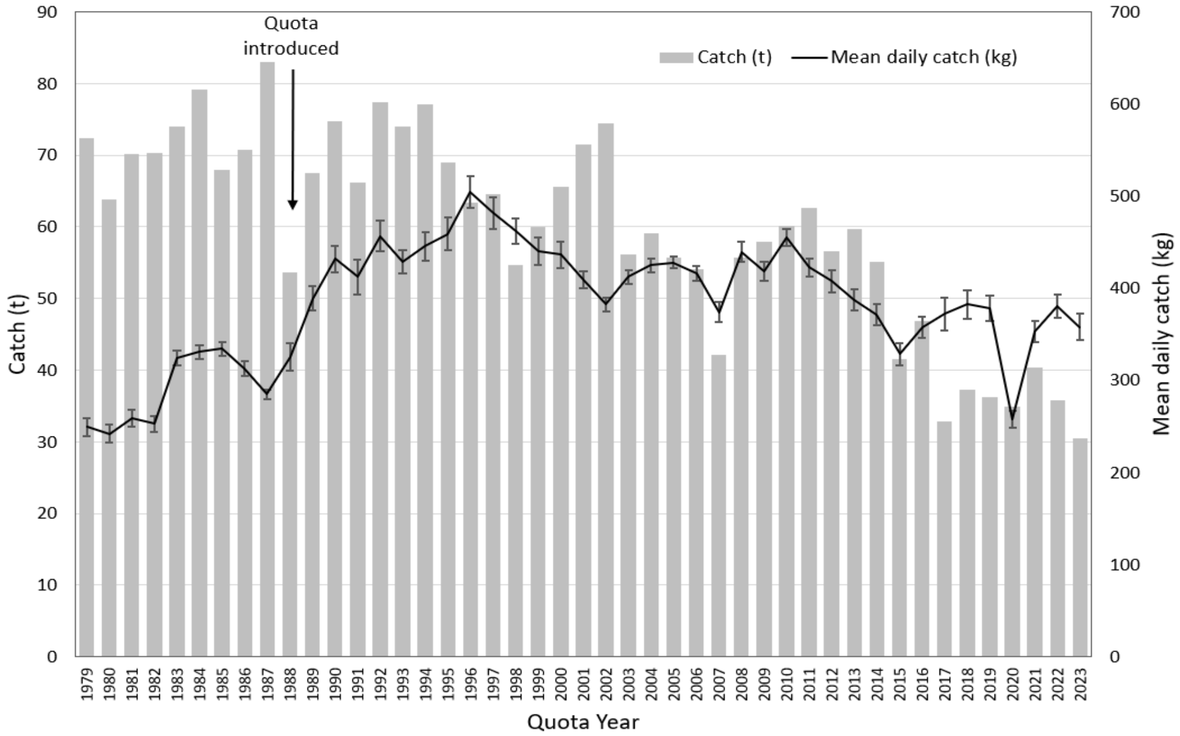


Figure 21: Total catch and mean daily catch for the Mallacoota East SMU from 1979 to 2023.

Nominal CPUE generally increased from 1992 to 2010, reaching a peak of 122 kg/hr before declining to 88 kg/h in 2016 (Figure 22). Nominal CPUE has ranged from 100 to 114 kg/h in the last six years.

generally increased to 106 kg/h in 2018 and has been stable thereafter. Standardised CPUE has generally followed the nominal trends, albeit at lower levels particularly in recent years.

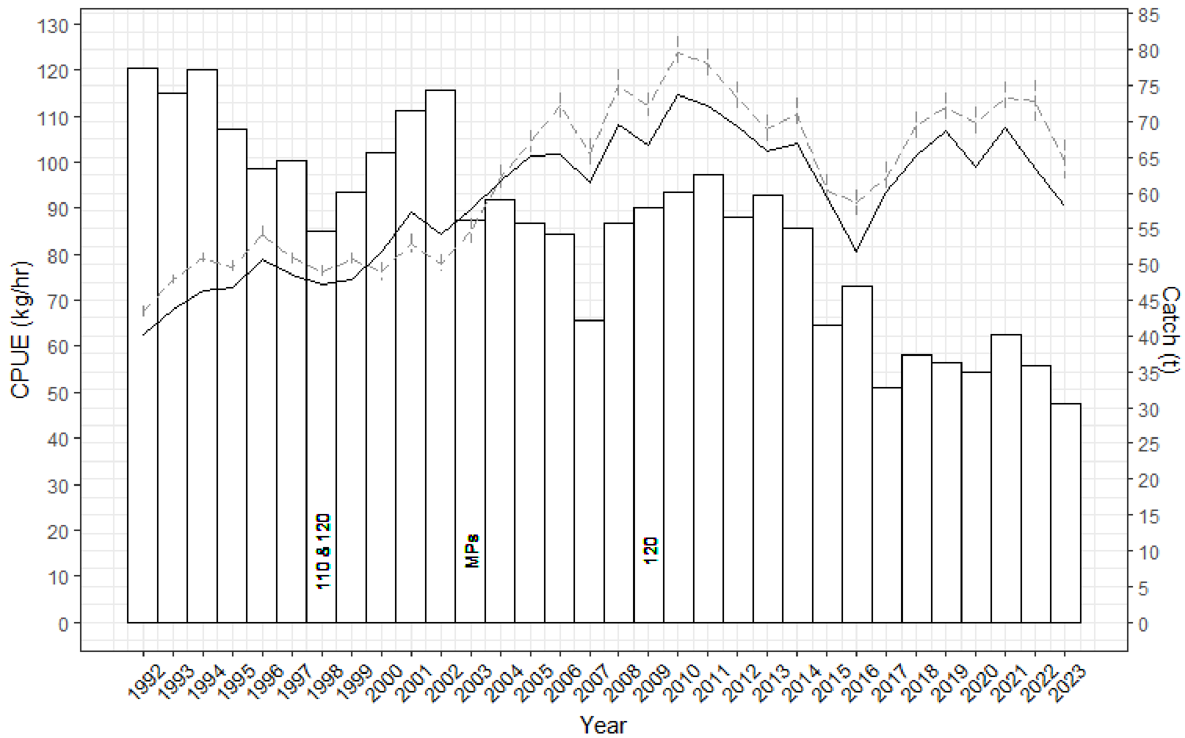


Figure 22: Mallacoota East SMU catch, and CPUE (nominal and standardised) from 1992/93 – 2023/24. Catch = bars, nominal CPUE = grey series (+/- SE), standardised series = black. Numbers in bars indicate changes to LMLs. MPs = introduction of Marine Parks.

Table 13: Catches by reefcode for the Mallacoota East SMU from 2018/19 to 2023/24, the five-year average catch from 2018/19 to 2022/23, and the OT for 2023/24.

Reefcode	2018/19	2019/20	2020/21	2021/22	2022/23	5-yr average	2023/24	OT	Difference (kg)
24.17 Gabo Island	23236	25897	26047	25613	24891	25137	20195	15200	4995
24.19 Iron Prince	11460	8312	6477	11877	8154	9256	7875	9000	-1125
24.18 Gunshot	2591	2004	2438	2810	2781	2525	2395	2000	395

The Mallacoota East SMU comprises three reefcodes, with Gabo Island the highest contributor in all recent years (Table 13). The catch at Gabo Island in 2023/24 was again well above the OT (33%), as it has been in all recent years. Catches at Iron Prince and Gunshot were close to the OT.

The trends from the “all sites” FIS data series (grey dashed) are difficult to interpret because of changes in sites over time. The standardised abundance of recruits at the two Top 15 sites declined from 2003 to 2009 and was generally stable up to 2021 (Figure 23). The abundance in 2023 was the lowest recorded.

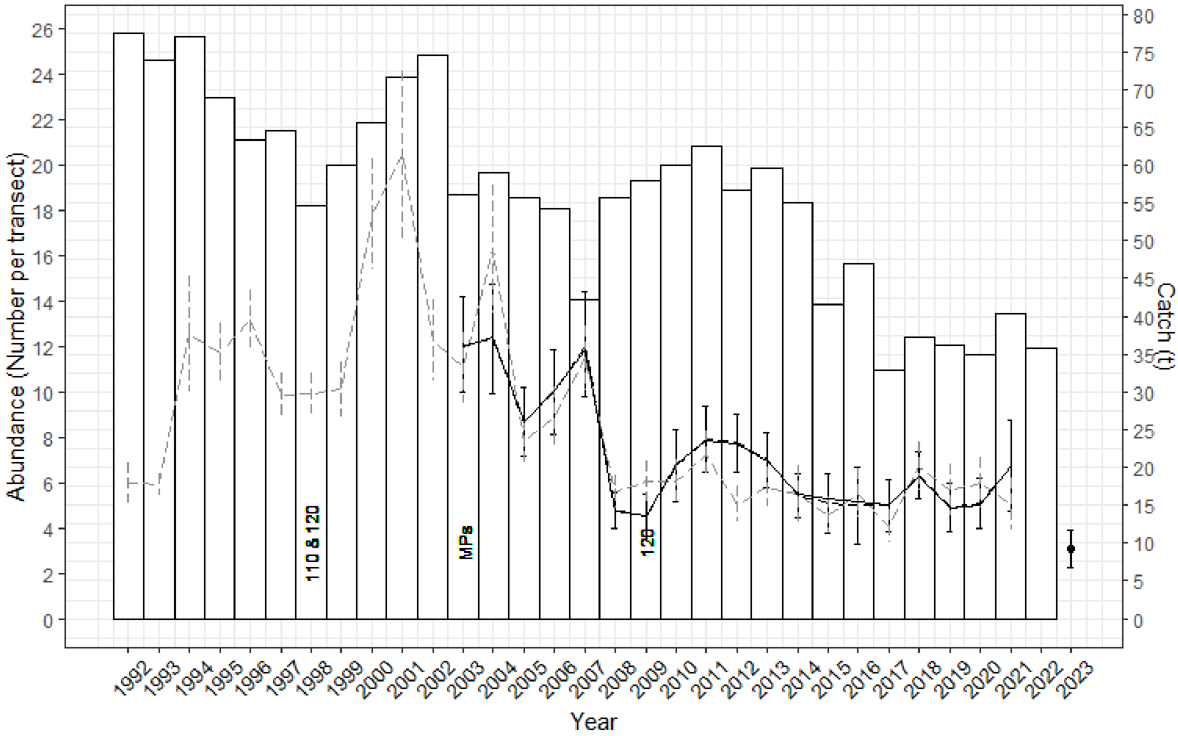


Figure 23: Recruit abundance and catch from 1992/93 – 2022/23 for the Mallacoota East SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the two Top 15 sites located within the Mallacoota East SMU.

Standardised pre-recruit abundance at the two Top 15 sites was variable from 2003 to 2013 but has declined thereafter (Figure 24). Standardised abundance in 2023 was the lowest recorded.

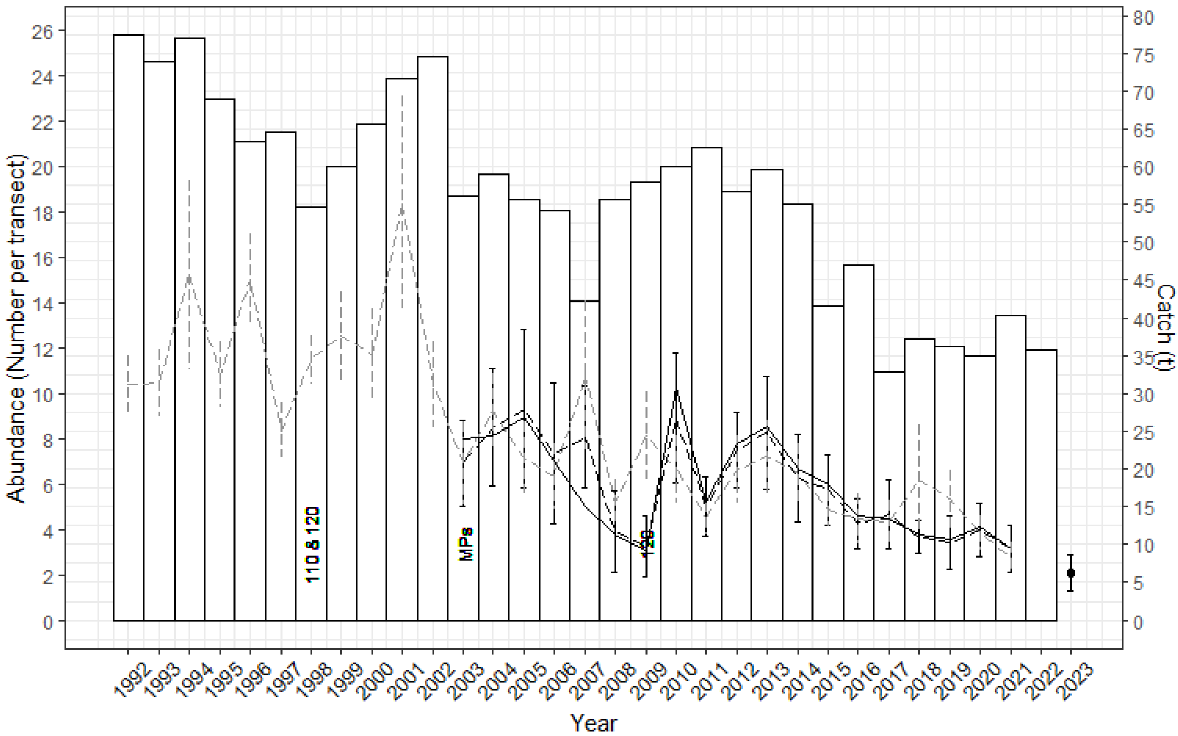


Figure 24: Pre-recruit abundance and catch from 1992/93 – 2022/23 for the Mallacoota East SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the two Top 15 sites located within the Mallacoota East SMU.

FIS length frequency data

There are few clear trends evident in the size structure of the population sampled during the FIS in the Mallacoota East SMU (Appendix 4). Mean size was variable, ranging from 113 to 124 mm and the proportion above the size limit has ranged from 35 to 66%, although notably the highest mean size and % above the size limit occurred in 2021. The modal size class has also varied considerably, from 115-119 mm to 130-134 mm.

Commercial length frequency data

While the size structure of the commercial catch was stable from 2010/11 to 2013/14, the mean and modal size has declined substantially in 2016/17 and 2018/19 with a higher proportion of abalone harvested closer to the size limit (Appendix 5). No data are available from 2018/19. Higher numbers of shells sampled would increase the certainty in this measure in future years.

Summary

The Mallacoota East SMU has contributed an average catch of 56 t since 1988, however catches in the last seven years have been much lower. The OT was reduced from 32.5 to 26.2 t in 2023/24, however catches were 16% above the OT and 30.5 t was caught. The OT was further reduced to 19.7 t for 2024/25. The Mallacoota East SMU comprises three reefcodes, with Gabo Island the highest contributor in all recent years. The catch at Gabo Island in 2023/24 was again well above the OT (33%), as it has been in all recent years. With the exception of 2020, mean daily catch has been fairly stable over the last decade. CPUE has also fluctuated without major trends for the last decade.

FIS data from all sites showed declines in recruit and pre-recruit abundances since the early 2000s. Pre-recruit abundance has continued to decline since 2003 while recruit abundance appears to have been relatively stable since 2008, likely the result of progressively reduced catches from this SMU during this period. Abundances of both recruits and pre-recruits at the two Top 15 sites declined to their lowest levels in 2023.

It is difficult to interpret trends in the size structure of the population from either FIS or commercial length frequency data.

For the Mallacoota East SMU, mean CPUE was above the Threshold level in the Draft Harvest Strategy and has been above the Threshold level for 35 consecutive years (Table 4). The Primary Indicator was Stable and the Secondary Indicator was Decreasing, which gave a Decreasing Primary Category (Table 5). The Tertiary Indicator was not available, resulting in a Decreasing Final Category for the SMU. The OT for 2024/25 was 19.7 t, and the results of the Harvest Strategy suggested decreasing this OT within a range of 16.7 to 18.7 t.

While CPUE and mean daily catch have been relatively stable for the last decade, recent assessments had highlighted the ongoing high catches at Gabo island, which have been well above the OT for the last 6 years. **While cuts to the OT were made for 2023/24, most of that was caught as the OT was again exceeded. Further substantial cuts have been made for the 2024/25 season, so it is too early to determine whether these reductions have improved stock performance. Again, diver observations will be critical in determining the OT for 2025/26.**

3.2.1 Mallacoota Large (Small SMU)

The Mallacoota Large SMU contributed 18.8 t in 2023/24 representing 6.6% of the TACC (Table 3) and 6.6% of the zone catch (Table 14). This was just above the OT (18.5 t). Standardised CPUE in 2023/24 was 9% higher than in 2003/04 and 5% lower than 2009/10.

Table 14: Summary of Catch, Optimum Targets and Performance Indicators for the Mallacoota Large SMU.

Catch					Long-term indicators CPUE 2003/04 – 2023/24 Abundance 2003-2023			Short-term indicators CPUE 2009/10 – 2023/24 Abundance 2009-2023		
2023/24		OT + carryover* (t)			CPUE	Pre-recruits	Recruits	CPUE	Pre-recruits	Recruits
(t)	(%)	22/23	23/24	24/25						
18.8	6.6	20.0	18.5	18.5	9	NA	NA	-5	NA	NA
LML = 135 mm		Mean daily catch=335 kg								

The Mallacoota Large SMU has produced an average catch of 37 t since 1979 and 30 t since 1988, with a peak catch of 78 t in 1983. Since the introduction of quota, the peak catch was 58 t caught in both 1992 and 1993 (Figure 25). Catch remained around 45 t in 1994 and 1995 before declining substantially to 19 t in 1996. Thereafter catch has ranged from 7 to 43 t, with an average catch of 25 t. The OT for 2024/25 has been maintained at 18.5 t.

Following the introduction of quota, mean daily catch was relatively stable from 1990 to 2014. In 2015 mean catch per day dropped to 302 kg/day before increasing to a historic high of 499 kg/day in 2018. Mean daily catch has declined substantially since then, reaching 335 kg/day in 2023, however mean daily catch has been affected by market forces that limit daily catches since 2020.

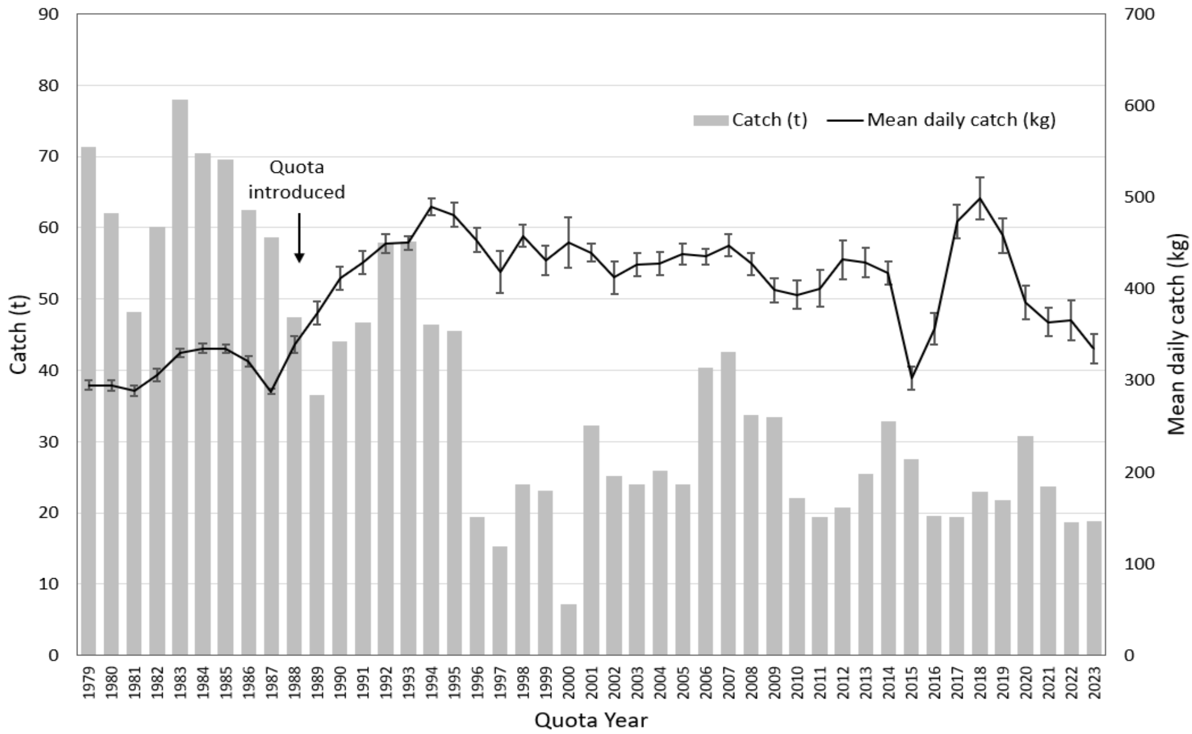


Figure 25: Total catch and mean daily catch for the Mallacoota Large SMU from 1979 to 2023.

Nominal CPUE generally increased from 1992 to 2007, where it peaked at 118 kg/hr, and has fluctuated from 95 to 120 kg/h thereafter (Figure 26). Standardised CPUE generally followed nominal trends until 2012, but since then standardised CPUE has decreased relative to nominal levels, Standardised CPUE has fluctuated without trend since 2018.

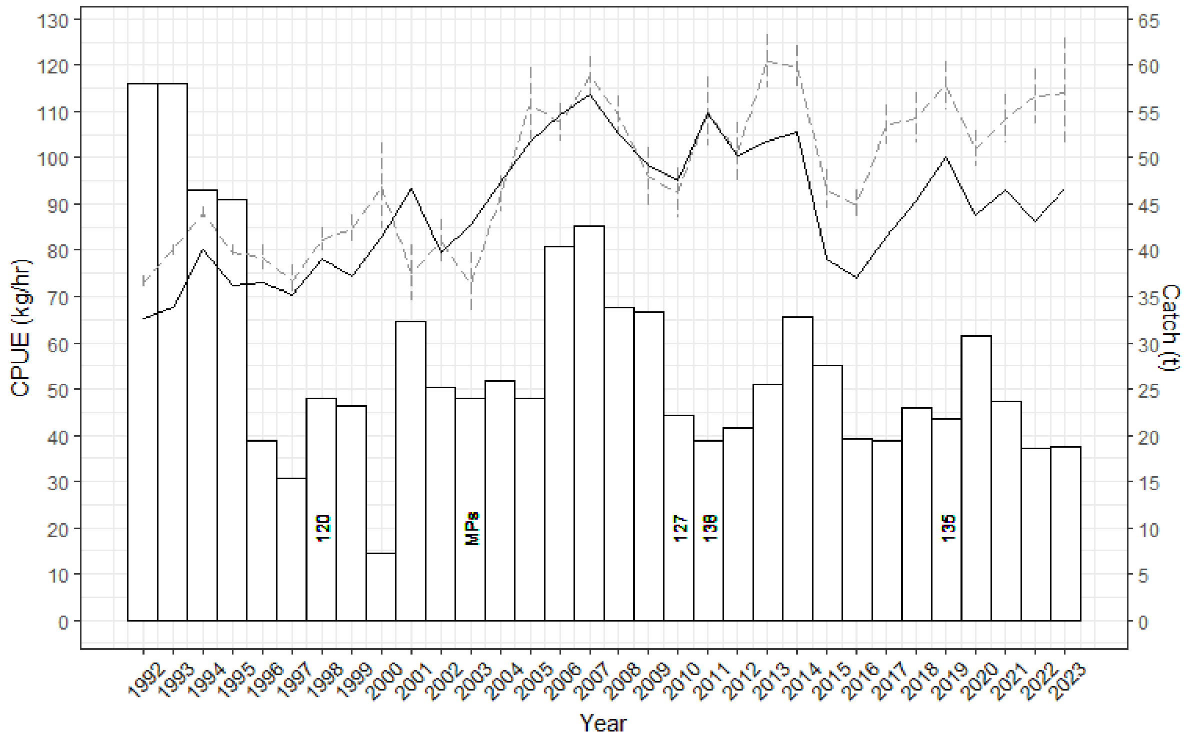


Figure 26: Mallacoota Large SMU catch, and CPUE (nominal and standardised) from 1992/93 – 2023/24. Catch = bars, nominal CPUE = grey series (+/- SE), standardised series = black. Numbers in bars indicate changes to LMLs. MPs = introduction of Marine Parks.

Table 15: Catches by reefcode for the Mallacoota Large SMU from 2018/19 to 2023/24, the five-year average catch from 2018/19 to 2022/23, and the OT for 2023/24.

Reefcode	2018/19	2019/20	2020/21	2021/22	2022/23	5-yr average	2023/24	OT	Difference (kg)
23.06 Big Rame	15589	15057	22246	14558	12960	16082	12094	12000	94
24.0 The Skerries	5212	5472	6645	7197	4353	5776	5345	5000	345
24.03 Easby Creek	2198	1323	1902	1887	1317	1726	1323	1500	-177

The Mallacoota Large SMU comprises three reefcodes, with Big Rame the highest contributor followed by The Skerries (Table 15). Catches were around the OTs at all reefcodes in 2023/24.

FIS data were not collected during 2022 and there were no Top 15 sites for the Mallacoota Large SMU. The trends from the “all sites” data series (grey dashed) are difficult to interpret because of changes in sites over time but in general recruit abundance declined from 1992 to 2015 and increased slightly thereafter (Figure 27).

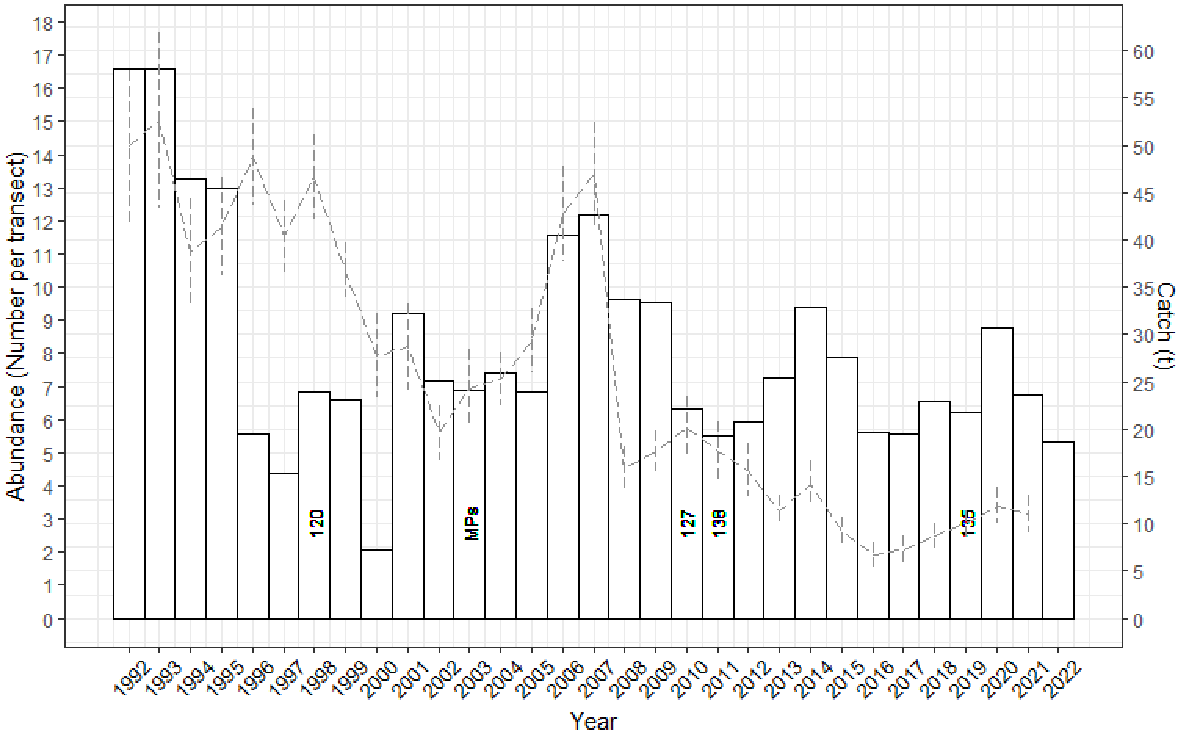


Figure 27: Recruit abundance (nominal grey dashed line) and catch (bars) from 1992/93 – 2022/23 for the Mallacoota Large SMU. There are no Top 15 sites in the Mallacoota Large SMU.

Pre-recruit abundance declined from 1992 to 2009 and remained low thereafter (Figure 28).

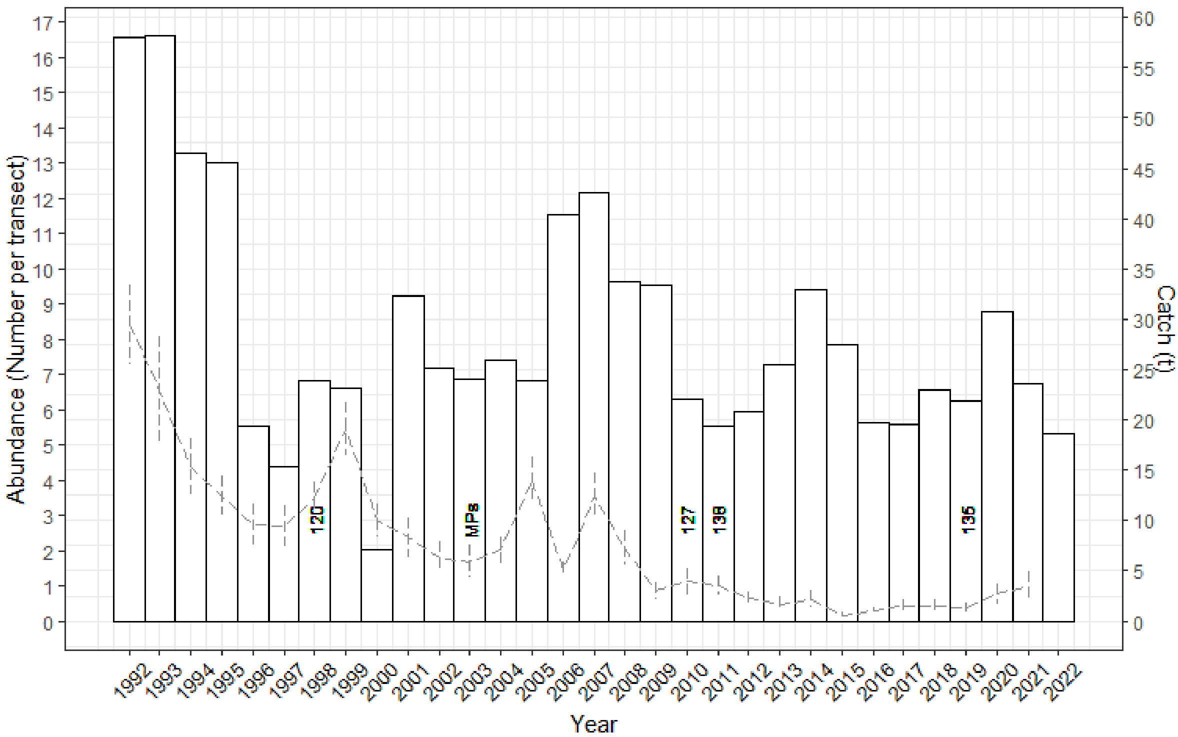


Figure 28: Pre-recruit abundance (nominal grey dashed line) and catch (bars) from 1992/93 – 2022/23 for the Mallacoota Large SMU. There are no Top 15 sites in the Mallacoota Large SMU.

FIS length frequency data

The size structure of the surveyed population in the Mallacoota Large SMU show clear trends associated with the decline in abundance of both recruit and pre-recruit abalone (Appendix 5). From 2003 to 2011, the mean size of the population ranged from 126 to 137 mm, with the proportion above the LML ranging from 33 to 53%. As the abundance of pre-recruits declined substantially thereafter and represent only a small proportion of the population, mean size increased to 135 to 140 mm and the proportion above the LML ranged from 55 to 69% from 2012 to 2020, except for 2019 where a relatively higher abundance of very small abalone (<70 mm) reduced the mean size to 130 mm.

Commercial length frequency data

Sample sizes from the commercial catch have ranged from 93 to 580 shells per year sampled and may not be a very representative sample of the underlying size distribution (Appendix 5).

Summary

The Mallacoota Large SMU has produced an average catch of 37 t since 1979 and 30 t since 1988, with a peak catch of 78 t in 1983. The 2023/24 catch of 18.8 t was just above the OT. Reefcode catches in 2023/24 were around their respective OTs. CPUE has been stable in recent years and is much higher than it was in 2014/15. Mean daily catch has declined in recent years but this is affected by market forces.

There were no Mallacoota Large FIS sites in the Top 15 and thus FIS data have not been collected since 2021. The data from all historic FIS show substantial declines in both recruit and pre-recruit abundances. No meaningful changes in size structure were evident from FIS and commercial length-frequency data.

For the Mallacoota Large SMU, mean CPUE was above the Threshold level in the Draft Harvest Strategy and has been above the Threshold level for 36 consecutive years (Table 4). The Primary Indicator was Stable and the Secondary Indicator was Increasing, which gave a Stable Primary Category (Table 5). The Tertiary Indicator was not available, resulting in a Stable Final Category for the SMU. The OT for 2024/25 was 18.5 t, and the results of the Harvest Strategy suggest an OT from 17.6 to 19.4 t.

Mallacoota Large was the only SMU not to have a reduction in OT during 2024/25. In recent years, this SMU has been managed by a cap that has prevented catches exceeding the OT due to a higher demand for larger abalone. Given the reductions in stock status and subsequently catch at most other SMUs, it is plausible the hard cap has helped to maintain stock status in this region. There is no evidence to suggest that changes are required to the OT.

3.2.2 Mallacoota West (Small SMU)

The Mallacoota West SMU contributed 18.1 t in 2023/24 representing 6.4% of the TACC (Table 3) and 6.4% of the zone catch (Table 16). This catch was 16% below the Optimum Target of 21.5 t. CPUE in 2023/24 was 1% higher than in 2003/04 and 12% lower than 2009/10.

Table 16: Summary of Catch, Optimum Targets and Performance Indicators for the Mallacoota West SMU.

Catch					Long-term indicators CPUE 2003/04 – 2023/24 Abundance 2003-2023			Short-term indicators CPUE 2009/10 – 2023/24 Abundance 2009-2023		
2023/24		OT (t)			CPUE	Pre-recruits	Recruits	CPUE	Pre-recruits	Recruits
(t)	(%)	22/23	23/24	24/25						
18.1	6.4%	44.0	21.5	12.0	-3	NA	NA	-14	NA	NA
LML = 125 mm			Mean daily catch=353 kg							

The Mallacoota West SMU has been an important historical contributor to the Eastern Zone TACC, with an average catch of 71 t since 1979 and 68 t since 1988, with a peak catch of 114 t taken during 1983 (Figure 29). Since the introduction of quota, catches increased from a low of 52 t at that time to a contemporary peak of 101 t in 2008 but have continually declined thereafter. Catches since 2016 have been below the 1988 level despite reductions in size limit during 2011 and 2015. The catch in 2023 was the lowest recorded. Notably, the OT for 2024/25 has been further reduced to 12.0 t.

Mean daily catch was consistent between 1989 and 2014, ranging from 397 to 507 kg/day with an average of 450 kg/day but as catches have declined mean daily catch has become more variable. In 2023, mean daily catch dropped to 353 kg/day which was similar due levels during 2020 when the impacts of covid-19 affected the fishery and its markets.

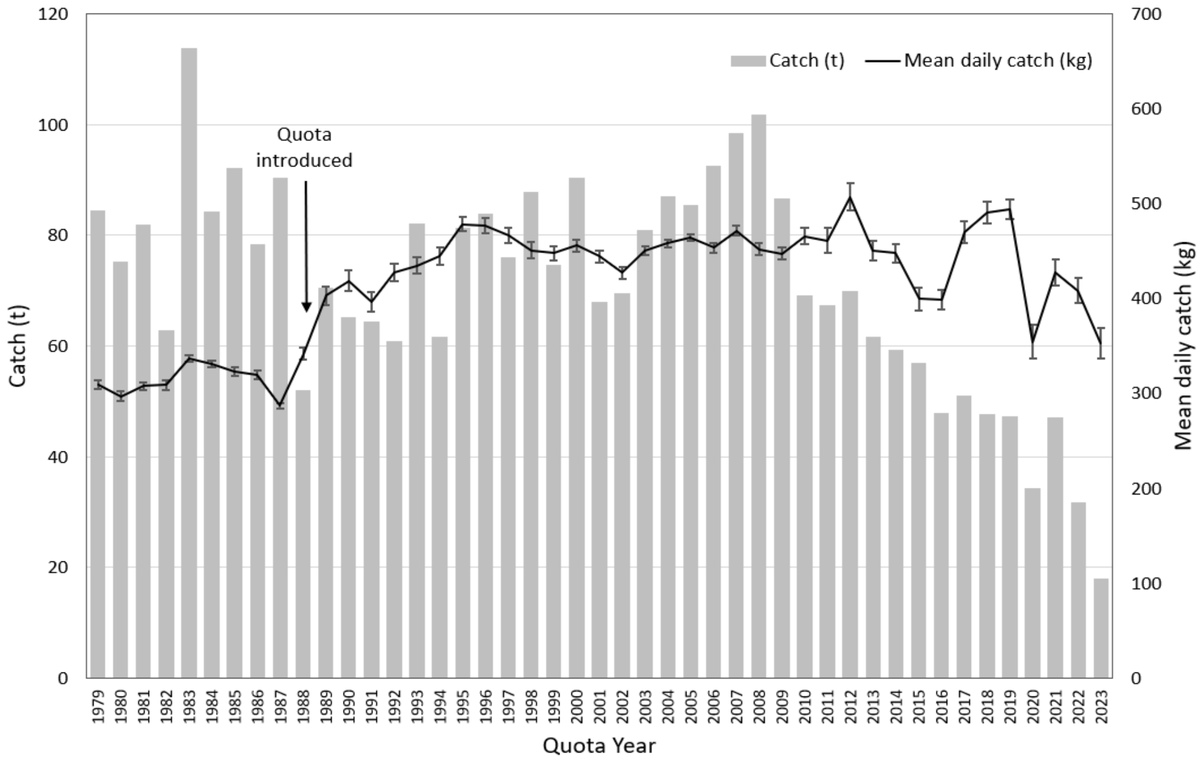


Figure 29: Total catch and mean daily catch for the Mallacoota West SMU from 1979 to 2023.

Nominal CPUE has showed three peaks in 2006, 2012 and 2019 (Figure 30) with substantial fluctuations in between. Nominal CPUE has declined over the last five years. Standardised CPUE was similar to nominal trends until around 2005, and has been lower than nominal CPUE in all subsequent years.

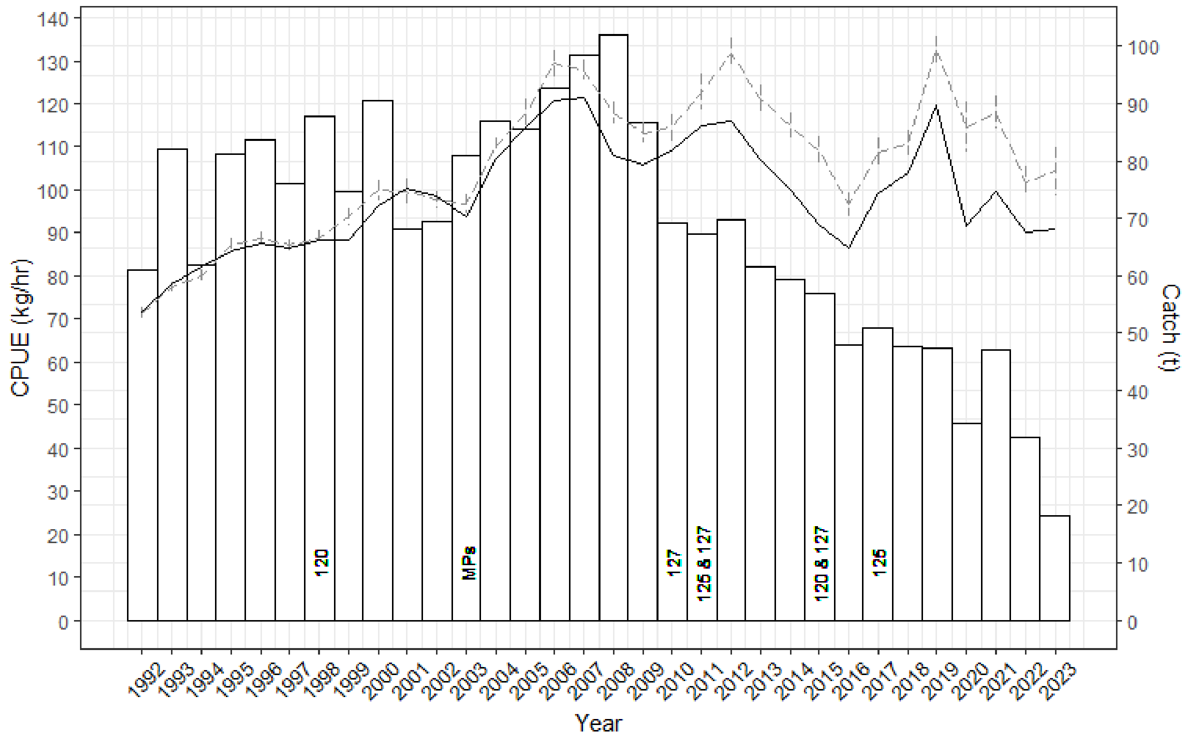


Figure 30: Mallacoota West SMU catch, and CPUE (nominal and standardised) from 1992/93 – 2023/24. Catch = bars, nominal CPUE = grey series (+/- SE), standardised series = black. Numbers in bars indicate changes to LMLs. MPs = introduction of Marine Parks.

Table 17: Catches by reefcode for the Mallacoota West SMU from 2018/19 to 2023/24, the five-year average catch from 2018/19 to 2022/23, and the OT for 2023/24.

Reefcode	2018/19	2019/20	2020/21	2021/22	2022/23	5-yr average	2023/24	OT	Difference (kg)
23.02 Whaleback	8343	5853	5708	5519	5580	6200	7732	6500	1232
23.04 Petrel Point	19015	20634	13239	20964	13708	17512	6359	9000	-2641
23.05 Island Point	15312	15108	13103	15685	8283	13498	2019	0	2019
23.03 Meuller	5075	5729	2334	5058	4282	4496	1945	6000	-4055

The Mallacoota West SMU comprises four reefcodes, with Petrel Point and Island Point the highest contributors (Table 17). The catch in 2023/24 was below the OT at Petrel Point (29%) and well below the OT at Meuller (68%). Whaleback is the only reefcode to have maintained it long-term average catch.

The trends from the "all sites" FIS data series (grey dashed) are difficult to interpret because of changes in sites over time. Standardised abundance of recruits at the two Top 15 sites declined from 2003 to 2008 and has been highly variable thereafter (Figure 31). Standardised abundance was the lowest recorded in 2023.

Standardised pre-recruit abundance at the two Top 15 sites declined from 2003 to 2021 but increased in 2023 (Figure 32).

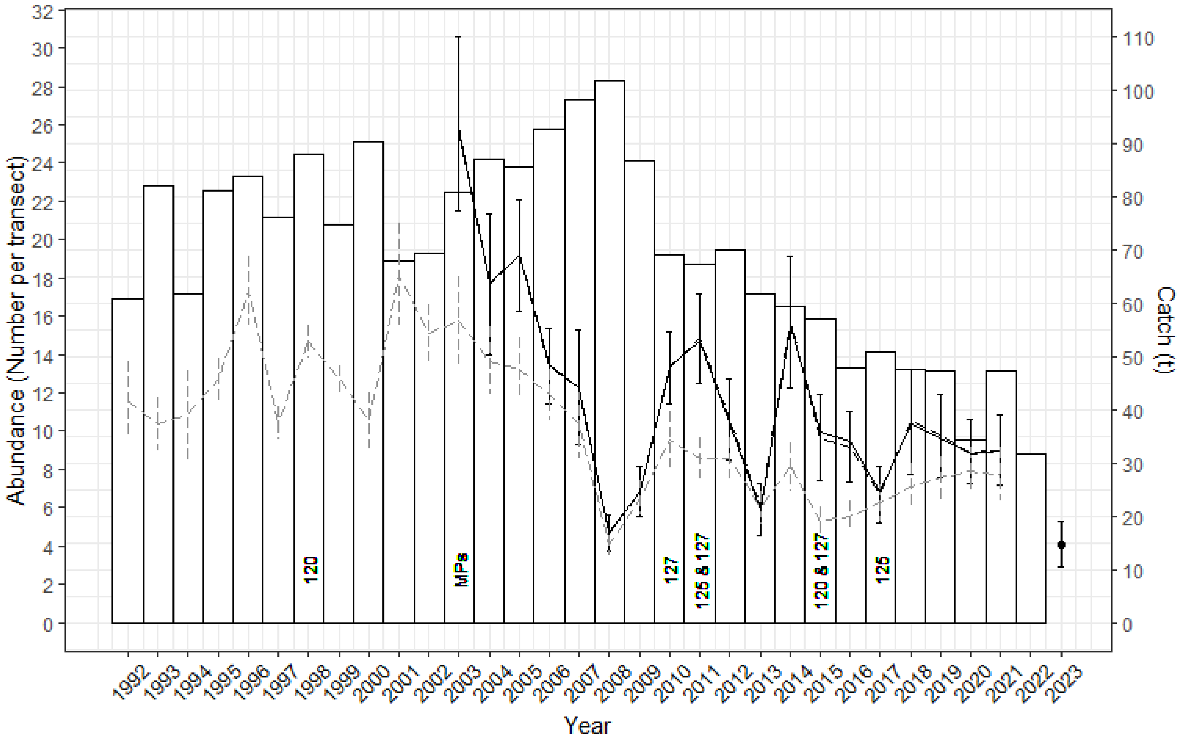


Figure 31: Recruit abundance and catch from 1992/93 – 2022/23 for the Mallacoota West SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the two Top 15 sites located within the Mallacoota West SMU.

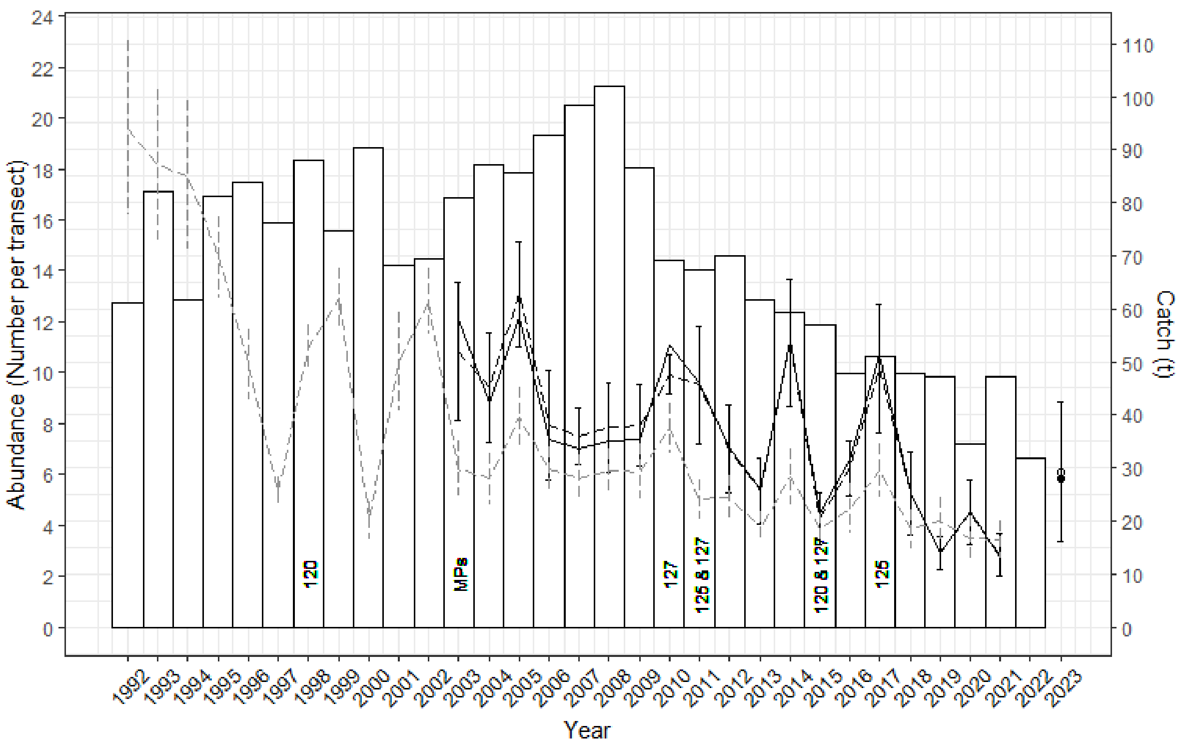


Figure 32: Pre-recruit abundance and catch from 1992/93 – 2022/23 for the Mallacoota West SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the two Top 15 sites located within the Mallacoota West SMU.

FIS length frequency data

There are few clear trends evident in the size structure of the population sampled during FIS in the Mallacoota West SMU (Appendix 4). Mean size has generally ranged from 118 to 124 mm (except for 115 mm in 2009) and the proportion above the size limit has ranged from 37 to 57%. The modal size class has been 125-129 mm or 130-134 mm in all years except 2015 and 2016 where it was 120-124 mm.

Commercial length frequency data

From 2010/11 to 2016/17, most of the sampled catch was in the size classes 130-134 and 135-139 mm (Appendix 5). In 2018/19 only 230 shells were measured, however more than 40% of these were just above the size limit (i.e. 125 – 129 mm size class). No data are available from 2018/19. Higher numbers of shells sampled would increase the certainty in this measure in future years.

Summary

The Mallacoota West SMU has been an important historical contributor to the Eastern Zone TACC, however catches have continually declined from the contemporary peak catch of 101 t taken during 2008 and currently catches are less than 20% of this level. Catches were below the OT at Petrel Point and well below the OT at Meuller. Although mean daily catch has been affected by market forces since 2020, there is some concern that mean daily catch declined in 2023/24 to similar levels to those observed in 2020. CPUE has declined substantially since 2019.

Recruit and pre-recruit FIS abundances from all sites are low in historical terms. Recruits fluctuated without trend from 2009 to 2021, whereas pre-recruits have declined slowly from 2003 to 2021. Two Top 15 sites were surveyed in 2023. Notably, recruit abundance declined by more than 50% compared to 2021, however on a more optimistic note pre-recruit abundance more than doubled during this period. Size structure data from FIS and commercial catch showed few trends up to 2021 and 2016/17, respectively.

For the Mallacoota West SMU, mean CPUE was above the Threshold level in the Draft Harvest Strategy and has been above the Threshold level for 32 consecutive years (Table 4). Both the Primary Indicator and Secondary Indicator were Stable, which gave a Stable Primary Category (Table 5). The Tertiary Indicator was not available, resulting in a Stable Final Category. The OT for 2023/24 was 12 t, and the results of the Harvest Strategy suggested an OT range from 11.4 to 12.6 t.

The OT for the Mallacoota West SMU has been reduced from 44 t in 2022/23 to 12 t in 2024/25. Given the severity of the reductions in OT for 2023/24 and lack of information to determine how the stock may have responded in this time, it is unclear whether further cuts are required. Diver observations will be critical in determining the OT for 2024/25.

3.2.3 Mallacoota Small (Small SMU)

The Mallacoota Small SMU catch of 17.7 t in 2023/24 represented 6.2% of the TACC (Table 3) and 6.2% of the total catch for the Eastern Zone (Table 18). The catch was 14% above the OT (15.5 t). Standardised CPUE was 5% lower than 2003/04 and 11% lower than 2009/10.

Table 18: Summary of Catch, Optimum Targets and Performance Indicators for the Mallacoota Small SMU.

Catch					Long-term indicators CPUE 2003/04 – 2023/24 Abundance 2003-2023			Short-term indicators CPUE 2009/10 – 2023/24 Abundance 2009-2023		
2023/24		OT (t)			CPUE	Pre-recruits	Recruits	CPUE	Pre-recruits	Recruits
(t)	(%)	22/23	23/24	24/25						
17.7	6.2	21.0	15.5	7.8	-5	NA	NA	-11	NA	NA
LML = 115 mm		Mean daily catch=304 kg								

The Mallacoota Small SMU has produced an average catch of 25 t since 1979 and 24 t since 1988 (Figure 33). Following the introduction of quota, catch from the Mallacoota Small SMU increased from 21 t to 1994 to a peak of 44 t in 1998. While catch declined to 20 t in 2001, it has remained stable thereafter with a minimum catch of 13 t and an average of 21 t. Notably, the OT for 2024/25 has been halved to 7.8 t.

Mean daily catch generally increased after quota was introduced from around 300 kg/day to a peak of 453 kg/day in 1998. Mean daily catch remained relatively stable from 1995 to 2019, with a range of 331-453 kg/day and an average of 393 kg/day. Mean daily catch has been affected by market forces since 2020.

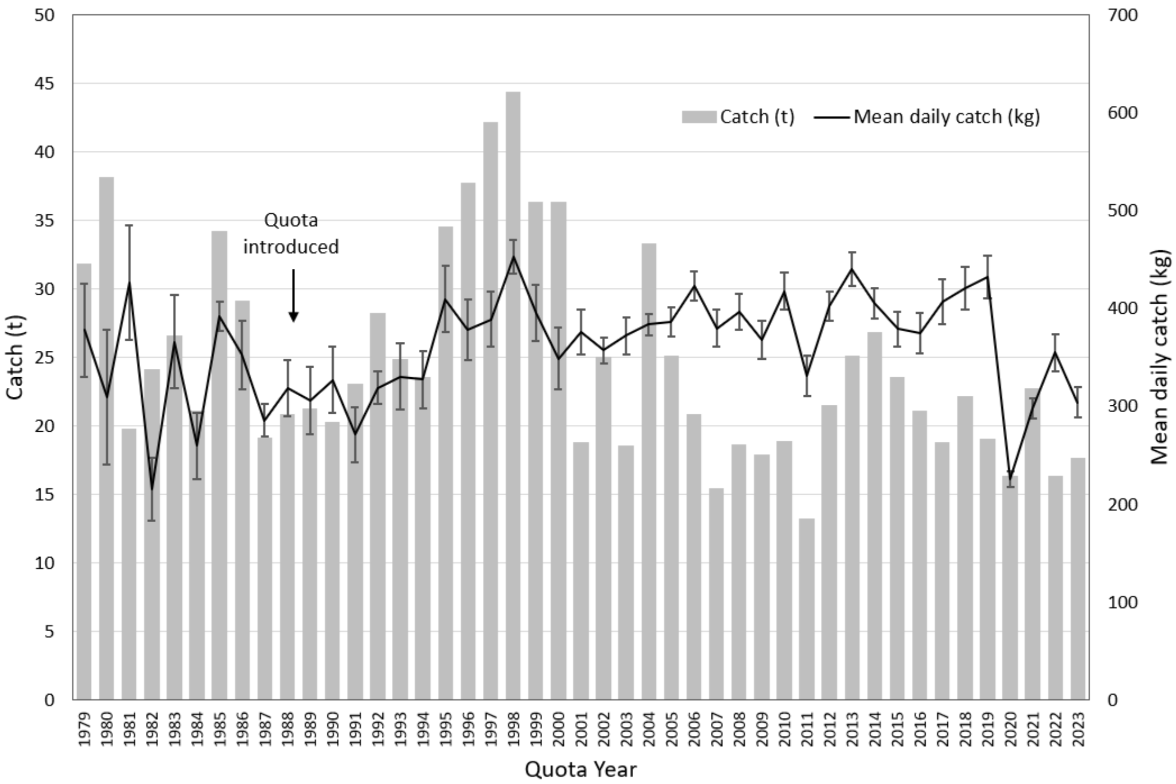


Figure 33: Total catch and mean daily catch for the Mallacoota Small SMU from 1979 to 2023.

Nominal CPUE generally increased from 1992 to 2009, decreased until 2017, increased to a peak of 120 kg/hr in 2017 (Figure 34). Nominal CPUE has declined thereafter. Standardised CPUE has shown similar annual trends but has been less variable over time. Standardised CPUE has also declined since 2019.

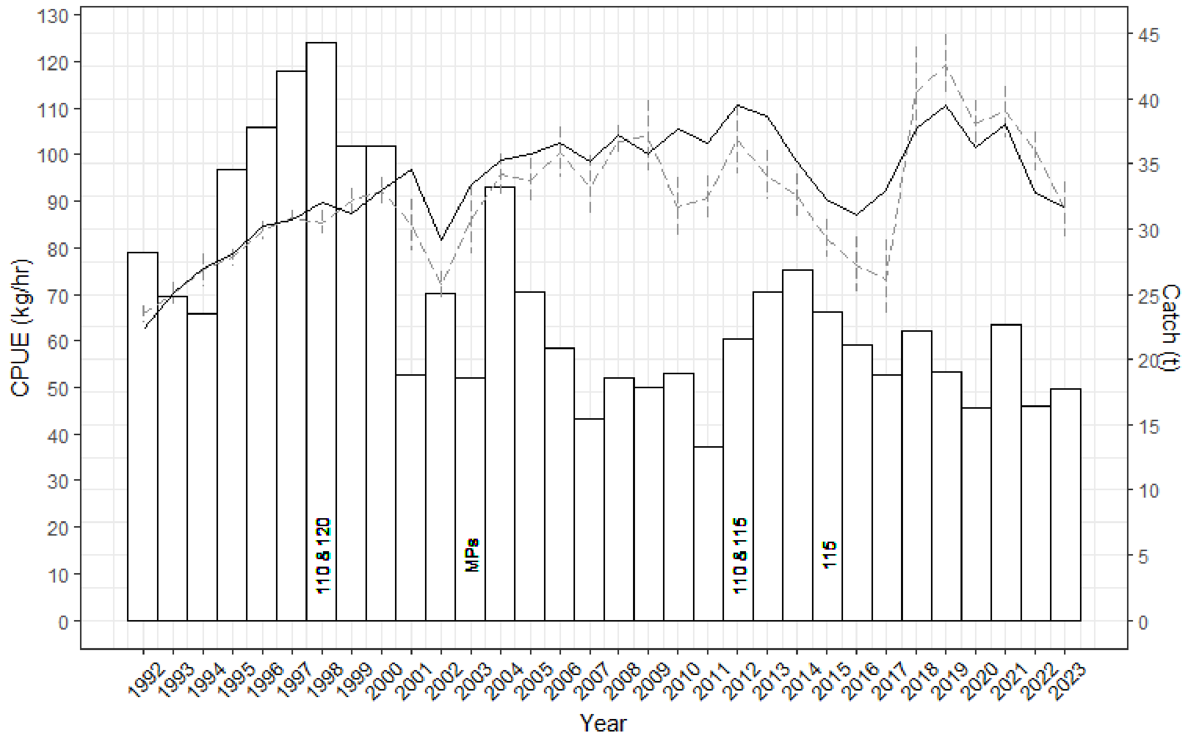


Figure 34: Mallacoota Small SMU catch, and CPUE (nominal and standardised) from 1992/93 – 2023/24. Catch = bars, nominal CPUE = grey series (+/- SE), standardised series = black. Numbers in bars indicate changes to LMLs. MPs = introduction of Marine Parks.

Table 19: Catches by reefcode for the Mallacoota Small SMU from 2018/19 to 2023/24, the five-year average catch from 2018/19 to 2022/23, and the OT for 2023/24.

Reefcode	2018/19	2019/20	2020/21	2021/22	2022/23	5-yr average	2023/24	OT	Difference (kg)
24.09 Little Rame	16115	12515	11270	14776	10342	13004	13990	10500	3490
24.14 Bastion Point	6093	6581	5063	7949	6025	6342	3691	5000	-1309

The Mallacoota Small SMU comprises two reefcodes (Table 19). Catch at Little Rame in 2023/24 was 3.5 t (%33%) above the OT and the catch at Bastion Point was 1.3 t (26%) below the OT.

There is only one Top 15 site for the Mallacoota Small SMU. The trends from the “all sites” FIS data series (grey dashed) are difficult to interpret because of changes in sites over time. Standardised recruit abundance at the one Top 15 site generally declined from 2003 to 2015 and has been variable thereafter (Figure 35).

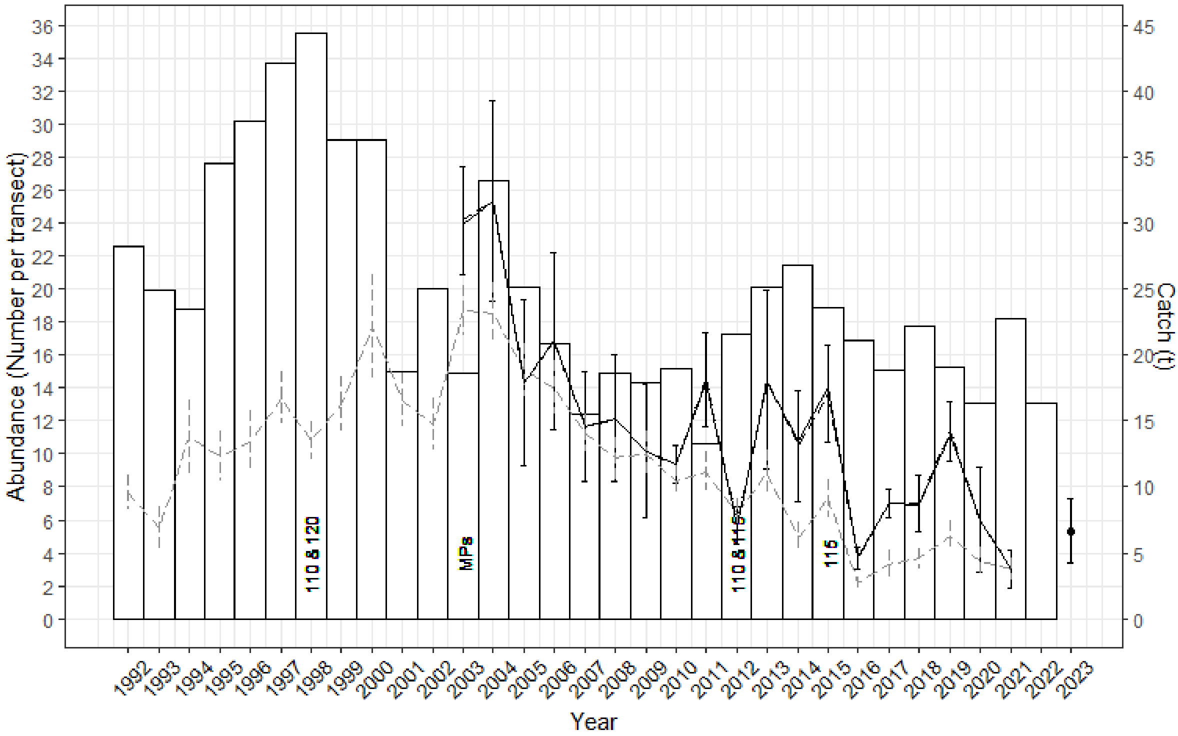


Figure 35: Recruit abundance and catch from 1992/93 – 2022/23 for the Mallacoota Small SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the one Top 15 site located within the Mallacoota Small SMU.

Standardised pre-recruit abundance at the one Top 15 site in the Mallacoota Small SMU has been highly variable since 2003 (Figure 36). The 2023 count was slightly above the long-term average.

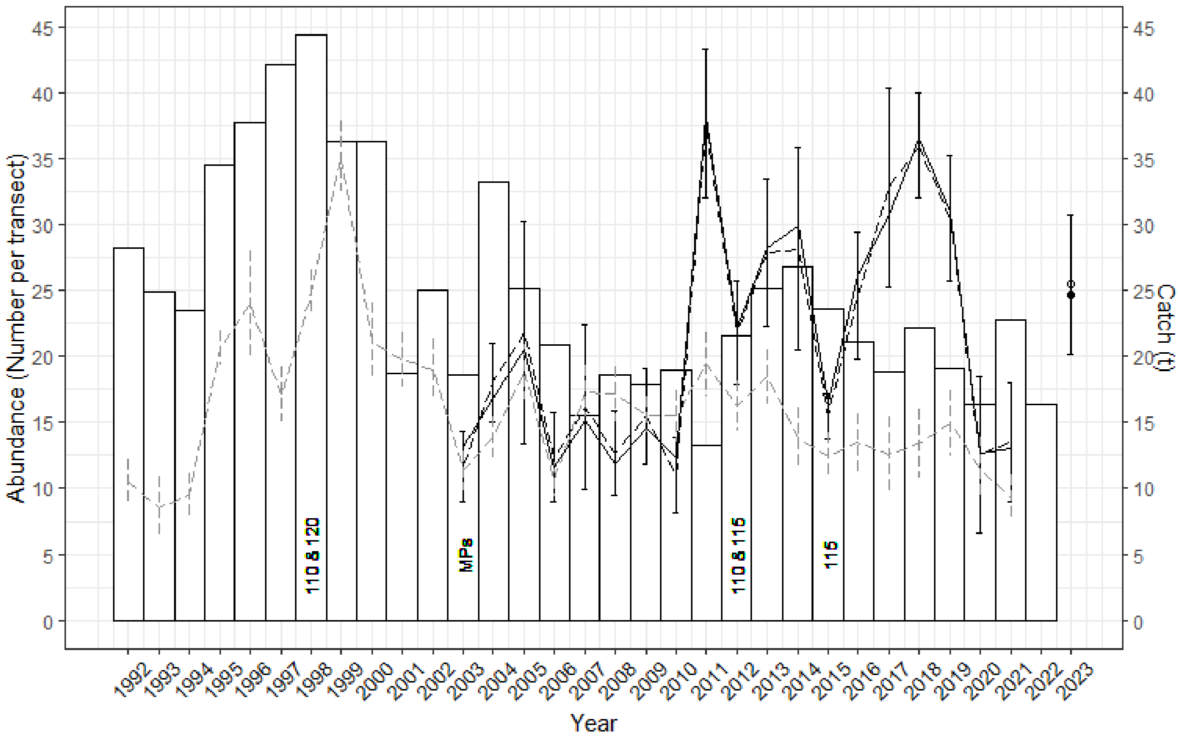


Figure 36: Pre-recruit abundance and catch from 1992/93 – 2022/23 for the Mallacoota Small SMU. Grey dashed series = nominal abundance across all FIS sites (+/-SE). Black series = nominal (dotted line) and standardised (solid line and dot point in 2023) abundance at the one Top 15 site located within the Mallacoota Small SMU.

FIS length frequency data

The size structure of the surveyed population in the Mallacoota Small SMU was relatively stable from 2003 to 2015 (Appendix 4). Modal size was 115 – 119 mm in each of those years, while mean size ranged from 107 to 114 mm. A decline in the abundance of recruits in 2016 and 2017 saw a reduction in mean size (105 and 106 mm, respectively) and modal size (105-109 mm and 110-114 mm, respectively). Size structures returned to more normal trends since 2018. Of note, relatively high abundances of juvenile abalone <70 mm were observed in 2019, however they did not appear to translate into increased abundances of pre-recruits in 2020.

Commercial length frequency data

The size structure of the commercial catch in the Mallacoota Small SMU has varied over time (Appendix 5). Of note, a higher proportion of sampled abalone were harvested closer to the size limit (115-119 mm size class) in 2015/16 and 2016/17, however sample sizes were low in these years. There were no data available from 2018/19 to 2023/24.

Summary

The Mallacoota Small SMU has produced an average catch of 24 t since 1988/89, with a peak catch of 44 t in 1998/99 before declining to 20 t in 2001/02. Thereafter, catch has remained relatively stable with a minimum of 13 t and an average of 21 t. The OT was reduced from 21 t to 15.5 t for 2023/24, however 17.7 t was harvested. Most of the over-catch came from the Little Rame reefcode. CPUE has declined since 2019.

Only one FIS site from the Mallacoota Small SMU contributed to the Top 15 sites and the abundances of recruits and pre-recruits from this site have been variable over time. A paucity of data also makes it difficult to interpret length frequency data from FIS and commercial data sources.

For the Mallacoota Small SMU, mean CPUE was above the Threshold level in the Draft Harvest Strategy and has been above the Threshold level for 31 consecutive years (Table 4). The Primary Indicator was Decreasing and the Secondary Indicator was Decreasing, which gave a Decreasing Primary Category (Table 5). The Tertiary Indicator was not available, resulting in a Decreasing Final Category for the SMU. The OT for 2023/24 was reduced to 7.8 t, and the results of the Harvest Strategy suggest an OT from 6.6 to 7.4 t.

CPUE has declined since 2019, though remains within historic levels. The OT has been reduced substantially in the last two years from 21 t to 7.8 t. It is too soon to determine whether the stock has responded to these large reductions in OT. While the Draft Harvest Strategy suggests reductions are required for 2025/26, diver observations will be important in determining whether this is required.

4. Factors affecting the Eastern Zone abalone fishery

As with all fisheries, a number of factors may influence the productivity, sustainability and interpretation of data for the Eastern Zone abalone stocks. As discussed in recent Stock Assessment Reports, average recruitment to the Eastern Zone stocks appears to have declined over the last two decades relative to early, more productive periods of the fishery. These trends have been noted throughout southern Australia, across several commercially important abalone species. In addition, changes in market conditions have also influenced the fishery dynamics, which in turn influences the interpretation of catch data.

Environmental influences

In recent years, diving conditions at the Marlo SMU have been reported to be poor, due to fresh water outflow from the Snowy River. While this has affected the total effort and catch from the Marlo SMU, the impacts of this water on the productivity of the stock are currently unknown. The EZAIA are currently investing in investigations into these impacts on the fishery.

Sea urchins

Another factor that has substantially impacted the Eastern Zone fishery is the incursion of sea urchins. Long-spined sea urchins (*Centrostephanus rodgersii*) are endemic to New South Wales waters, but in recent decades they have spread further south into eastern Victorian and eastern Tasmanian coastlines. Appendix 7 provides information on sea urchin abundance obtained from the abalone FIS that was updated for the 2022/23 stock assessment report (Dixon et al 2023).

Market forces

The following information was provided by Mr Charles Nelson, Operations Manager at Mallacoota Abalone Ltd (i.e. the Mallacoota Co-operative), which processes most of the Eastern Zone abalone catch.

There are two key factors that influence the interpretation of CPUE and mean catch per day analyses. The first is daily catch limits and the second is an increased demand for large abalone, particularly through the “live” abalone market which obtains a higher price per kg (ranging from $9/kg to 18/kg higher during the recent years).

The Mallacoota Co-op was lost during the bushfires of 2019/20 (around new year). The factory was rebuilt and operations recommenced in June 2020. Around this time, the abalone market was also severely impacted by Covid-19. Upon reopening, the factory began processing for the “live abalone” market in response to changes in the market price. The size and weight of individual abalone for canning/frozen is much lower than that for the live market. As a result, divers fishing for the live market will either target SMUs that have higher LML’s, or alternatively, will leave some legal-size abalone alone and fish to a higher size limit. In the latter case, the choice of market will therefore substantially affect CPUE. Some divers fish for live only, however others “split off” the larger abalone from their catch for the live market while the rest go for canning/frozen.

Daily catch limits imposed by the Co-op for individual divers are variable and are worked out daily, based on the desired throughput and the number of divers that wish to work each day. Typically, the factory aims to process 2,400 kg for canning/frozen and 1,000 kg for the live market each day. If ten divers fished on one day, for example, each would receive an allocation of 240 kg of canning/frozen catch, and 100 kg of live catch. Desired throughput is determined by things such as market requirements, staffing levels and key absences within operational staff. These types of processor-driven daily catch limits greatly influence the interpretation of mean daily catch data.

5. Conclusions and recommendations

5.1 The approach to stock assessment

As reported in previous Stock Assessment Reports and associated review documents, there are substantial uncertainties associated with the two primary sources of data for assessment. CPUE data are positively biased due to hyperstability, and therefore present an overly optimistic assessment of stock status. FIS data are negatively biased because historic FIS site locations are not representative of the entire stock, and thus they represent an overly pessimistic assessment of stock status. As a result, in recent years VFA have requested reviews of the current CPUE standardisation approach (Dichmont et al 2022) and the FIS approach (Dixon 2023). This report is the first to use a revised CPUE standardisation model that has been developed through the ASWG. In 2024, new fixed transects were established at some of the “Top 15” historic sites to test the establishment of the new fixed transect approach, and to provide comparison data between FIS methods. Establishment of new fixed transect sites in shallow water reefs representative of the current fishing grounds is planned to commence in 2025. Reviews of other components of the management system are also required over time as the assessment framework is refined (e.g. Performance Indicators, Harvest Strategy, Management Plan).

Uncertainties in the available data have resulted in assessment outcomes that have been misleading in recent years. A 2022 report by MRAG (Dixon et al 2022) highlighted how poorly the outcomes from the weight of evidence assessment and Draft Harvest Strategy had translated into TACC outcomes for the Eastern Zone. This reflected a lack of confidence from industry in the assessment outcomes, with most TACC decisions being based on industry views rather than the stock assessment outcomes. In 2024, the industry voluntarily proposed large cuts to the TACC to reduce fishing mortality rates in the hope of halting declines in biomass. These reductions were well beyond those suggested through the Draft Harvest Strategy. Large reductions in OTs were implemented at five of the seven SMUs: Mallacoota Central, Marlo, Mallacoota East, Mallacoota West and Mallacoota Small.

This assessment is based on information for the 2023/24 season, which ended on 30 March 2024. The large reductions in TACC implemented last year are for the current 2024/25 season. Analyses of up-to-date data from the 2024/25 season will be provided at the TACC setting meeting in December but are not included in this report. As expected, this year’s report identifies concerning trends in the primary data source of commercial CPUE, which result in suggested reductions in TACC through the Draft Harvest Strategy. However, the proactive reduction in TACC proposed by industry at last year’s TACC setting meeting has effectively “gotten ahead” of the need for TACC reductions based on 2023/24 data. As a result, the advice provided in this report at the SMU scale is effectively a “wait and see” approach regarding the need for further reductions in OTs, particularly at SMUs that have already been substantially reduced. On this basis, the observations of divers at these SMUs will be critical in determining whether further reductions in OT are required.

5.1.1 CPUE standardisation

This year’s report for the Eastern Zone is the first to use a revised CPUE standardisation, agreed through the ASWG. The revised model is a modified version of that recommended through the CPUE standardisation review (Dichmont et al 2022). Compared to the previous model (Giri and Gorfine 2018), the revised model has removed some of the previous interaction terms that were considered to cause unnecessary complication, and importantly, has replaced the “month” term with a “quarter” term which is considered to better reflect the patterns of fishing across a year. In addition, a revised set of filters on the input dataset has been applied to remove many of the influential outliers.

Importantly, it must be acknowledged that the key issues with hyperstability of CPUE remain. However, the revised model does show some departure from the nominal mean over time at the Zone level and at most SMUs. While this does not mean it is representative of trends in biomass, a departure away from the nominal mean in the negative direction would be expected under the scenario of reduced biomass over time which has occurred for the Eastern Zone. This provides some indication that the current model is a better representation of changes in biomass than the previous model. Further improvements to the CPUE standardisation are expected to continue, developed through the ASWG.

5.1.2 Performance Indicators

Previous reports have identified that the current Performance Indicators require review. The Performance Indicators are assessed for the long-term from 2003 to current and for the short-term from 2009 to current. This was a highly productive period of the fishery and clearly stocks have declined substantially since that time. These reference points would be useful if the objective for the fishery was to recover stocks to 2003 levels, however no such objectives exist at this time. It is recommended that explicit biological objectives regarding stock status (i.e. stock recovery objectives) are determined to help inform an appropriate performance assessment.

In this report, we include an additional analysis of the Performance Indicators over the last four years, which aligns with the timelines of the Draft Harvest Strategy. We also included a performance measure of mean daily catch which could be considered in a future review, however we note that this measure has been substantially affected by market forces in recent years. While CPUE will likely remain a key performance measure in the future, the issues associated with hyperstability need to be better accounted for. That said, the revised CPUE standardisation model does demonstrate some departure from the nominal in a manner expected for a stock in decline. The current FIS program is being restructured with new sites likely being implemented in current fishing grounds in 2025. However, it will be several years before meaningful data are available that can inform performance measures. Finally, the review of Performance Indicators must include potential measures that can be derived from commercial effort logger data that have been gathered for the last two years.

5.1.3 Draft Harvest Strategy

Like all fishery assessment tools, harvest strategies evolve over time as new information is acquired. The current Draft Harvest Strategy was first implemented in the 2017/18 season. Since 2018/19, results from the Draft Harvest Strategy have been prepared as a separate report and have also been included explicitly in this report and the stock assessment process. The six most recent stock assessments have used an independent weight of evidence assessment for each SMU and compared these directly with the Draft Harvest Strategy outcomes. These two sources of information have then been presented at TACC setting meetings where final recommendations on the OT for an SMU are determined by stakeholders.

Previous assessments have described weaknesses associated with the Draft Harvest Strategy including the heavy reliance on hyperstable CPUE data, the limited influence of the tertiary indicator (which is no longer available), non-conservative reference levels that determine limit, threshold and target values, and the reliance on data from a previous season to inform a TACC for a future season. These issues should continue to be addressed through the ASWG.

This year’s Draft Harvest Strategy results used the revised CPUE standardisation model. As for previous years, the Reference Points were also based on the standardized CPUE time series. It is worth noting that the Reference Points in the published Draft Harvest Strategy (VFA 2019b) based on nominal CPUE are more conservative, however their use would have made no difference to the recommended OTs for any of the SMUs this year. This is primarily because the current Reference Points are not appropriate for the fishery, as highlighted by the fact that all SMUs are currently well above the Threshold levels despite large cuts in OT being implemented for most SMUs in recent years.

The FRDC Project 2019-118: Drawing strength from each other: simulation testing of Australia's abalone harvest strategies, is close to completion. Dr Cathy Dichmont shared some of the results of the Management Strategy Evaluation (MSE) work with MRAG staff prior to its publication. The main criticism of the current Harvest Strategy is that it is overly conservative and, under certain circumstances, can result in declines in catch over time. Theoretically, this occurs when CPUE fluctuates with variation around a stable mean level so that the Secondary Indicator drives the Primary Category result. Nevertheless, it should be noted that TACC decisions for the EZ have not followed the outcomes of the Harvest Strategy in recent years. Moreover, having some conservatism in the Harvest Strategy when stocks have been in decline should be seen as a positive. It is hoped that the MSE model can be used to help inform the development of a revised harvest strategy for the fishery in future.

5.1.4 Weight of evidence

The weight of evidence assessment is impeded by the same data uncertainties as the Harvest Strategy and Performance Indicators, particularly regarding the importance of CPUE as the primary data source. The FIS review identified that historic FIS site locations are no longer representative of the current fishing grounds. The Top 15 sites provide some data for sites adjacent to the current fishing grounds, however these data need to be augmented with data from shallower sites to provide a reliable index of abundance at the Zone scale, across current fishing grounds. This year's report includes analysis of mean catch per day, however changes in marketing/processing forces arrangements have influenced the interpretation of mean catch per day data in recent years. An improved understanding of daily catch limits per individual diver may help to improve this measure.

Length frequency data from the commercial catch were only collected up to 2018/19 and length frequency data gathered during FIS include two sources of bias that mean they should be given little weight in the assessment of stock status.

5.2 TACC setting and Optimal Target catches

The TACC setting process occurs in December of each year for the Eastern Zone, around two thirds of the way through a current quota year. TACC setting is complicated by the lag in time between the assessment of stock status based on data from the previous quota year and the need to establish a TACC for the following quota year (i.e. a full year lag). In the last three years, informal assessments of up-to-date summaries of catch (SMU and reefcode) and CPUE (SMU only) have been provided at the TACC setting meeting, and this will occur again in December 2024. However, future assessment processes should aim to incorporate all available data into the assessment and TACC setting process in a formal manner. It is expected that progress of this will occur through the ASWG in the next few months.

The importance of timely data has never been more apparent than for this year's assessment process. This report identifies concerning trends in the primary data source of commercial CPUE, which results in suggested reductions in TACC through the Draft Harvest Strategy. However, last year's TACC was reduced substantially from 284 t to 208 t following a recommendation by industry. In the last two years, substantial reductions in OT have been made for five of the seven EZ SMUs. On this basis, the recommended reductions in OT through the Draft Harvest Strategy are not necessarily required because the industry has predetermined "gotten ahead" of these outcomes and made the cuts voluntarily before the Harvest Strategy can take effect. The two SMUs where the OT has been largely maintained are the Airport SMU and the Mallacoota Large SMU. It is noted that the Draft Harvest Strategy outcomes for both SMUs is Stable.

The large reduction in TACC that was implemented voluntarily by industry for the 2024/25 season was a responsible decision that reflects concerns over declining biomass across most of the fishery. Any response in stock status will not be observed in available data immediately. On this basis, it is recommended that the current OTs remain stable in the short-term, unless individual diver observations suggest that further reductions in OT are required at some SMUs. Increases in TACC should not be considered until clear evidence of stock recovery over several years is apparent.

5.3 Eastern Zone trends in available data

The commercial catch in the Eastern Zone for 2023/24 was 284.5 t, which was close to 100% of the TACC (284.6 t). Catches in recent years have been the lowest observed since commercial logbook data were gathered the fishery (from January 1969). The 2023/24 catch was 41% lower than that harvested in 2003/04 and 38% lower than that harvested in 2009/10. The TACC for the current 2024/25 season was reduced to 208 t.

Mean daily catch in 2023/24 was 367.8 kg/day, which was 14% lower than 2003/04 (426.5 kg/day), 15% lower than the 2009/10 (433.3 kg/day), but 33% higher than 2020/21 (277.5 kg/day). Mean daily catch has been substantially impacted by market forces in recent years and thus recent trends should be interpreted cautiously.

Standardised CPUE (95.8 kg/h) has declined in recent years and is currently 3% lower than 2003/04 (98.6 kg/h), 11% lower than 2009/10 (107.7 kg/h), and 6% lower than 2020/21 (102.2 kg/h). Fishing effort is around 30% of the historic high levels. CPUE has also been influenced by market factors in recent years, with some effort targeting the live market which requires only large abalone to be harvested. The extent of the impact of this on CPUE is unknown.

Ten of the "Top 15" historic sites were surveyed in 2024. Of these ten sites, six were near Mallacoota and four were near Marlo. The six Mallacoota sites showed some increases in total abundance relative to recent years, while the four Marlo sites show further decreases in total abundance. While these sites are not considered representative of the current fishery, the declines in abundance at Marlo correlate with diver views that this region has declined in abundance in recent years, potentially the result of environmental factors associated with higher water flows exiting the Snowy River.

5.4 Eastern Zone Stock Status

The latest Status of Australian Fish Stocks (SAFS) assessment of the Victorian Eastern Zone Abalone Fishery is based on data up to and including 2021/22 (Mundy et al. 2024). The authors conclude *"Given the uncertainties around both CPUE and the fishery independent surveys, there is considerable uncertainty in the trajectory of the biomass in the Victorian Eastern Zone management unit [Dixon et al. 2022]. However, it is apparent that there have been significant declines in biomass over the last 2–3 decades, and recent landings have not been consistent with targets meaning several SMU have received a disproportionally high level of fishing pressure [Dixon et al. 2022] and are therefore likely to have experienced further declines in biomass. Coupled with the effects of increased urchin abundance, the available evidence indicates that the biomass of Blacklip Abalone in the Victorian Eastern Zone management unit is still declining, but not to the extent that the stock could be considered to have become depleted or recruitment impaired.*

On the basis of the evidence provided above, the Victoria Eastern Zone Fishery management unit is classified as a depleting stock.".

The above assessment was based on the 2021/22 Stock Assessment Report (Dixon et al 2022). Since then, further reductions in TACC have been implemented, particularly for the current 2024/25 season where the TACC was reduced from 284 t to 208 t. This report identifies further declines in

CPUE for the 2022/23 season, however the industry/VFA have already acted upon these trends by taking the large reductions in TACC for 2024/25.

The factors affecting the Eastern Zone stock over the last two decades appear to have affected most, if not all, Australian abalone stocks, primarily through reduced recruitment over a prolonged period (at least two decades). In addition, sea urchins have increased in abundance and have reduced the available habitat for abalone in the Eastern Zone. The EZAIA is also investigating potential impacts from higher recent water flows from the Snowy Rover that may have impacted abalone stocks in the Marlo SMU.

While the causes for decline in biomass are important to understand, the primary tool available to the fishery to manage these impacts is through appropriate management of fishing mortality (i.e. the TACC). It was encouraging to see that proactive decisions were made on a voluntary basis by industry, supported by VFA, through large reductions in TACC for the 2024/25 season. It is too soon to determine whether these reductions have been sufficient to halt the biomass decline. On this basis, the status of the stocks remains as “declining”.

5.5 Future Monitoring and Research

The research, assessment and management framework for the fishery is currently undergoing a period of critical review and development. Reviews of CPUE measures and the FIS program have been in progress for the last few years. The need for other reviews has been identified, including review of performance measures, Draft Harvest Strategy, and the Management Plan.

In February 2024, the ASWG was established by VFA to utilise the experience and expertise of independent scientific personnel, fishery managers and abalone industry members to provide recommendations on how best to assess and monitor the Victorian Abalone Fishery. Industry participation in the research planning process through the ASWG is critical in improving the assessment framework, and engendering acceptance of its outcomes. The short-term priorities identified by the ASWG for 2024 were focussed on improvements to the stock assessment process, specifically changes to the filters applied to the CPUE dataset, and changes to the CPUE standardisation modelling. These changes have been incorporated into this report.

This year’s report has highlighted several issues that should be considered by the ASWG in the short-term. In particular, the time lag between the data used in this assessment and the Draft Harvest Strategy needs to be reduced. For the last three years, up-to-date data have been provided to MRAG by VFA in November, one month prior to the TACC setting process. These data are analysed by MRAG and are presented at the TACC setting forum. Undoubtedly, the assessment would be substantially improved if these data were formally included in this report, however there are several logistical issues that currently prevent this from occurring (including the time taken to prepare reports, and the format of the up-to-date data provided to MRAG In November).

A key source of data for future assessments will be commercial logger data that can provide spatial assessments of effort and size structure of the catch. In addition, depth and water temperature data should be gathered through a depth logger program. These data have been routinely gathered in the Western and Central Zones for several years, as well as other abalone producing States. Increasingly, commercial logger data are being formally included into the assessment process in other States, and the establishment of these programs remains an urgent priority for the Eastern Zone.

6. References

DEDJTR. 2015. “Victorian wild harvest fishery management plan – 2014.” Melbourne: Department of Environment; Primary Industries.

Dichmont, C.M, Dixon, C.D., and Potts, J. (2022). Developing a new CPUE standardisation for the Central and Eastern Zones of the Victorian Abalone Fishery. MRAG Asia Pacific, Brisbane, Australia.

Dixon, C., and D. Dichmont. 2019. “2018/19 Draft Stock Assessment for the Eastern Zone of the Victorian Abalone Fishery.” MRAG.

Dixon, C.D., Potts, J. and Dichmont, C.M. (2020). Draft Stock Assessment for the Eastern Zone of the Victorian Abalone Fishery 2019/20. MRAG Asia Pacific, Brisbane, Australia.

Dixon, C.D., Potts, J. and Dichmont, C.M. (2021). Draft Stock Assessment for the Eastern Zone of the Victorian Abalone Fishery 2020/21. MRAG Asia Pacific, Brisbane, Australia.

Dixon, C.D., Potts, J. and Dichmont, C.M. (2022). Assessment of the Central and Eastern Zones of the Victorian Abalone Fishery 2019/20 to 2021/22. Final Report. MRAG Asia Pacific, Brisbane, Australia.

Dixon, C.D. (2023). Review of fishery-independent surveys for the Central and Eastern zones of the Victorian abalone fishery. Year 1 Report. MRAG Asia Pacific, Brisbane, Australia.

Dixon, C.D., and Lowe, J. (2023). Stock Assessment for the Eastern Zone of the Victorian Abalone Fishery 2022/23. MRAG Asia Pacific, Brisbane, Australia.

Giri, K., and H. Gorfine. (2018). “Application of a mixed modelling approach to standardize catch-per-unit-effort data for an abalone dive fishery in Western Victoria, Australia.” *Journal of the Marine Biological Association of the United Kingdom*, 1–9.

Gorfine, H., Forbes, D., and Gason, A. (1998). A comparison of two underwater census methods for estimating the abundance of the commercially important blacklip abalone, Haliotis rubra. Fisheries Bulletin 96: 438-450.

Gorfine, H., Taylor, B., and Smith D.C. (2008). Abalone - 2001. Fisheries Victoria, Assessment Report Series No. 43.

Hart, A. 2017. “Review of fixed sites surveys used by the Victorian Abalone Science Program.” Independent Review for VFA. A. Hart, WAFRML.

Hart, A., and H. Gorfine. 1997. “Abundance Estimation of Blacklip Abalone (Haliotis rubra) II. A Comparative Evaluation of Catch-Effort, Change-In-Ratio, Mark-Recapture and Diver-Survey Methods.” *Fisheries Research* 29: 171–83.

Miner, C. M., J. M. Altstatt, P. T. Raimondi, and T. E. Minchinton. 2006. “Recruitment failure and shifts in community structure following mass mortality limit recovery prospects of black abalone.” *Marine Ecology Progress Series* 327: 107–17.

Mundy, C., and H. Jones. 2017. “Tasmanian abalone fishery assessment 2016.” Institute for Marine; Antarctic Studies, Hobart. MRAG 2019. Draft Stock Assessment for the Eastern Zone of the Victorian Abalone Fishery 2018/19.

Mundy, C., R. Chick, B. Stobart, VFA and L. Strain. 2021. “Blacklip abalone *Haliotis rubra rubra*.” In, Toby Piddocke, Crispian Ashby, Klaas Hartmann, Alex Hesp, Patrick Hone, Joanne Klemke, Stephen Mayfield, Anthony Roelofs, Thor Saunders, John Stewart, Brent Wise and James Woodhams (eds) 2021, Status of Australian fish stocks reports 2020, Fisheries Research and Development Corporation, Canberra.

Mundy, C., R. Chick, B. Stobart, VFA, L. Strain and Burnell. 2023. “Blacklip abalone *Haliotis rubra rubra*.” In, Anthony Roelofs, Toby Piddocke, Crispian Ashby, Simon Conron, Klaas Hartmann, Alex Hesp, Patrick Hone, Ian Jacobsen, Marlee Jesson-Kerr, Stephen Mayfield, John Stewart, Michael Usher, James Woodhams and Daniel Wright (eds) 2024, Status of Australian Fish Stocks Reports 2024, Fisheries Research and Development Corporation, Canberra.

VFA (2018) 2017/18 Draft Victorian Abalone Stock Assessment – Eastern Zone. Victorian Fisheries Authority Science Report Series No. Draft only.

VFA. 2019a. “Victorian Abalone - Methods used for fishery assessment, Version 1.4 30 June 2019.”

VFA. 2019b. “Draft Harvest Strategy Victorian Central and Eastern Zone Blacklip Abalone Fishery. Draft Version 2. VFA, February 2019.”

VFA (2020) Spatial and temporal trends in the abundance of long-spined sea urchins (*Centrostephanus rodgersii*) in Eastern Victoria using available fishery and fishery independent information. Victorian Fisheries Authority Science Report Series No. 10.

Appendix 1: Summary of LML changes

Summary of changes in LML for the Eastern Zone. All measurements are in millimetres. Multiple LMLs indicate different LMLs for reefcodes within an SMU. LMLs on 1 April 1998 continue to be the current legislated LMLs. All other changes are voluntary.

Date from	Marlo	Mallacoota West	Mallacoota Large	Mallacoota Central	Mallacoota Small	Airport Undersize	Airport	Mallacoota East
1 Apr 1998	120	120	120	120	110 & 120	110	120	110 & 120
2 Mar 2009	120	120	120	120	110 & 120	110	120	120
1 Apr 2009	120	120	120	120	110 & 120	110 & 112	120	120
1 Apr 2010	120 & 127	127	127	127	110 & 120	110 & 112	120	120
1 Apr 2011	120 & 125	125 & 127	138	127	110 & 120	110	120	120
1 Apr 2012	120 & 125	125 & 127	138	127	110 & 115	110 & 115	120	120
1 Apr 2013	120 & 125	125 & 127	138	127	110 & 115	110	120	120
1 Apr 2015	120 & 125	120 & 127	138	123 & 127	115	110	120	120
1 Apr 2017	120	125	138	125	115	110	120	120
1 Apr 2019	120	125	135	125	115	110	120	120

Appendix 2: Correlation between nominal CPUE and nominal FIS recruit abundance.

6.1.1 Comparison of CPUE and FIS data

The Hart (2017) review examined correlations between CPUE and FIS abundance. Among his conclusions, the author reported "*Close agreement also occurred between the recruit abundance index from the FIS programme and the commercial fishery catch rates….The correlation of these two indices means there is redundancy in the abundance indices available for assessment.*" The Hart (2017) analysis was based on data from all three Zones combined for the period 2003 to 2016.

In recent Stock Assessment Reports for the Eastern Zone, trends in CPUE and FIS abundance measures provide conflicting messages regarding the status of the stock at the Zone and SMU scales. To address this issue, we compared the three nominal measures at the SMU and Zone (bottom right) scales relative to the average of each series for ease of comparison (i.e. the grey dashed line = 1, Figure 52). The standardised trends are essentially the same as the nominal, except the series is shorter. FIS data were not gathered in 2022, so the following results were based on data up to and including 2021.

The two measures that are comparable are commercial CPUE and FIS recruits. If both were representative of the harvestable biomass, these should be highly correlated, as was found by Hart (2017). However, the figures above provide a strongly contrasting view. In all cases, CPUE has continued to increase over time. While CPUE declined from 2013 to 2016 to average levels, the rapid increases in recent years result in CPUE being around its highest contemporary levels. In contrast, recruit abundance is currently at its lowest levels at all spatial scales except for the Airport SMU, where recruit abundance is currently at the average. In general, recruit abundance was highest in the early 2000s then declined rapidly over the next decade. Thereafter, recruit abundance has stabilised at some SMUs and continued to decline slowly at others. Critically, the rapid decline observed in FIS recruit abundance was not reflected in CPUE which continued to increase until 2013, despite catches from 2003 to 2008 being the highest observed during this period (i.e. 1992 to 2021).

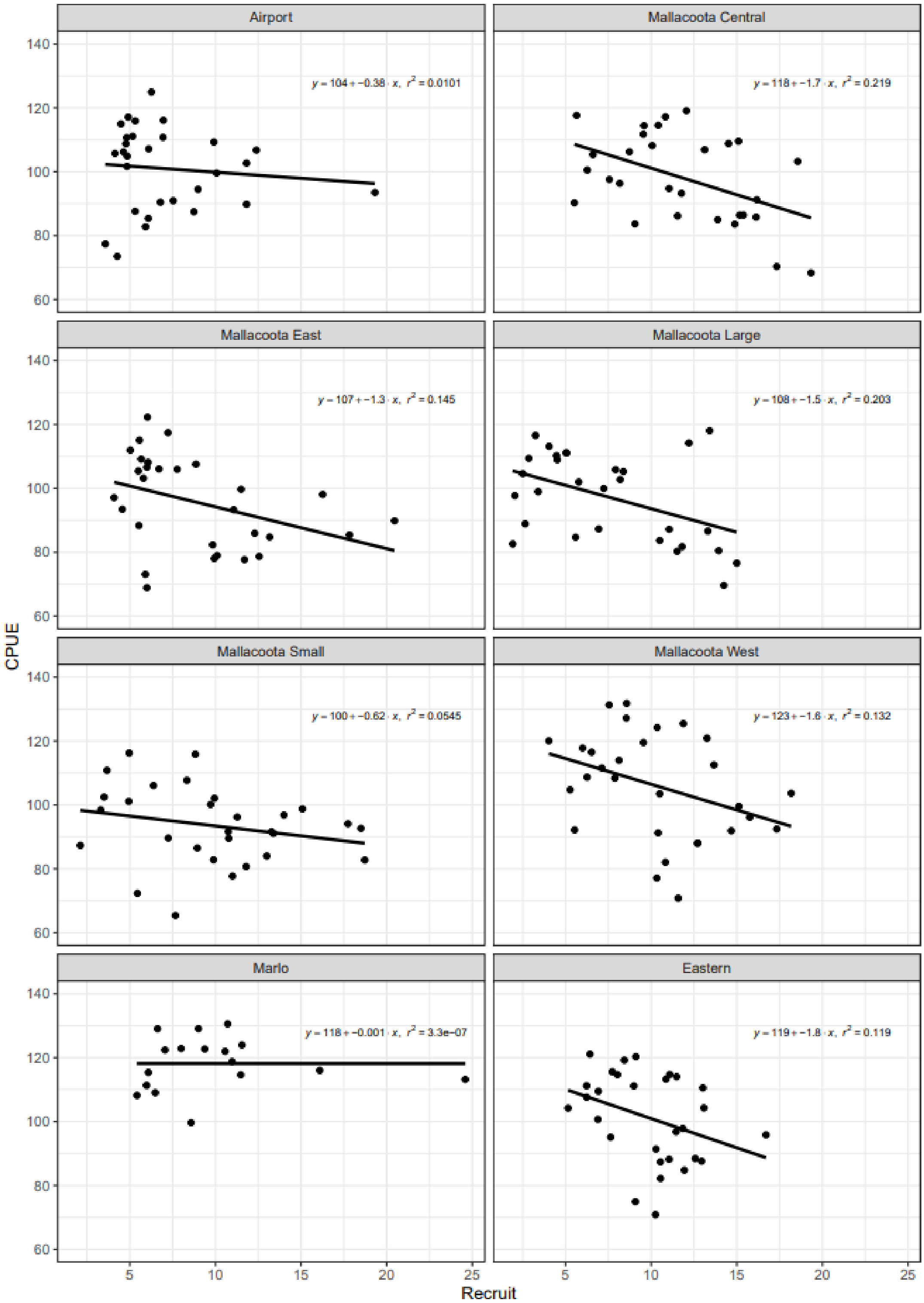
To explore the relationship between CPUE and FIS recruit abundance, we repeated the analysis of Hart (2017) for each SMU and for the Eastern Zone (Appendix 3). In his review, Hart reported a significant positive correlation between higher CPUEs and higher FIS abundance during the period

2003 to 2016 across all three Zones combined. However, using the full period of available data (1992 to 2020) and the same time series as Hart (2003 to 2016) for each SMU and for the Eastern Zone, we found no correlation at any spatial or temporal scale. It should be noted that for both analyses in this report, FIS recruits are measured consistently over time against the LML (i.e. 110 or 120 mm) whereas CPUE has been affected by voluntary size limit increases in some SMUs. This implies that the trends should be even more exaggerated than those observed.

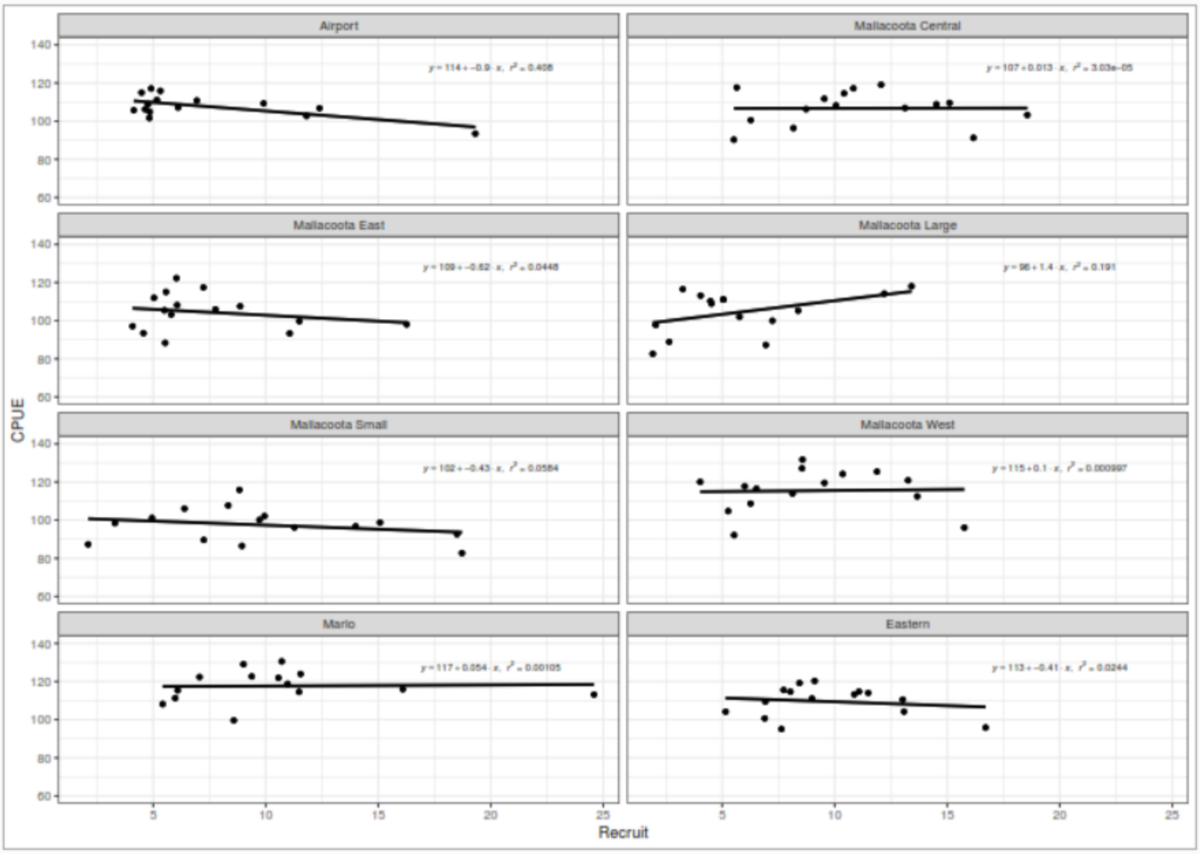
FIS pre-recruit abundance has declined at all SMUs except Mallacoota Small and is more pronounced at SMUs with higher LMLs that are assumed to be reflective of faster average growth rates (Figure 52). The magnitude of the overall decline in pre-recruits has generally been more severe than for recruit sized abalone across the time series. At the Zone scale, the steepest decline in pre-recruit abundance occurred from 1999 to 2006 and appears to be a precursor to the sharp decline in recruit abundance from 2003 to 2008 observed at these sites. While the decline in pre-recruit abundance appears to have slowed in the last 7 years, concerningly it remains a significant declining trend.

These opposing trends in the two primary data sources (rising commercial CPUEs despite substantial declines in abundance at survey sites) together with the possibility that survey sites are not representative of the main contemporary fishing grounds, severely compromises the current assessment of stock status.

Relative trends in nominal commercial CPUE, nominal FIS recruits and nominal FIS pre-recruits from 1992 to 2020 for each SMU and for the Eastern Zone as a whole. Grey dashed line represents the average for each series.



Comparison of nominal commercial CPUE (kg/h) and FIS recruit abundance (no. per site) from 1992 to 2020 for all SMUs and the Eastern Zone (bottom right).



Comparison of nominal commercial CPUE (kg/h) and FIS recruit abundance (no. per site) from 2003 to 2016 for all SMUs and the Eastern Zone.

Appendix 3: Comparison of size structure data gathered in FIS since 2003.

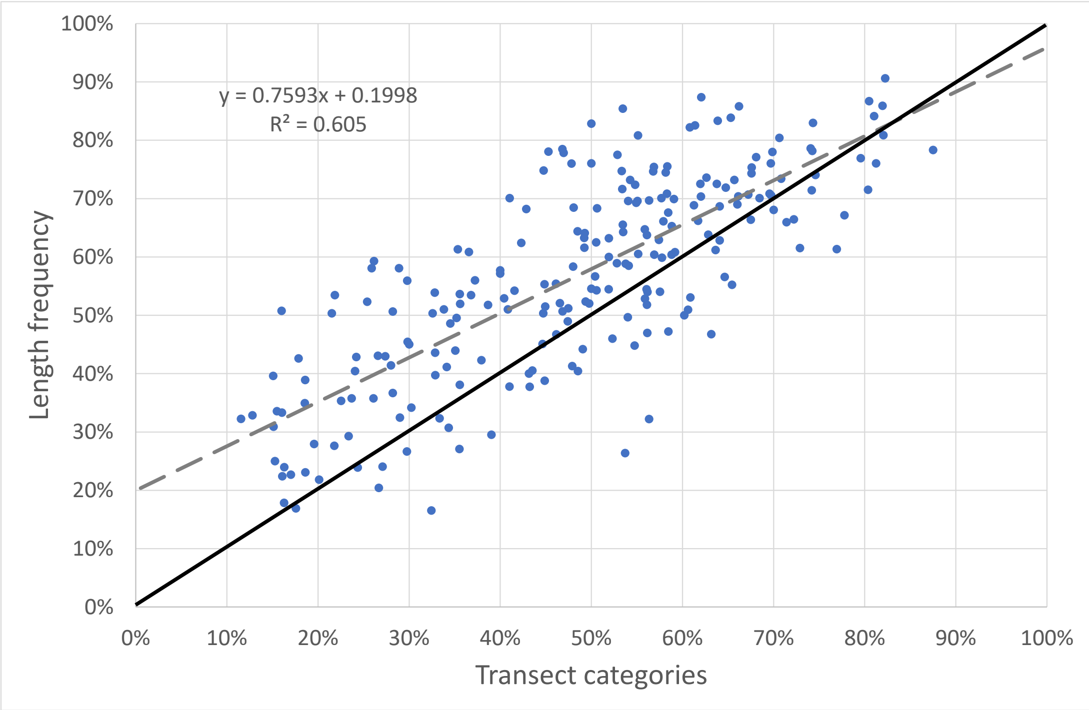
The manner in which length frequency data were gathered from historic FIS changed considerably over time. Originally, all abalone encountered on a transect were collected and brought to the surface to be measured before being returned to the bottom at the same site. This approach was modified when concerns were raised that collecting abalone from within the site may affect the abundance within the site the following year. On this basis, from 2000/01 all abalone encountered on transects were instead counted *in situ* in size categories (VFA 2019). At the end of each transect, divers were then instructed to collect the first 25 abalone randomly encountered. VFA (2019) state "*At the end of each transect 25 abalone are collected as far as possible without bias".* On this basis, it appears the objective of the random collection was to gather an independent length-frequency sample that was representative of the surveyed population within transects.

To examine how well the length frequency samples reflected the abundance on transects by size category, we converted the length-frequency data into recruit and pre-recruit abundances and compared the proportion of recruits versus pre-recruits (juvenile counts were excluded) for each data source from data gathered for the Eastern and Central Zones between 2017 and 2020. To reduce the variation in these results, sites were excluded if the total abundance encountered on transects was less than 50 abalone, which approximately halved the number of data points available for the analysis to 222 total. As a result of this reduction, the total counts from length frequency samples ranged between 95 and 158 per site.

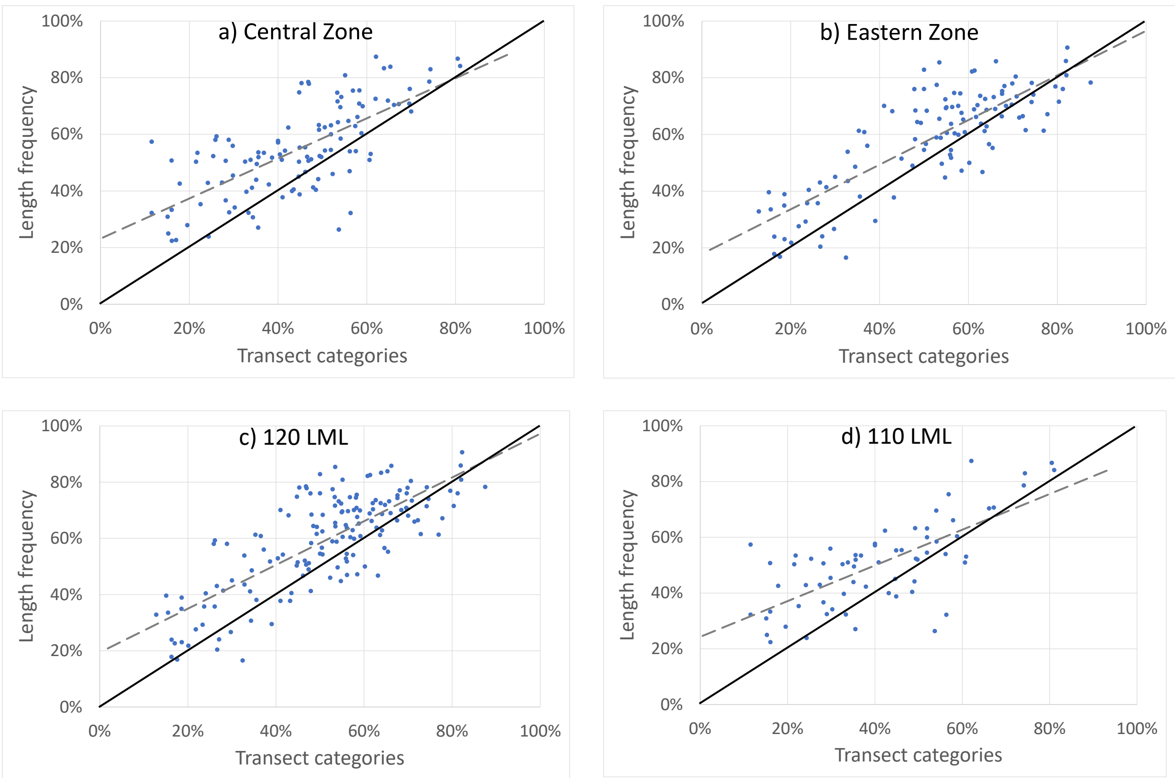
Figure 2 shows the proportion of recruits versus pre-recruits expressed as percentage of recruits for all data combined. The dashed grey line represents the line of best fit for these data. The solid black line that runs from the origin of the axis should be the theoretical line of best fit if there was no bias in these data collection methods. Clearly, there is a strong bias towards collecting larger abalone (i.e. recruits) when gathering length frequency samples at the end of each transect. This bias is strongest when the proportion of recruits observed during transects is low. Figure 3 breaks the dataset into Central and Eastern Zones, and the size limits 110 and 120 mm. The same bias exists at all spatial scales. Interestingly, data gathered from the Central and Eastern Zones were gathered by two different groups of research divers during this period, yet both showed the same trends suggesting this is more to do with the methods of data collection than the individuals involved.

It is considered unlikely that bias in size structure would result from the in situ transect counts as abalone are encountered in a systematic manner. This is supported by Gorfine (1998) who states "*Because the application of radial transacts avoids targeting some emergent abalone to the exclusion of others, there is less potential for divers to bias their sample towards larger abalone as may occur with time searches…. Time searches do not necessarily permit this separation of pre recruits from post recruits because of the potential for divers to collect larger, more accessible abalone at the expense of smaller abalone".* It seems logical to conclude that the bias in length frequency counts has resulted from divers collecting in the manner of a timed-swim and not "*as far as possible without bias"*.

The bias suggests that caution should be applied in the analysis of trends in length frequency data gathered from historic surveys, including the pre-recruit measure in the Harvest Strategy. Further, if independent length frequency samples are to be gathered away from fixed transects in any future surveys, strict methods for collection must be applied to ensure a systematic, unbiased, representative size structure is attained.



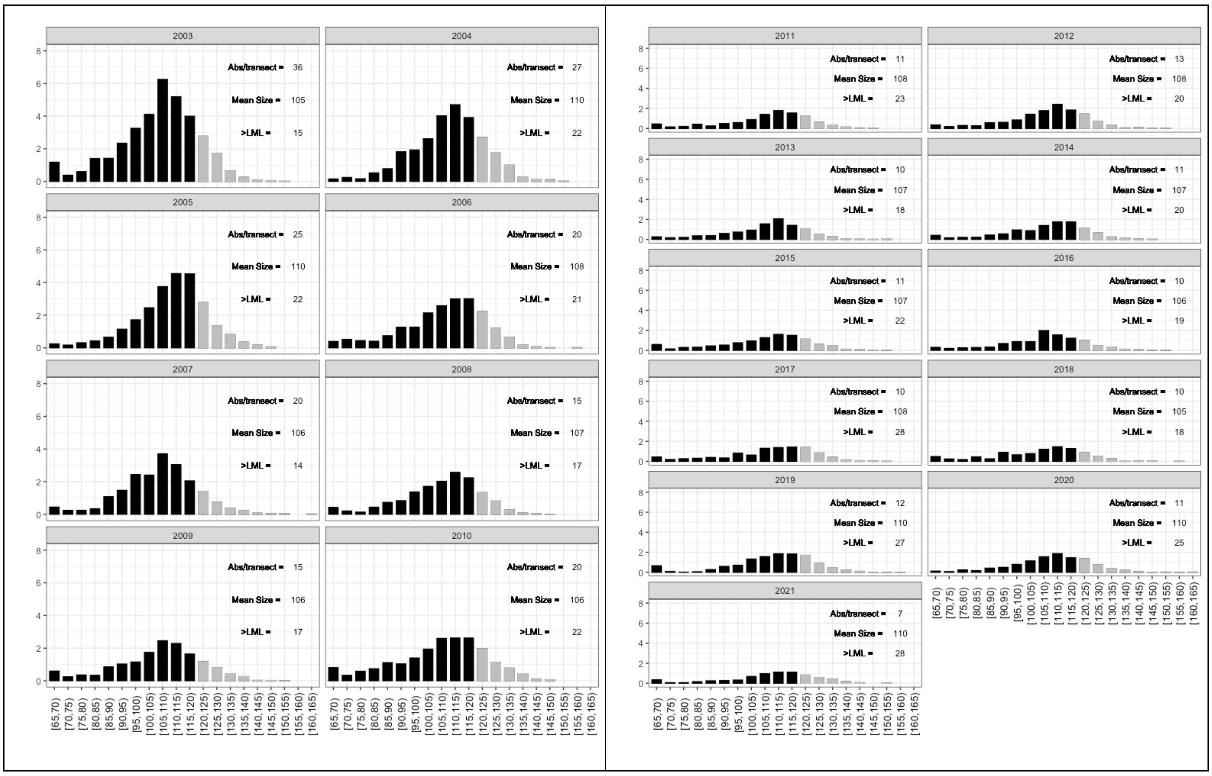
The proportion of recruits versus pre-recruits, expressed as percentage of recruits. The dashed grey line, equation and R squared represents the line of best fit for these data. The solid black line that runs from the origin of the axis should be the theoretical line of best fit if there was no bias in these data collection methods.



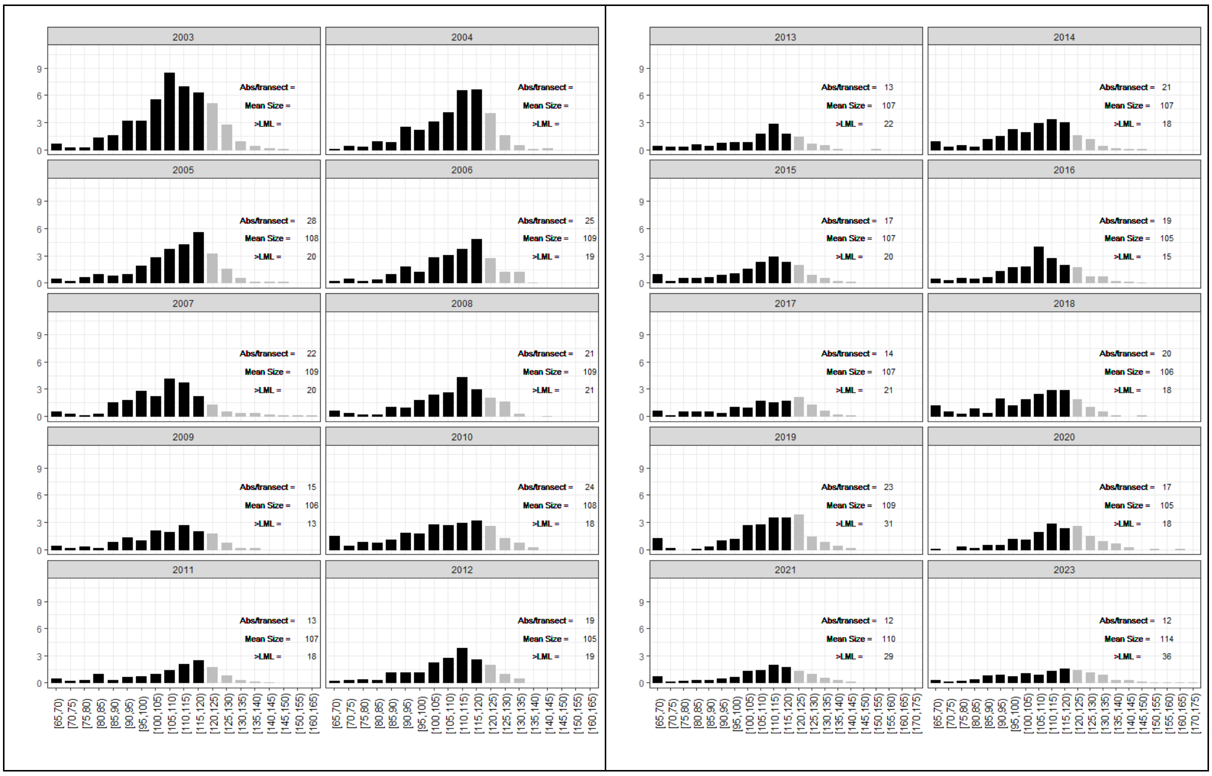
The proportion of recruits versus pre-recruits, expressed as percentage of recruits for a) Central Zone, b) Eastern Zone, c) 120 mm LML and d) 110 mm LML. The dashed grey line represents the line of best fit for these data. The solid black line that runs from the origin of the axis should be the theoretical line of best fit if there was no bias in these data collection methods.

Appendix 4: FIS length frequency data for (a) all sites and (b) Top 15 sites at each SMU

Size frequency distributions for the Airport SMU from (A) 2003 to 2021 for all sites and (B) from 2003 to 2023 for the three Top 15 sites. Black bars represent undersize abalone, grey bars represent (current) legal size abalone. FIS data were not collected in 2022. Note scales differ slightly. (A)

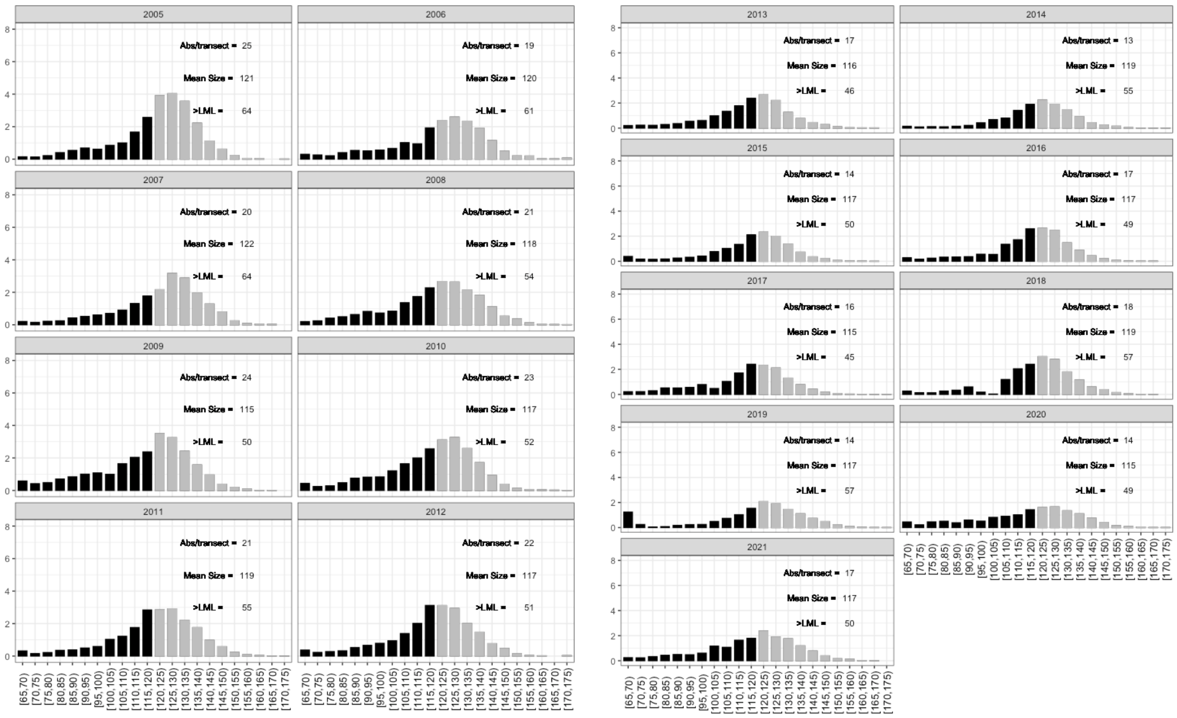


(B)

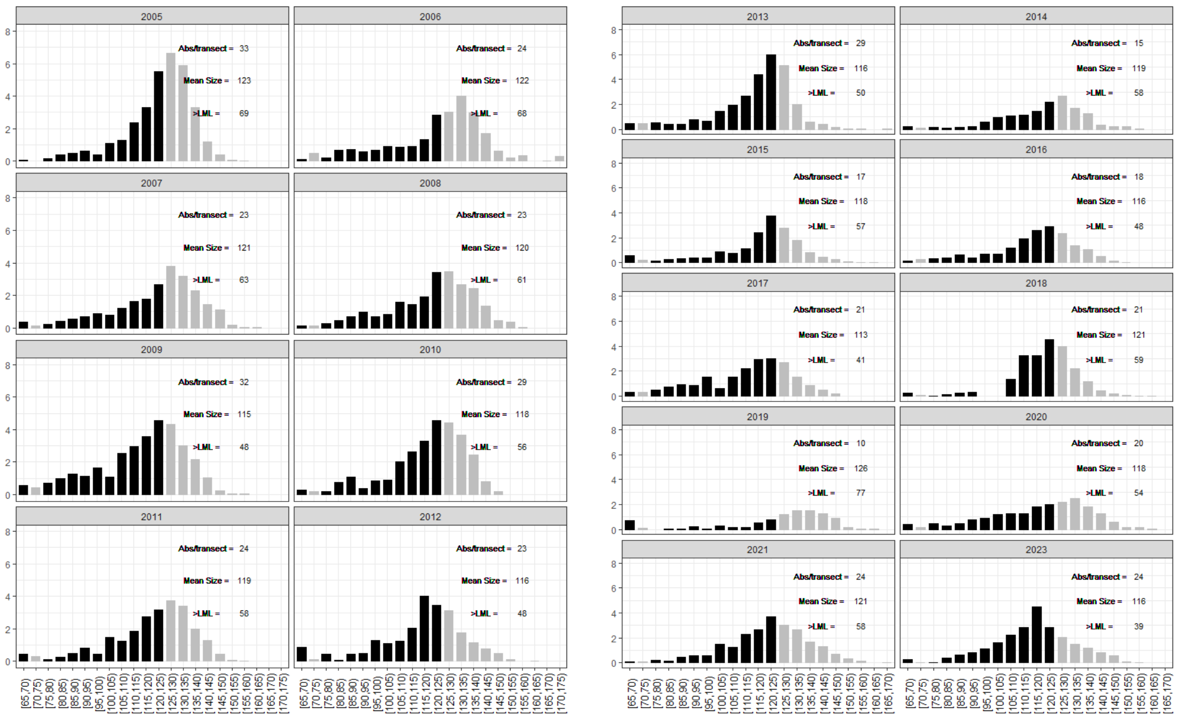


Size frequency distributions for the Marlo SMU from (A) 2003 to 2021 for all sites and (B) from 2003 to 2023 for the four Top 15 sites. Black bars represent undersize abalone, grey bars represent (current) legal size abalone. FIS data were not collected in 2022.

(A)

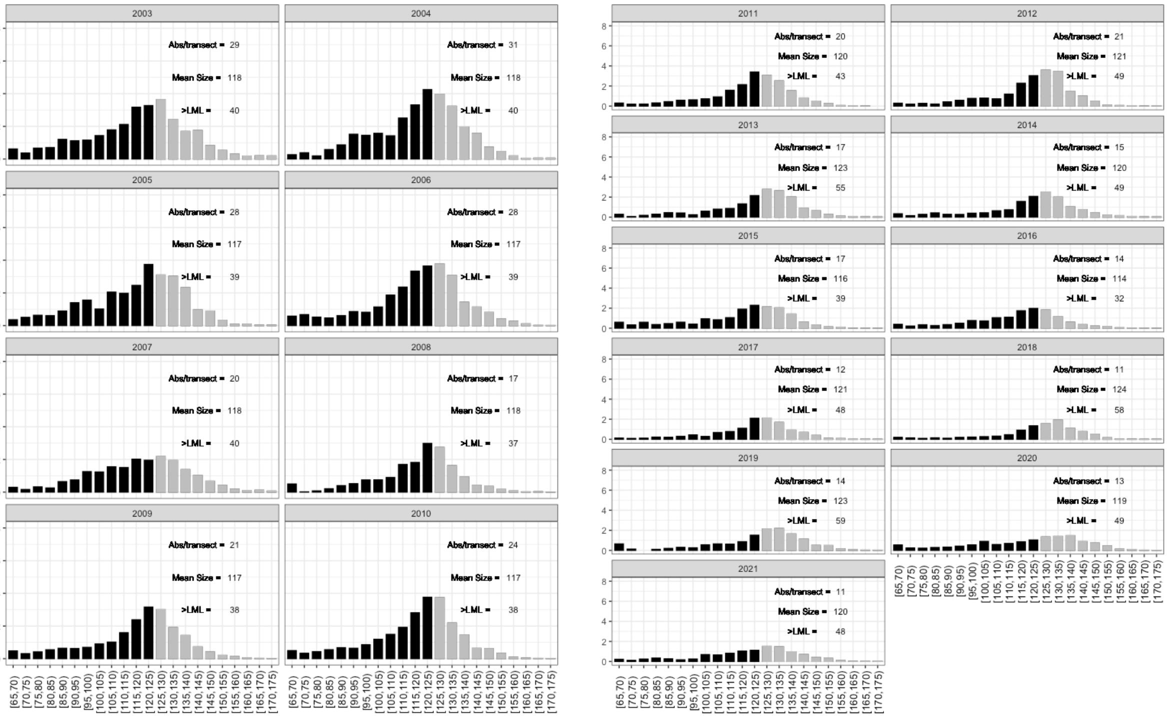


(B)

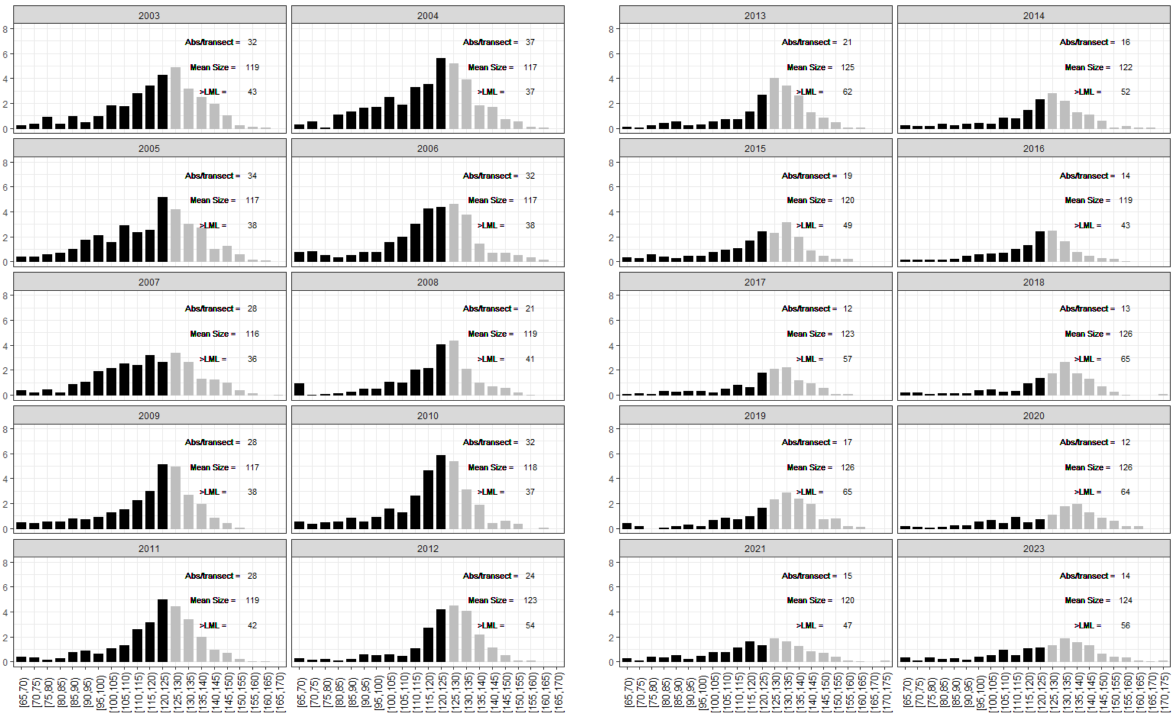


Size frequency distributions for the Mallacoota Central SMU from (A) 2003 to 2021 for all sites and (B) from 2003 to 2023 for the three Top 15 sites. Black bars represent undersize abalone, grey bars represent (current) legal size abalone. FIS data were not collected in 2022.

(A)

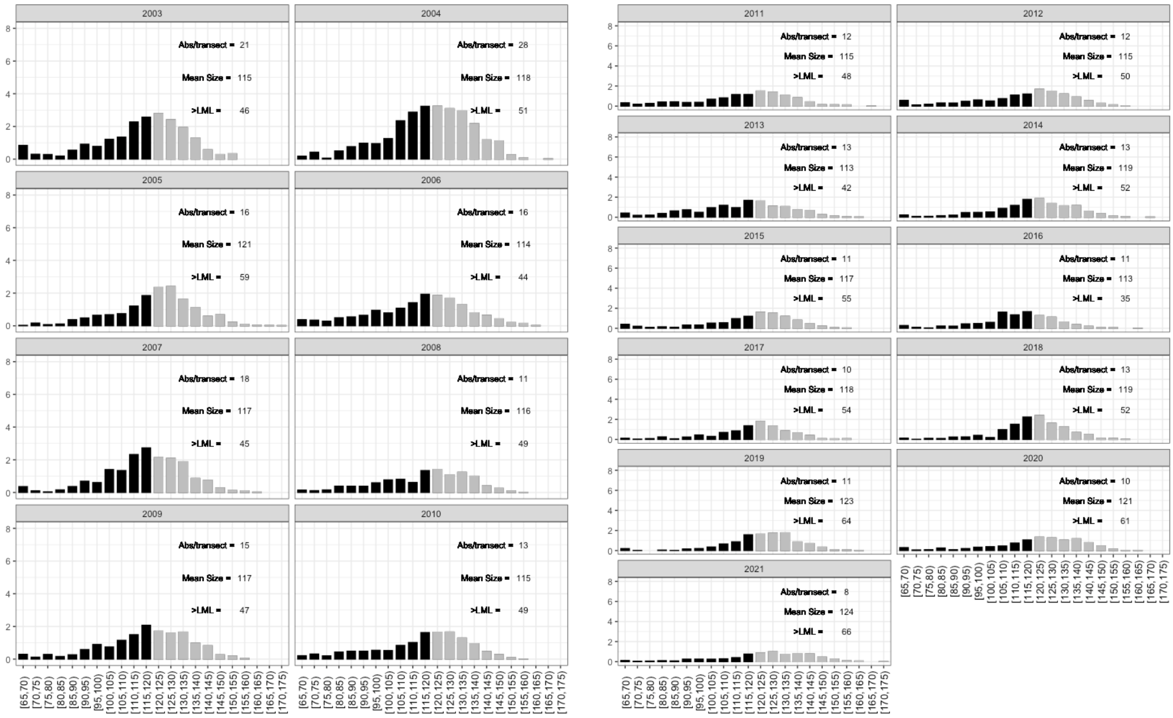


(B)

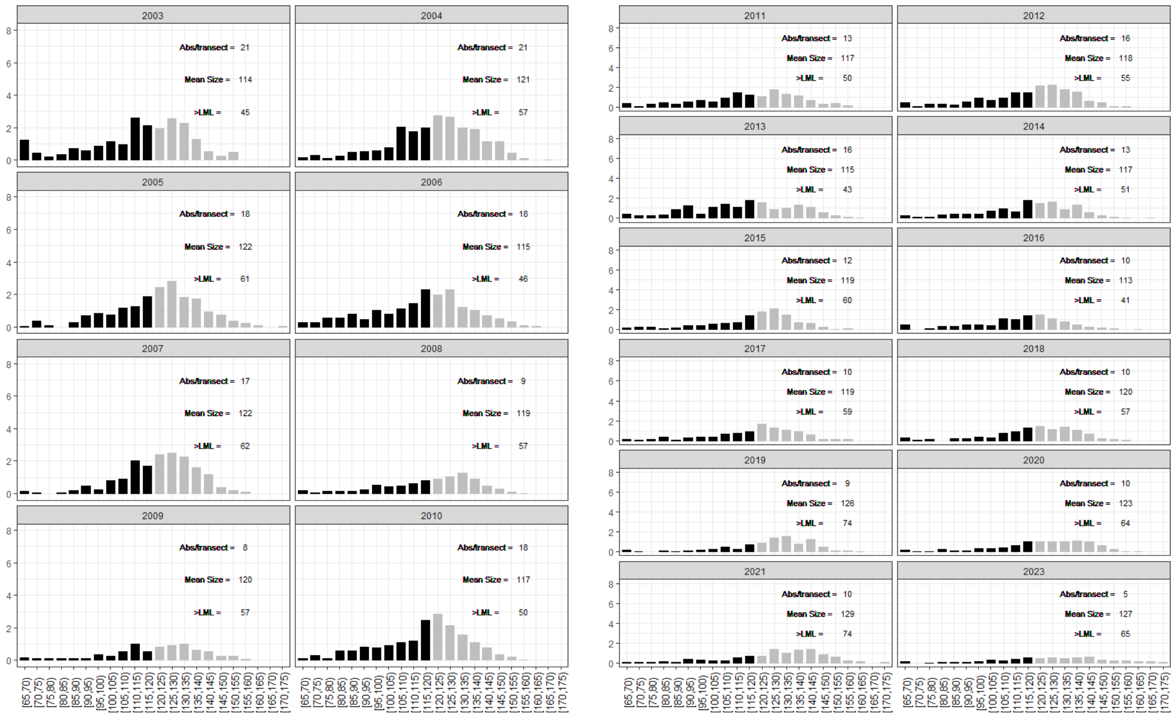


Size frequency distributions for the Mallacoota East SMU from (A) 2003 to 2021 for all sites and (B) from 2003 to 2023 for the two Top 15 sites. Black bars represent undersize abalone, grey bars represent (current) legal size abalone. FIS data were not collected in 2022.

(A)

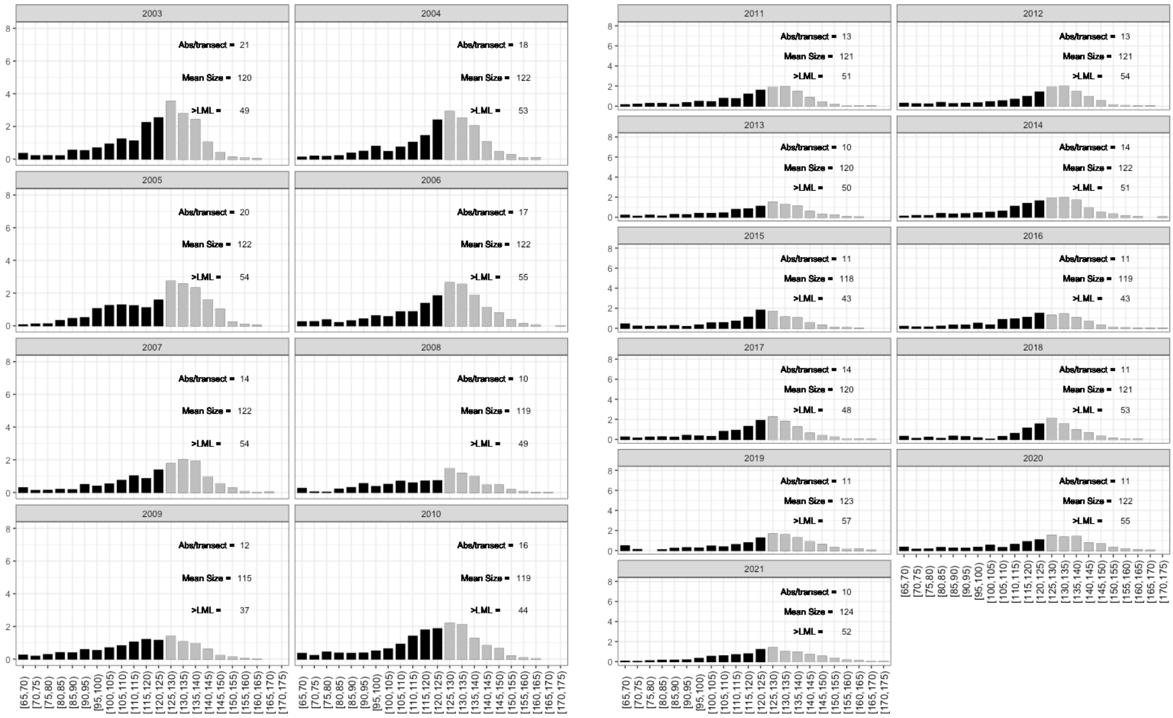


(B)

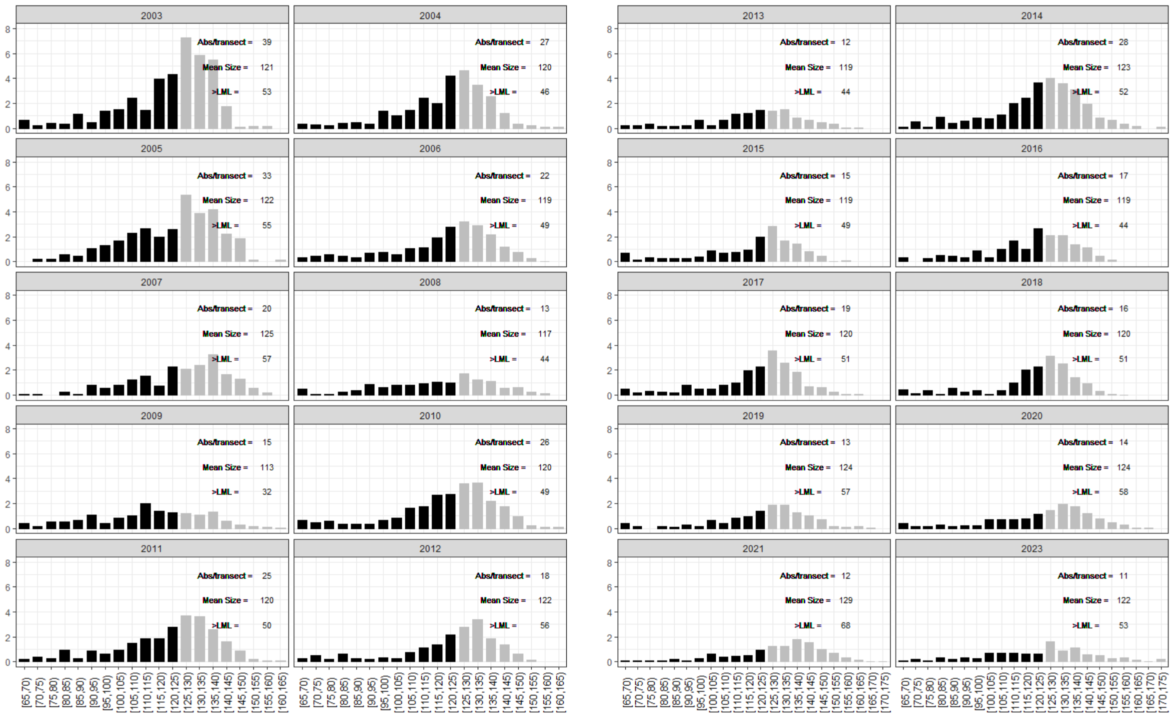


Size frequency distributions for the Mallacoota West SMU from (A) 2003 to 2021 for all sites and (B) from 2003 to 2023 for the two Top 15 sites. Black bars represent undersize abalone, grey bars represent (current) legal size abalone. FIS data were not collected in 2022.

(A)

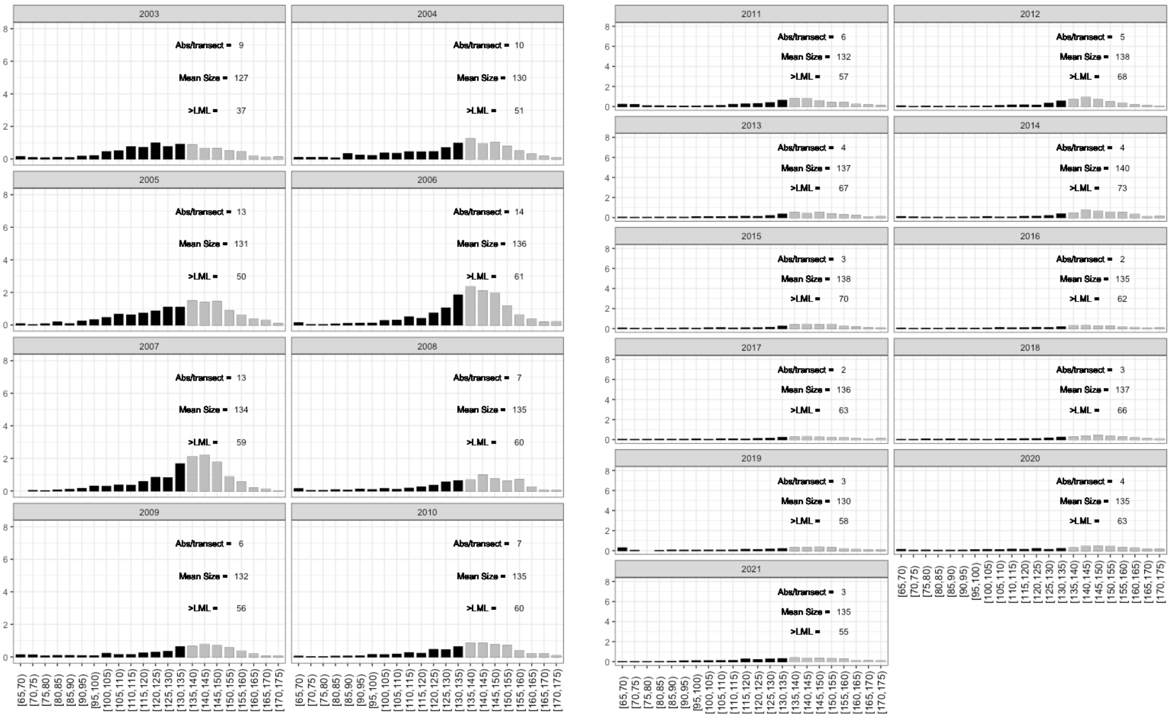


(B)



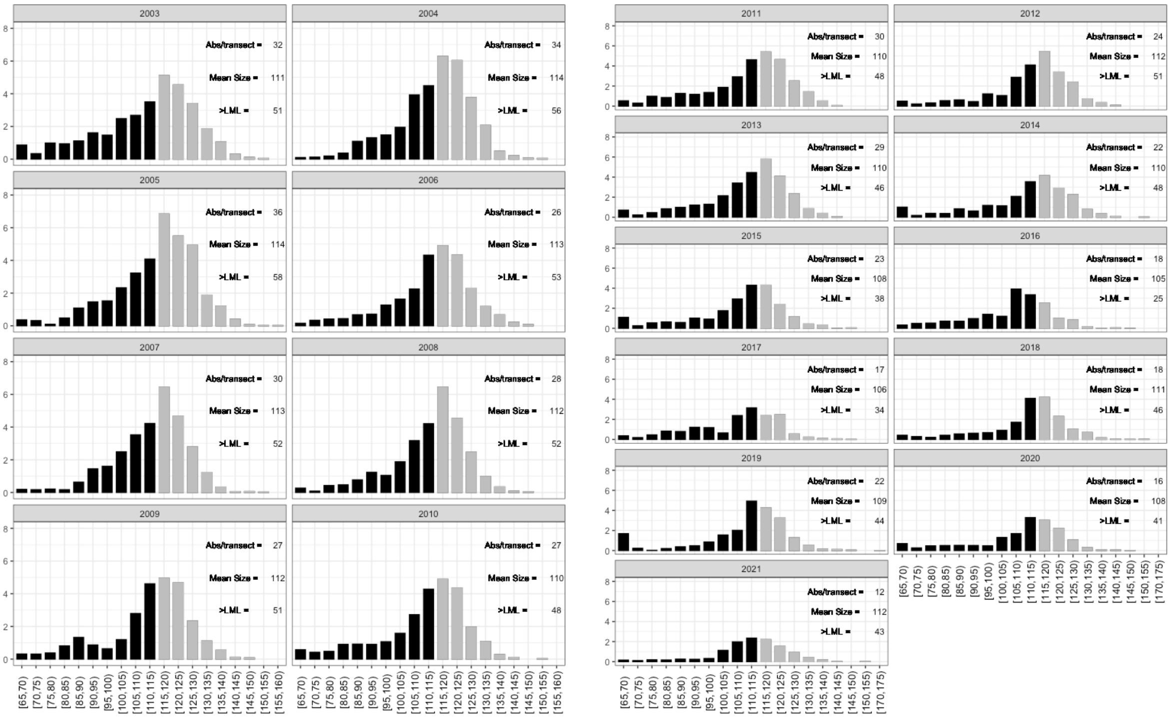
Size frequency distributions for the Mallacoota Large SMU from 2003 to 2021 for all sites There were no Top 15 sites done in the Mallacoota Large SMU in 2023. Black bars represent undersize abalone, grey bars represent (current) legal size abalone. FIS data were not collected in 2022.

(A)

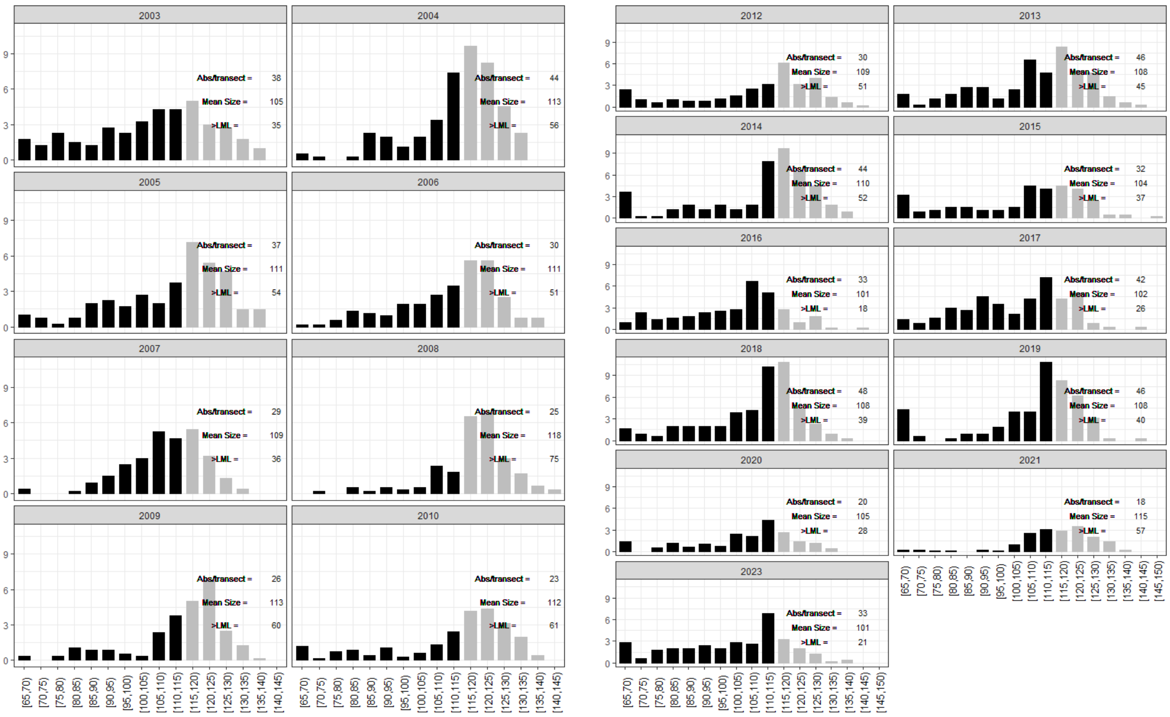


Size frequency distributions for the Mallacoota Small SMU from (A) 2003 to 2021 for all sites and (B) from 2003 to 2023 for the two Top 15 sites. Black bars represent undersize abalone, grey bars represent (current) legal size abalone. FIS data were not collected in 2022. Note the scales differ slightly.

(A)



(B)



Appendix 5: Commercial length frequency data for each SMU

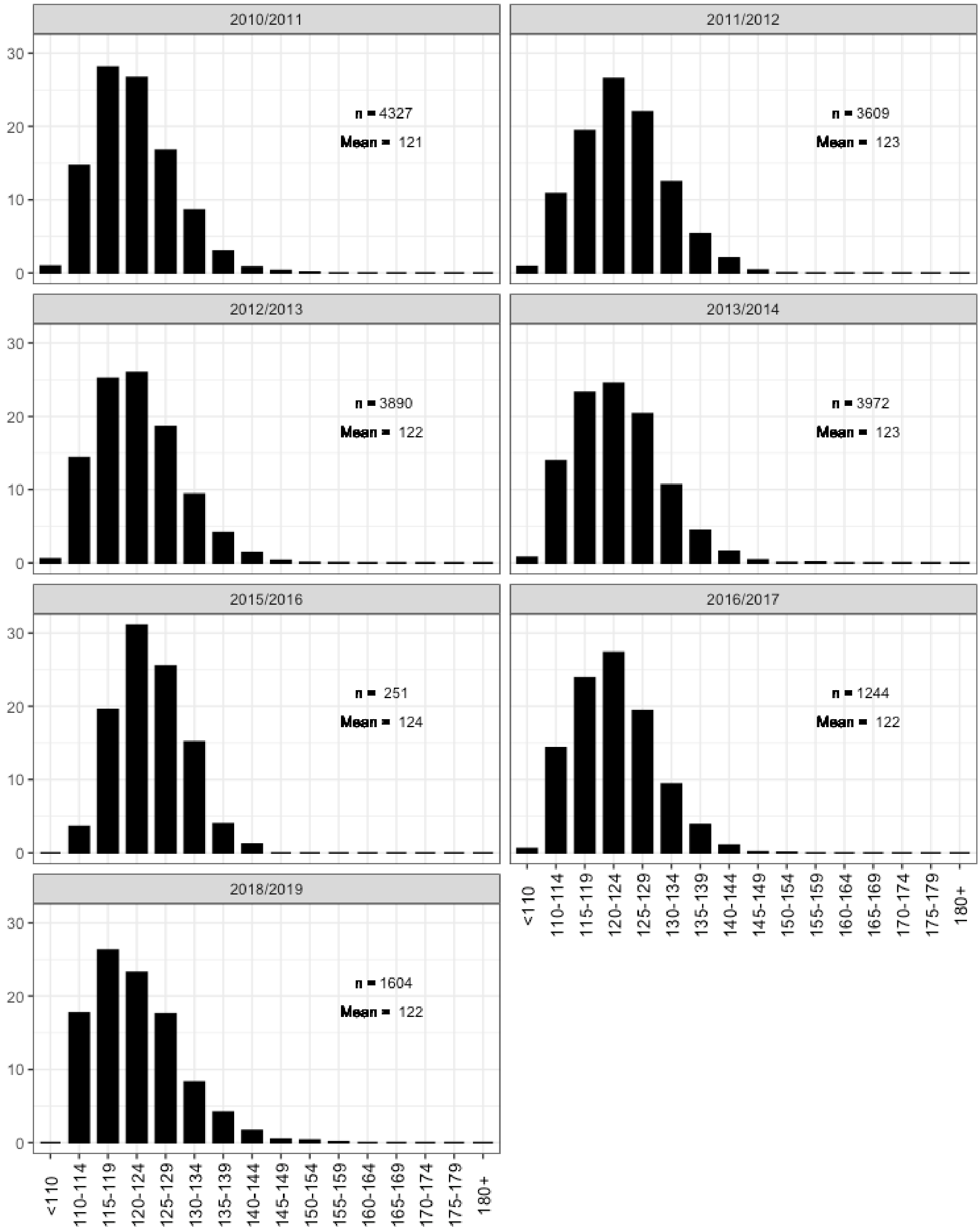
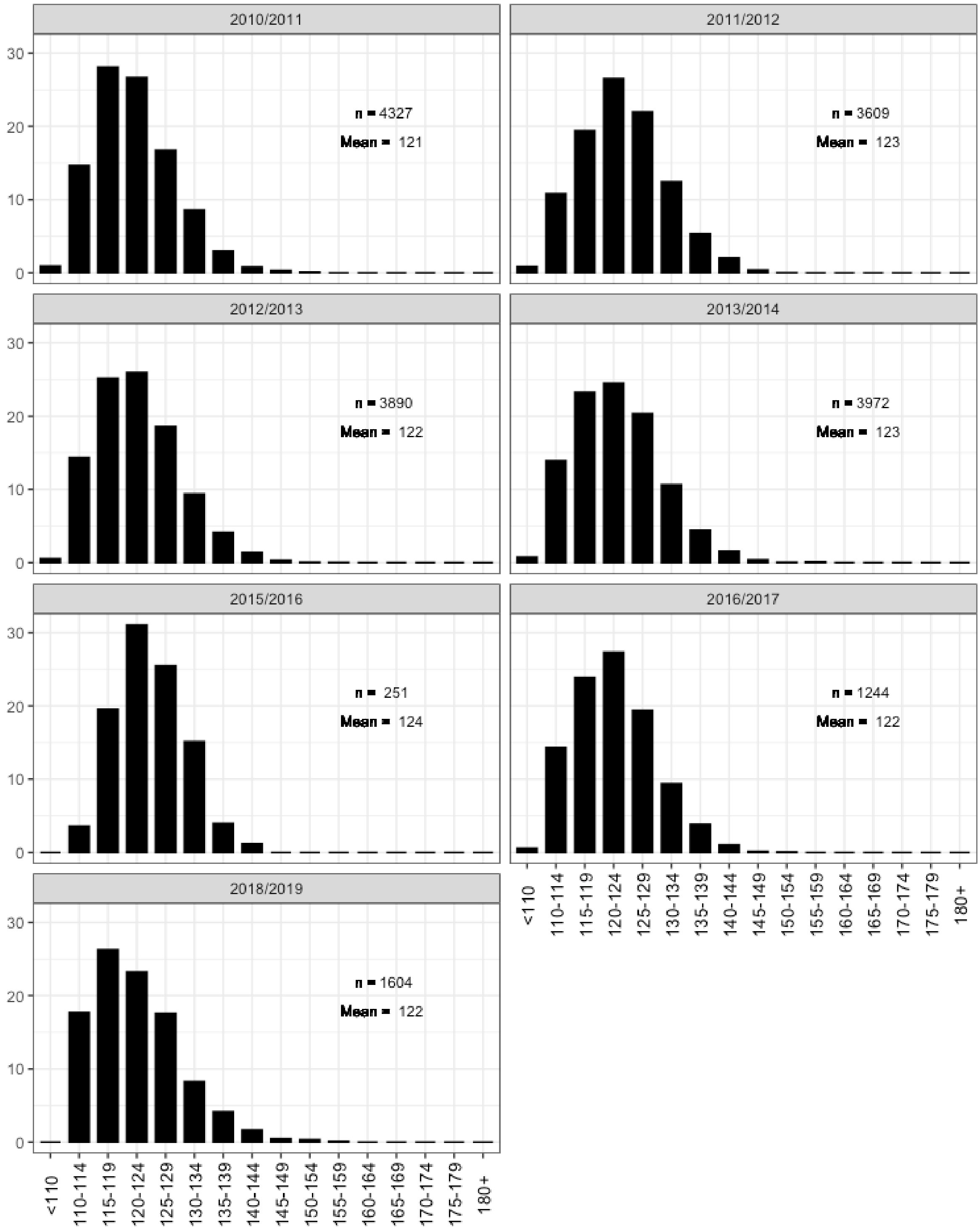
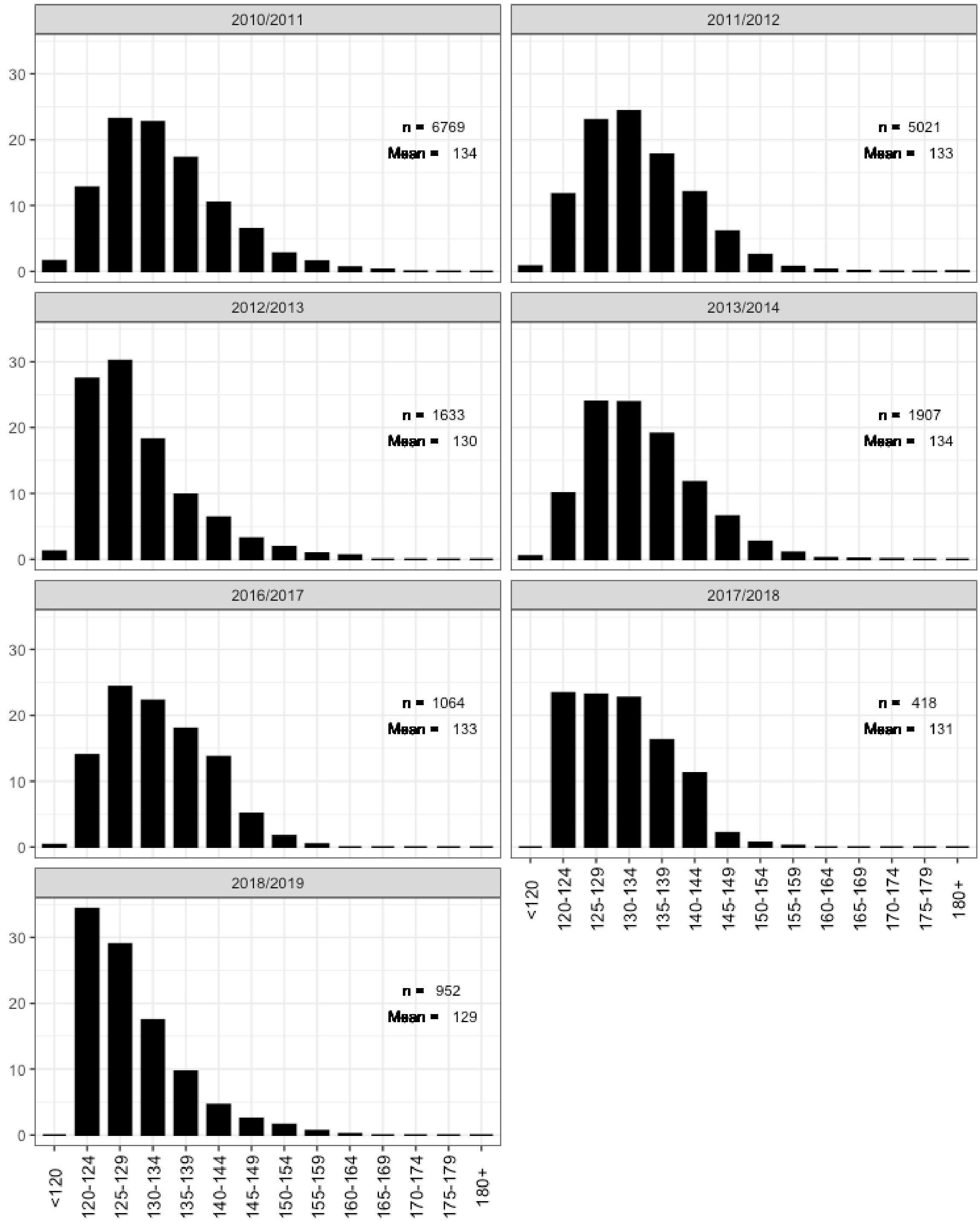


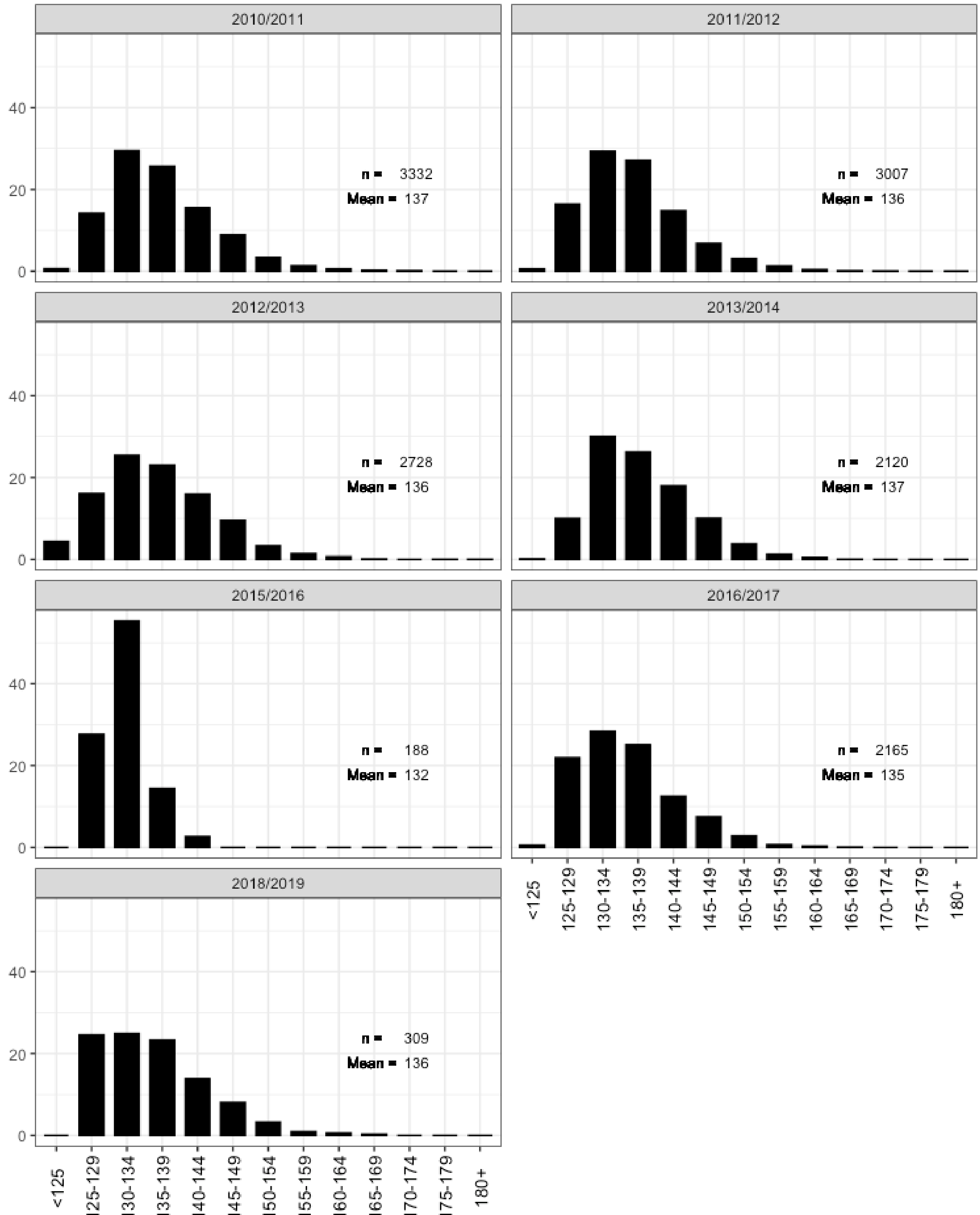
Figure 9: Size frequency distributions for the Airport SMU from commercial catch sampling from 2011 to 2022. 'n' is the number of abalone measured, 'Mean' is the mean size of the samples.



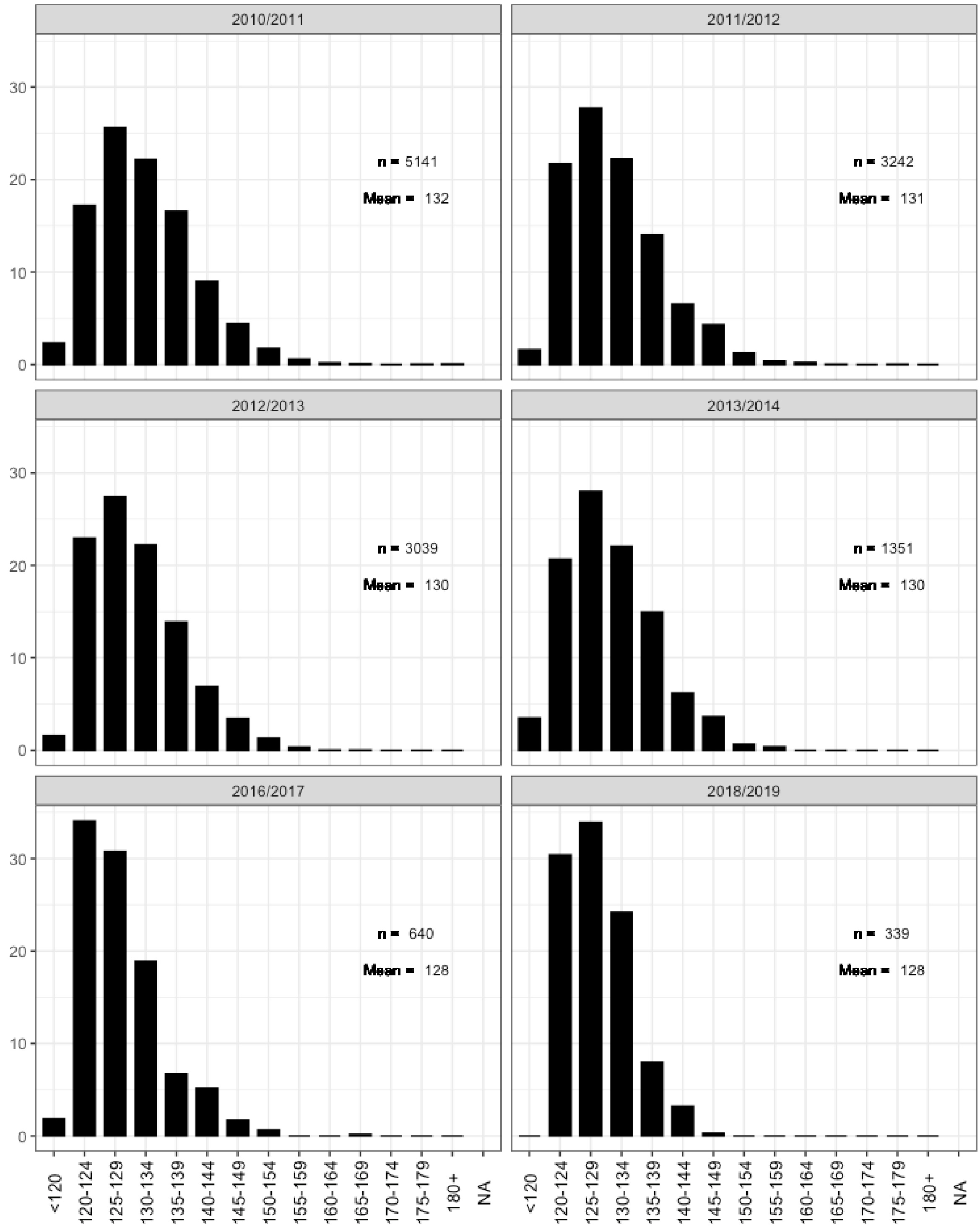
Size frequency distributions for the Airport SMU from commercial catch sampling from 2011 to 2022. 'n' is the number of abalone measured, 'Mean' is the mean size of the samples.



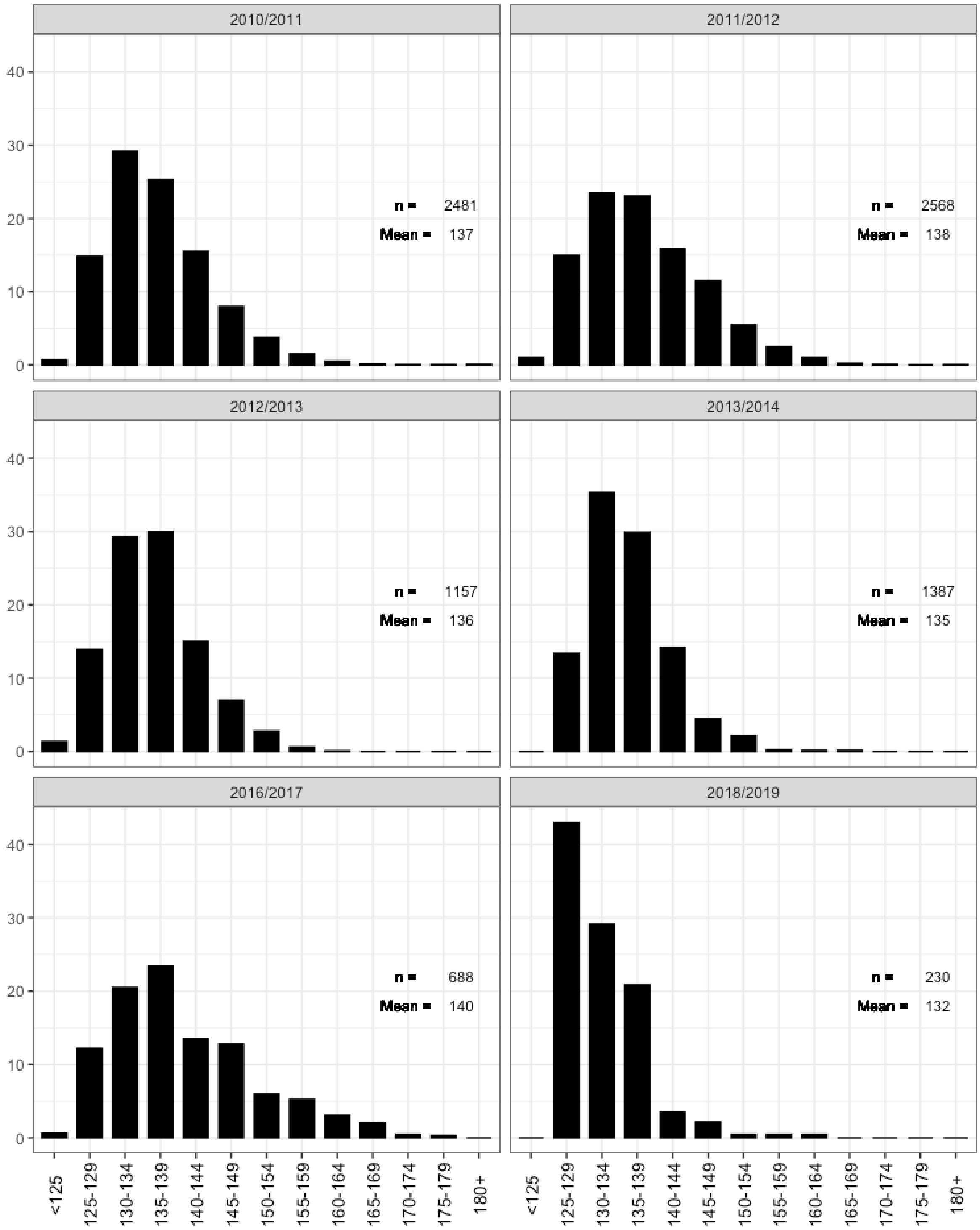
Size frequency distributions for the Marlo SMU from commercial catch sampling from 2011 to 2022. 'n' is the number of abalone measured, 'Mean' is the mean size of the samples.



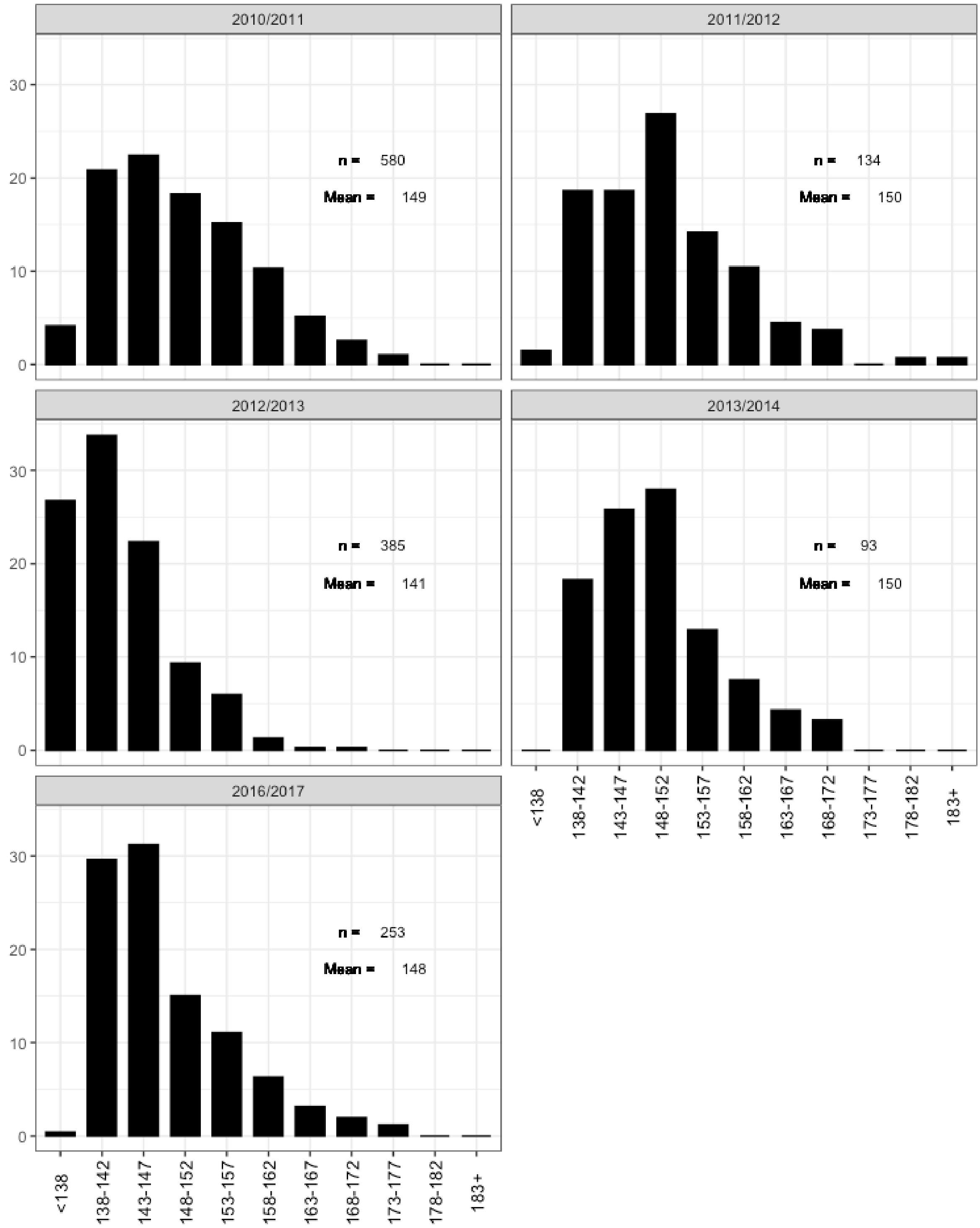
Size frequency distributions for the Mallacoota Central SMU from commercial catch sampling from 2011 to 2022. 'n' is the number of abalone measured, 'Mean' is the mean size of the samples.



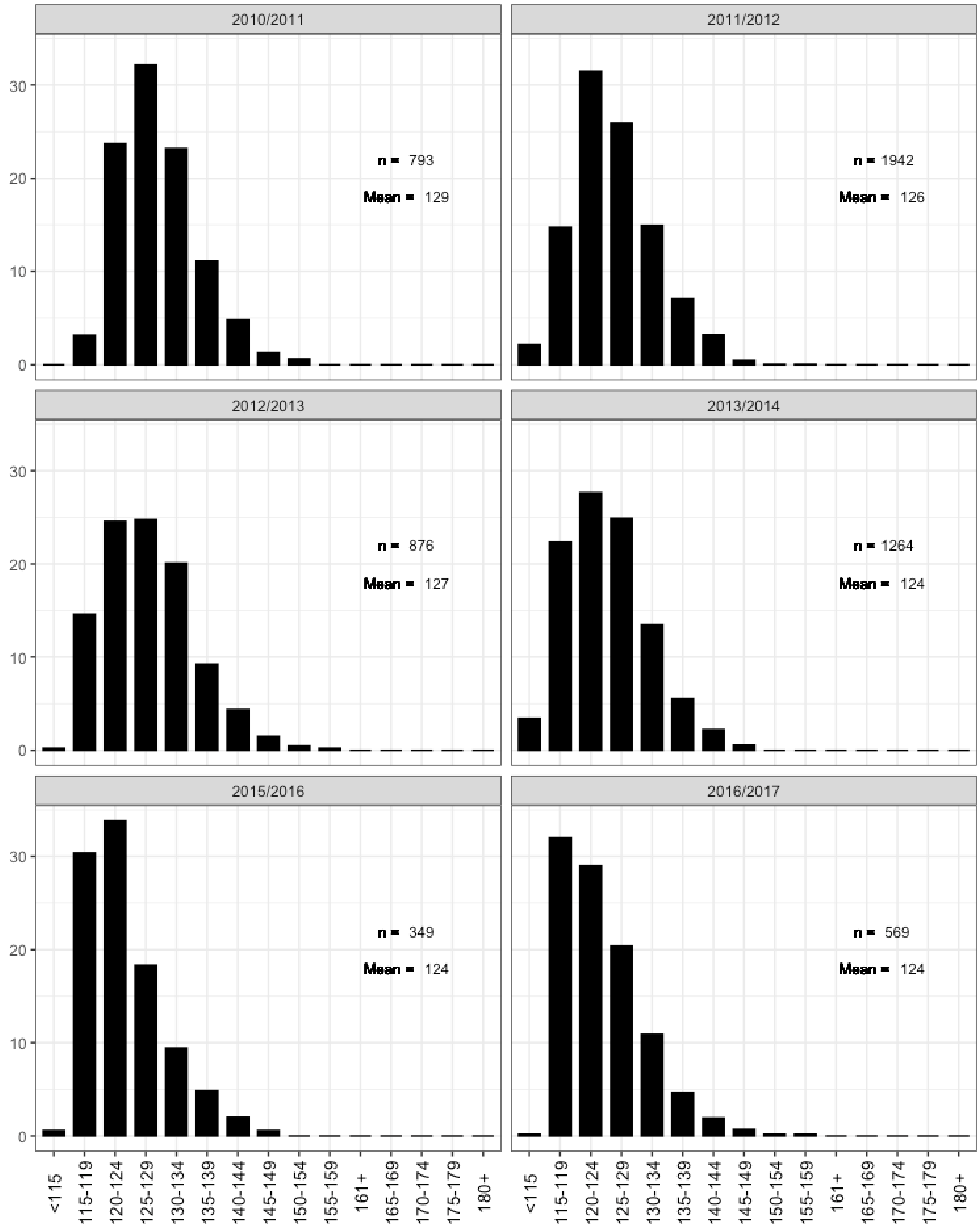
Size frequency distributions for the Mallacoota East SMU from commercial catch sampling from 2011 to 2022. 'n' is the number of abalone measured, 'Mean' is the mean size of the sampled catch.



Size frequency distributions for the Mallacoota West SMU from commercial catch sampling from 2011 to 2022. 'n' is the number of abalone measured, 'Mean' is the mean size of the samples.

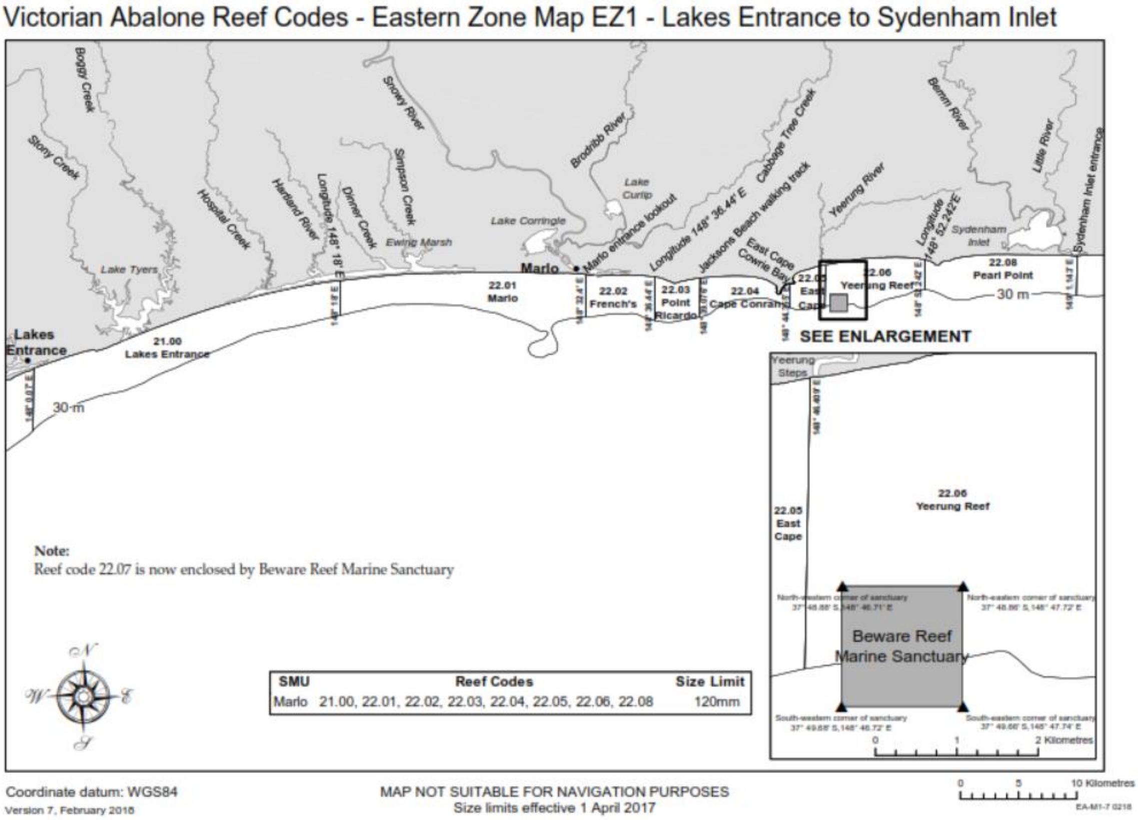


Size frequency distributions for the Mallacoota Large SMU from commercial catch sampling from 2011 to 2022. 'n' is the number of abalone measured.

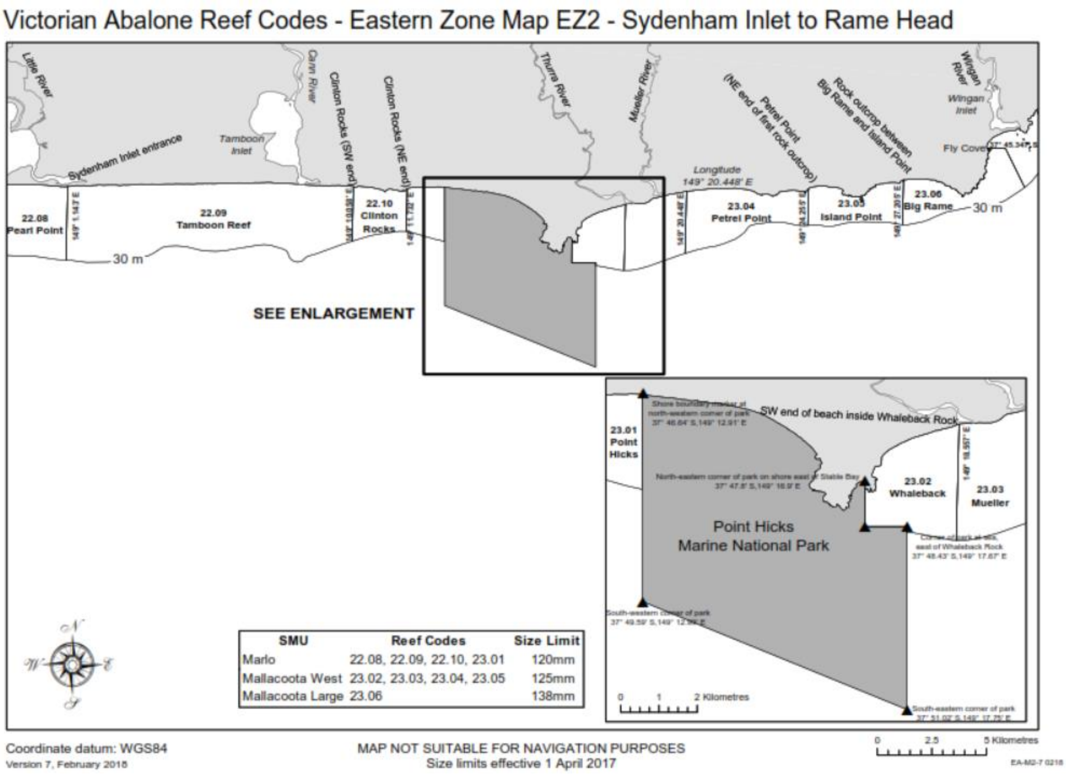


Size frequency distributions for the Mallacoota Small SMU from commercial catch sampling from 2011 to 2022. 'n' is the number of abalone measured.

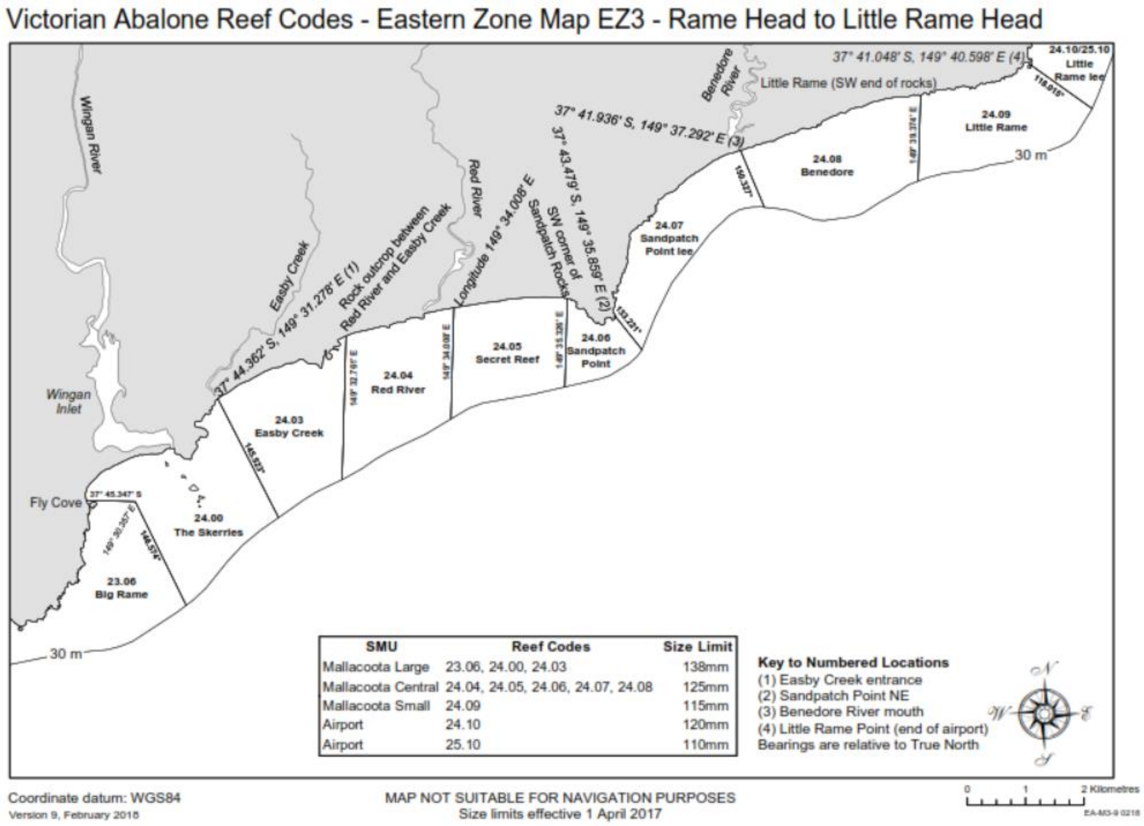
Appendix 6: Eastern Zone SMU and reefcode maps



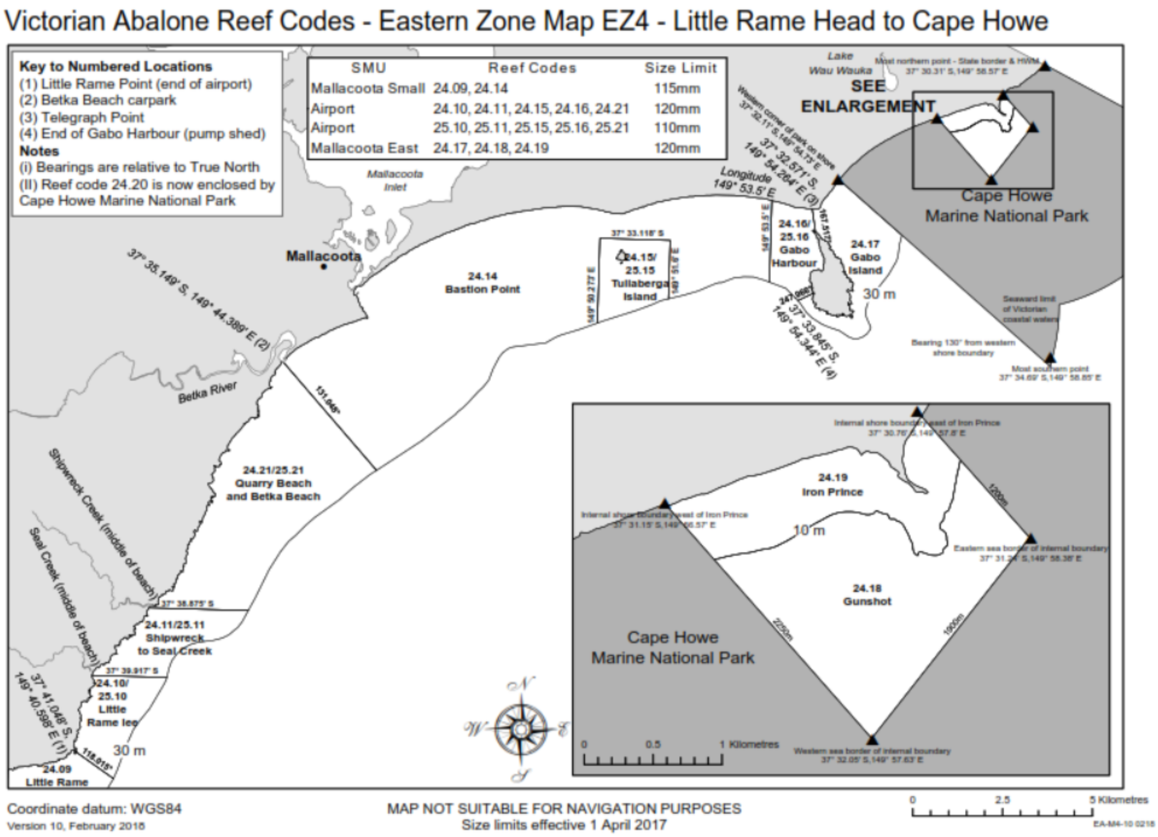
The location of the Marlo SMU and the reef codes within it.



The location of the Mallacoota West and Large SMUs and the reef codes within them.



The Mallacoota Central and Small SMUs and the reef codes within them.



The location of the Airport SMU, part of Mallacoota Small SMU and Mallacoota East SMU and their reef codes.

Appendix 7: Long-spined sea urchin abundance from abalone FIS.

In 2020, VFA produced a report (VFA 2020) that examined all available data on sea urchin abundance in the Eastern Zone. This included an analysis of data from abalone FIS up to 2019. Here, we update the abundance data up to 2021 for all sites, and up to 2023 for the Top 15 FIS sites.

Trends in data from all sites combined are not meaningful, because of spatial variation in sea urchin abundance and changes in the FIS design. On this basis, we have included graphs of the abundance over time for all sites and for the Top 15 sites only (Appendix 7).

For the Top 15 sites at the Zone scale, the abundance of sea urchins declined from 2003 to 2023 (Figure 36). These trends appear counter-intuitive given we know that sea urchins have become an increasing problem for the fishery, however they are not completely unexpected. When sea urchin abundance first begins to increase at an otherwise “healthy” abalone reef, the abundance increases over time while they consume the algae on that reef. But once the sea urchin population has eaten all the algae and have turned the reef into a “barrens” habitat, the abundance of sea urchins declines and stabilises at lower numbers. For example, this may explain the trends seen in Figure 37 for Mallacoota East. On this basis, FIS abalone sites are not a good indicator of changes in the overall abundance of sea urchins.

As identified in VFA (2020), urchin abundance is higher in the far east of the Zone from Little Rame through to the New South Wales border. Fortunately, abundances of urchins are unlikely to increase substantially in shallow waters to the south west of Little Rame because of wave exposure.

FIS sites have been established to monitor abalone abundance, and thus additional data collected such as sea urchin abundance can provide useful information, but the program is not designed to provide sea urchin specific information. Developing a project that examines all data sources, including VMS spatial effort data from the commercial sea urchin and abalone fisheries, would greatly enhance the understanding of the impact of sea urchin incursion on the abalone stocks in the Eastern Zone.

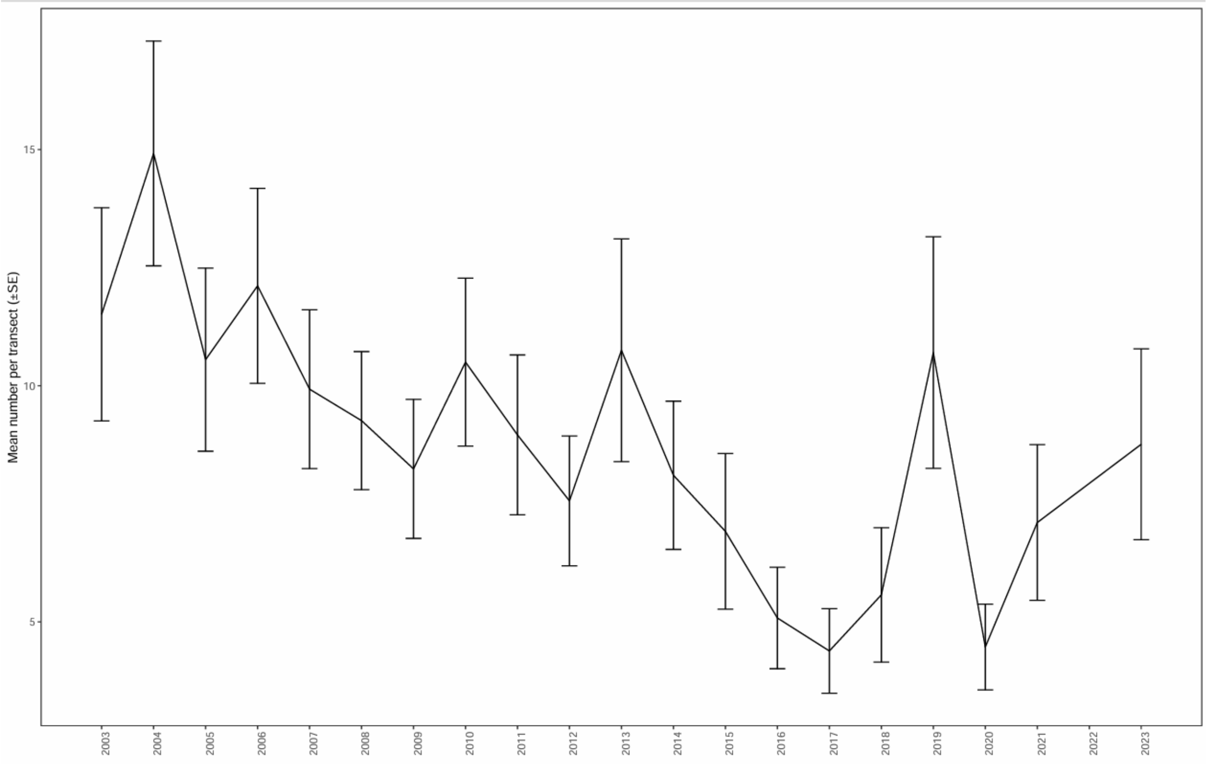


Figure 36: Abundance of sea urchins at the Zone scale for the Top 15 FIS sites.

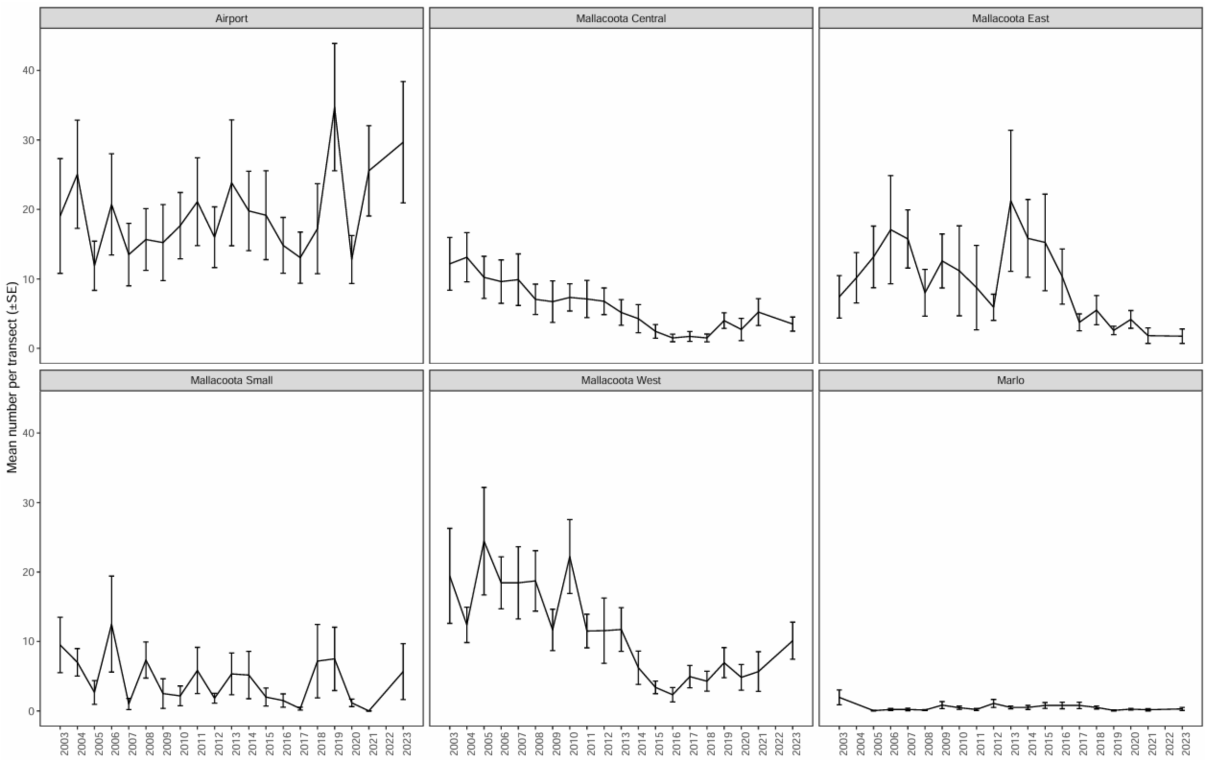
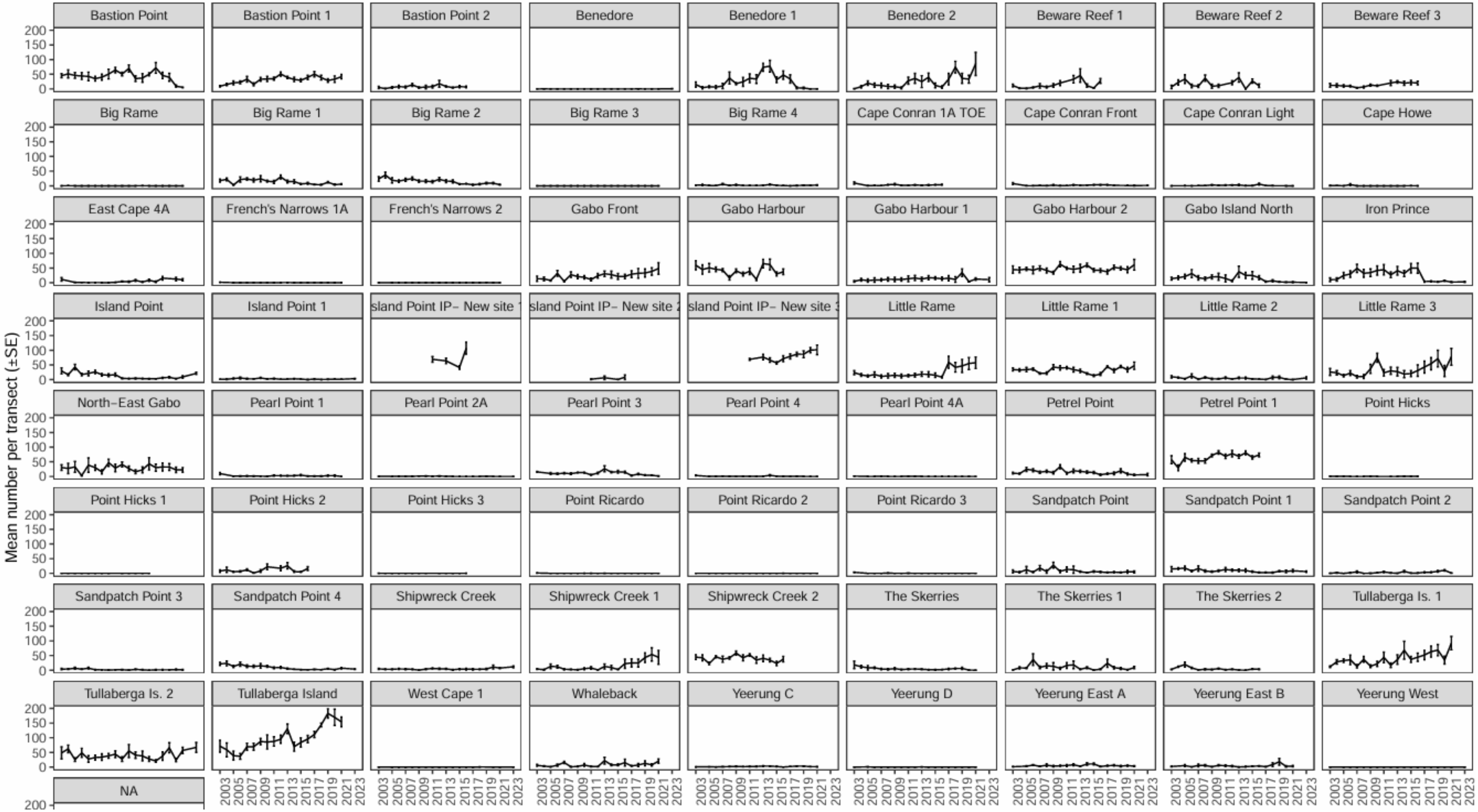


Figure 37: Abundance of sea urchins at the SMU scale for the Top 15 FIS sites.

Sea urchin abundance for each site in the Eastern Zone from 2003 to 2023.



Sea urchin abundance for each Top 15 site in the Eastern Zone from 2003 to 2023.