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Bass Strait Central Zone Scallop Fishery — 2024 Survey

AFMA Project 2022-0808

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Executive Summary

At the start of each Bass Strait and Central Zone Scallop Fishery (BSCZSF) fishing season, the Australian Fisheries Management Authority (AFMA) provides a 150 t research catch allowance to enable fishers to search for commercially-viable scallop (*Pecten fumatus*) beds. Industry members must then undertake research surveys to determine if the fishery can remain open under a Tier 1 (catches \leq 2,000 t) or Tier 2 (catches $>$ 2,000 t) management arrangement. Research surveys must carry an independent observer or apply electronic monitoring that is able to verify catch quantity, shell size and any other scientific data required to determine biomass estimates. This report provides the results of the 2024 research surveys.

Five commercial fishing vessels were selected by an independent panel to conduct the 2023 scallop surveys: the *Shandara*, *Northern Star*, *Rachel Maree*, *Odette C* and the *Dell Richey II*. During April/May 2024, stratified random surveys were conducted using these vessels on four beds in the Flinders Island (FI) region (including the new bed: FI South – North of Babel North-East), seven beds in the King Island (KI) region including four new beds (KI – 3 Hummocks South, KI – 3 Hummocks South-East, KI – Lavinia East and KI – Lavinia North), and one bed in the Apollo Bay (AB) region. Choice and prioritisation of these beds was based on previous surveys, commercial catches from 2023, and input from the Scallop Resource Assessment Group (ScallopRAG) and the Industry Co-Management Committee. Biomass estimates of scallops were calculated for each bed using area swept calculated from the straight-line distance between the start and end tow points and the measured internal width of dredges. Based on previous experimental work, an assumption of 33% dredge efficiency was used for the biomass estimates.

Biomass of commercial scallops greater than 85 mm (shell length) was estimated to be 1,742 t at the AB – The Hill bed, 40,978 t across the seven KI Beds and 1,525 t across the four FI beds. Total biomass of scallops greater than 85 mm at all sites combined was 44,185 t. The percent of commercial scallops greater than 85 mm in length was less than 80% at seven of the twelve beds, with the lowest proportion of 48.7% at KI – 9, and the highest of 97.4% at KI – Lavinia North. Densities of individual scallops per m² ranged from 0.005 at FI-NBNE to 3.44 at KI – Lavinia North

Catch composition varied greatly among beds surveyed. Overall, live commercial scallops comprised 18% of the catch, whereas broken shell (35%), old single shell (24%), doughboy scallops (4%) and new single shell (4%) comprised the other components of the catch. A further 17% of the catch comprised a total of 76 different bycatch species / groups with significant amounts of sponges and oysters. Two high-risk species were recorded: Southern blue-ringed octopuses at FI-FI1 and FI-NB; and black and white seastars at KI-Lavinia East. A number of species of gastropod mollusc were present in catches. These were generally only identified to the family or genus level and included Volutidae, Cassidae and Cypraeidae.

These results were presented at the ScallopRAG meeting on 6 June 2024 and at the Scallop Management Advisory Committee (ScallopMAC) meeting on 7 June 2024.

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Steve Hall (AFMA), together with ScallopRAG, ScallopMAC and the BSCZSF Co-Management Committee provided valuable input into the survey logistics and design.

1 Introduction

The main target species in the Bass Strait Central Zone Scallop Fishery (BSCZSF) is the commercial scallop, *Pecten fumatus*. Commercial scallops are short-lived species (up to nine years of age) (Gwyther and McShane 1988), but have been observed to die-off rapidly after only three to five years in some situations (Haddon *et al.*, 2006). Scallops are generally subject to high spatial and temporal variability in recruitment and abundance. They show variable growth and mortality, and rapidly changing meat yield and reproductive condition (Gwyther and McShane 1988). This variability means that management of commercial scallops must adapt to short-term changes in distribution and abundance of scallops, yet still ensure conservation of the resource consistent with the *Commonwealth Fisheries Harvest Strategy Policy 2018* (HSP).

Under the original HSP, the initial harvest strategy for the BSCZSF was developed during 2007. The harvest strategy was revised during the 2012 season. Furthermore, in response to industry concerns about the cost-effectiveness and flexibility of management, the HSP was further revised during 2014. The current BSCZSF Harvest Strategy (the Harvest Strategy) has two primary objectives. To:

1. keep stocks within the BSCZSF at ecologically sustainable levels and, within that context, maximise the economic returns to the Australian community; and,
2. pursue efficient and cost-effective management in attaining (1) above.

The HSP uses a tiered approach designed to apply different levels of management and research input depending on the state of the resource. Underpinning the tiered approach is the need to balance the risk of over exploitation whilst obtaining knowledge on the status of the stock at the commencement of the season through pre-season surveys.

At the start of each fishing season, the Australian Fisheries Management Authority (AFMA) provides a 150 t research catch allowance to enable fishers to search for commercially-viable scallop beds, defined as “...an area or scallop bed containing no greater than 20 per cent of scallops of a size less than 85 mm”. To increase the catch allowance above 150 t, industry members must undertake research surveys to determine if the fishery can remain open under Tier 1 or Tier 2 level management arrangements (as defined below).

- **Tier 1 management arrangements** require initial closure of an area/s (not more than 2 scallop beds) that contain a total biomass of $\geq 1,500$ tonnes of high-density scallops of a minimum size of 85 mm. The season begins with a 1,000 t total allowable catch (TAC) that can be increased to 2,000 t if good catches are achieved.
- **Tier 2 management arrangements** require initial closure of an area/s (not more than 2 scallop beds) that contain a total biomass of $\geq 3,000$ tonnes of high-density scallops of a minimum size limit of 85 mm. The season begins with a 2,000 t TAC that can be increased if good catches are achieved.

Research surveys must carry an independent observer or apply electronic monitoring that is able to verify catch quantity, shell size and any other scientific data required to determine biomass estimates. This report provides the results of the 2024 stratified random surveys.

1.1 Objectives

1. Estimate the scallop biomass and potential commercial catch rates in three different areas of the BSCZSF.
2. Measure the size frequency distribution of scallops in each area to calculate discard rates.
3. Report results to AFMA, the Scallop Resource Assessment Group (ScallopRAG) and the Scallop Management Advisory Committee (ScallopMAC).

2 Methods

2.1 Survey History

The 2015 survey covered three beds in the King Island (KI) region and one bed in the Flinders Island (FI) region (Figure 1, Figure 2, Figure 3, Table 1). To provide greater flexibility in management arrangements regarding closures, the pre-season survey was expanded in 2016 with the addition of an extra four beds in the KI region and another bed in the FI region. In addition to the extra sites, the boundaries of some of the 2015 beds were modified. For example, northern and southern boundaries of the bed known as KI-Main in Knuckey *et al.* (2015) were contracted slightly, and the eastern and western boundaries moved east slightly to form a bed titled KI-2 in Knuckey *et al.* (2016).

The beds surveyed during 2017 were based on advice from the Scallop Research Workshop and input from ScallopRAG and the BSCZSF Co-Management Committee. They comprised previously surveyed beds, modified beds and new exploratory beds. In 2018 two beds were added off King Island, whereas Apollo Bay (AB) – 3, AB – 4, FI – 3 and FI – 4 were not surveyed. In 2019, together with the FI bed, AB 1 and 2 were surveyed, and two new beds (one stretching south-east of KI Bluedot Extended (BDE) and another called the KI – JH bed comprising high density of juvenile scallops) were added. To protect the juvenile scallops at KI – JH, sampling intensity was reduced, and a fine mesh cover was placed over half of the dredge to improve sampling of small scallops. No survey was undertaken in 2020 because of concerns regarding the COVID-19 outbreak. Twelve beds were surveyed in 2021 when the FI – North - The Sisters and FI – North of Babel (NB) beds were added in the FI region, the KI – JH site was extended to the southeast, AB – 2 was extended to the north and AB – The Hill and AB – Five Hours sites were added in the AB region.

Significant catches were taken from an area to the north-west of the FI South – North of Babel site during 2021. Accordingly, reflecting these catches, new beds were surveyed in 2022 (FI – Wreck A together with FI – The Wreck B).

New beds introduced in 2023 included: KI – Three Hummocks East, KI – Three Hummocks West and FI – The Sisters East. The Three Hummocks beds were based on results of an FRDC-funded industry survey in December 2021 that showed high densities of undersized scallops. The Three Hummocks beds showed decreasing size of scallops with depth. These two beds were subsequently split at approximately the 52 m line, with the two new beds called KI – Three Hummocks Shallow and KI – Three Hummocks Deep. KI – Three Hummocks Deep was one of the beds closed during the 2023 season. Similarly, VMS data showed high fishing effort in a new bed east of the Sisters and so a new bed (FI North – The Sisters East) was surveyed there in 2023. Other beds surveyed in 2023 were: KI – 9, KI – 10, KI – BDSE, AB – The Hill North, FI, FI North – The Sisters, FI South – North of Babel, FI – The Wreck A and FI – The Wreck B.

Beds surveyed in 2024 were based on previous surveys, analysis of 2023 catch and effort data and advice from the ScallopRAG and the BSCZSF Co-Management Committee.

Changes to the beds surveyed since 2015 are outlined in Table 1.

For the 2024 survey, ScallopRAG recommended including the following beds:

1. King Island 6
2. King Island 9
3. King Island 10
4. Three Hummock South
5. Three Hummock South East
6. King Island Lavinia North
7. King Island Lavinia East
8. Apollo Bay – The Hill North
9. Flinders Island 1
10. Flinders Island exploratory South
11. Flinders Island exploratory North
12. Flinders Island North - The Sisters
13. Flinders Island South – North of Babel – backup bed if Flinders Island exploratory areas don't yield a productive scallop bed

The Flinders Island exploratory areas did not yield a productive scallop bed and so Flinders Island South – North of Babel was surveyed and exploratory fishing to the north-east of Flinders Island South – North of Babel did reveal good densities of scallops and so that area was mapped, and a new bed defined and surveyed called Flinders Island – Babel North East. This bed partially overlaps with the previously surveyed Flinders Island – The Wreck B bed.

Instead of surveying the Flinders Island 1 as recommended, the smaller but overlapping FI bed surveyed in 2015 was surveyed in 2024 by mistake. Results presented in this report and to the RAG and MAC are the actual results from the survey of the smaller area, not the results extrapolated to the larger Flinders Island 1 area. We note however that densities and size frequencies at the smaller FI bed surveyed appear to be representative of the Commercial Scallop densities and size frequencies observed at the larger Flinders Island 1 area from previous surveys.

New and modified beds surveyed in 2024 are highlighted in Table 1 and shown in Figure 4 and Figure 5. Surveyed beds and their size are shown in Table 2.

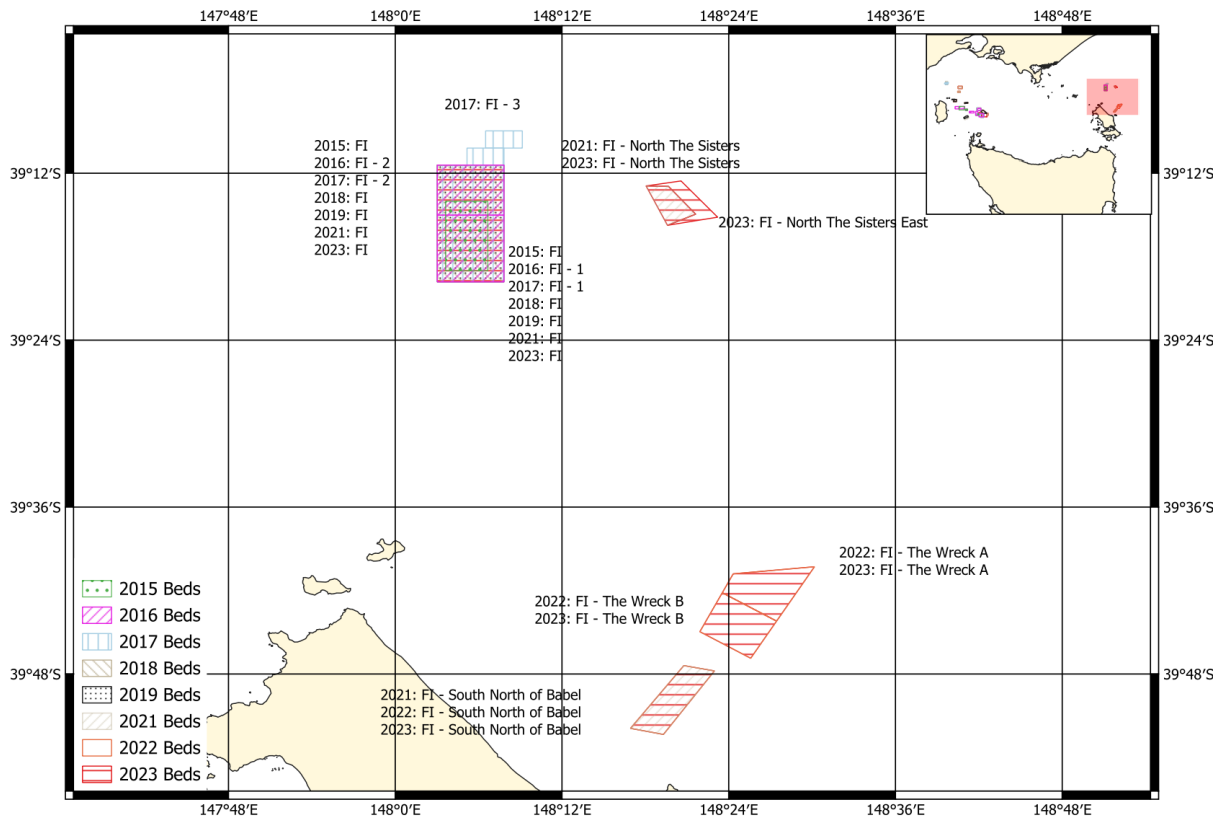


Figure 1. History of beds surveyed off Flinders Island from 2015 to 2023.

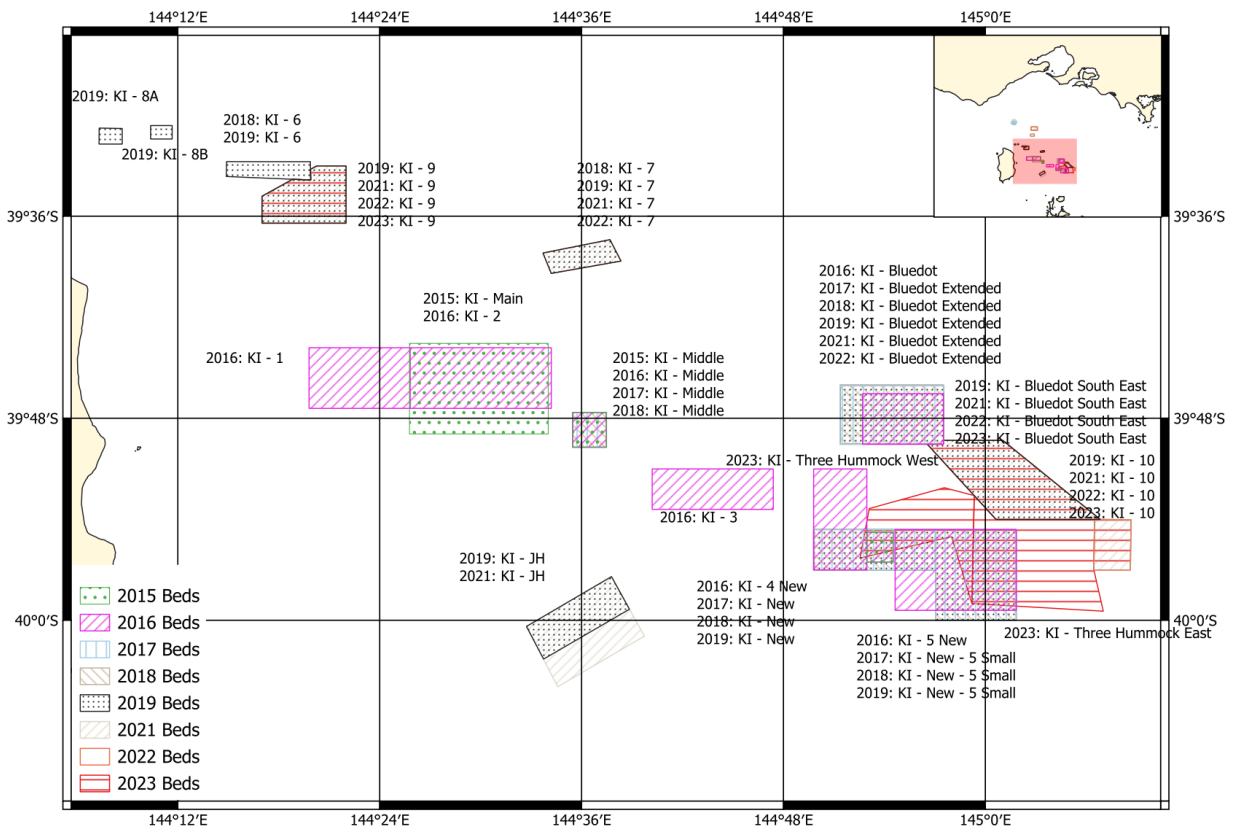


Figure 2. History of beds surveyed off King Island from 2015 to 2023.

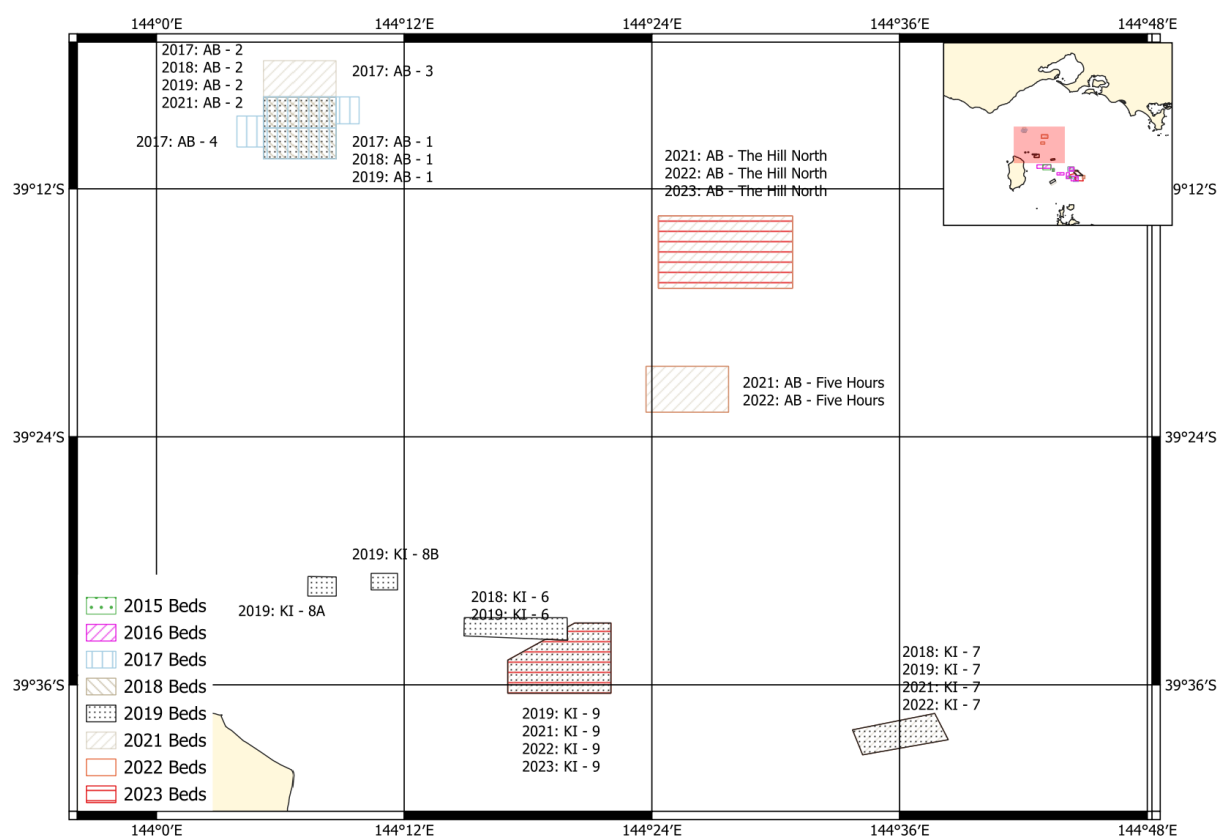


Figure 3. History of beds surveyed off Apollo Bay and King Island from 2015 to 2023.

Table 1. Description of beds surveyed since 2015 and beds new to 2024. See Figure 1, Figure 2 and Figure 3 for maps of beds.

Name	Description
KI – 5S	Originally a larger area that was surveyed in 2016, KI – 5S was formed by extending the eastern boundary of KI-New south to -40°S, and including the area of KI – 5 to the east of that. This bed remained unchanged from the 2017 to 2019 when it was last surveyed.
KI – New	KI-New was a bed that was defined for management proposes (it formed the initial closure) after the 2016 survey, covering at least parts of three different beds surveyed in 2016. It comprised parts of a bed called KIEast which was surveyed during 2015, and again in 2016, along with two new adjacent beds, KI – 4 and KI – 5. KI – New remained unchanged from the 2017 to 2019 when it was last surveyed.
KI – BDE	During the TAC setting by the MAC for the 2016 season, industry provided information regarding a dense bed of small scallops that would be more suitable for closure than the KI – New bed. This bed titled King Island Blue Dot was mapped out and then surveyed during August of 2016. The area was expanded north and west to form an area closure that replaced the closure of KI – New. The boundaries of this expanded area are shown in Figure 2. This bed remained unchanged from the 2017 to 2022 surveys.
AB – 1 and AB – 2	Seven exploratory marks in the KI region were provided by industry in 2017 to be explored and considered for additional survey beds. Only one of those showed sufficient density to survey, and the skippers mapped out the area, splitting it into two beds. Two additional smaller beds were added to each of the western and eastern boundaries. However, these beds contained low densities of scallops and were omitted from the 2018 and future surveys. The AB-1 and AB – 2 bed boundaries remained unchanged during the 2018 and 2019 surveys. For the 2021 survey, only AB – 2 was surveyed, and the northern boundary was moved north

Name	Description
	to cover relatively high levels of commercial effort in that area. Neither bed were surveyed in 2022
KI – 6	Examination of 2018 commercial catch and effort data revealed significant catches in a large area at approximately longitude 144° 17', latitude 39° 32'. The vessels mapped out this area to provide a smaller area with high density scallops within the boundaries shown in Figure 2. The bed boundaries remained unchanged from the 2018 survey, was resurveyed in 2019, but omitted for the 2021 survey.
KI – 7	Examination of 2018 commercial catch and effort data revealed significant catches in a large area at approximately longitude 144° 36', latitude 39° 38'. The vessels mapped out this area to provide a smaller area with high density scallops within the boundaries shown in Figure 2. The bed boundaries remained unchanged from the 2018 survey, was resurveyed in 2019 and was surveyed in 2021 as a replacement for KI – Mid (in accordance with ScallopRAG recommendations).
FI	FI-1 was called the “Flinders Island” bed during the 2015 survey. For the 2016 and 2017 surveys, the area was expanded and split into the two beds (FI – 1 and FI – 2). Two additional smaller beds were added to the northern boundary of FI-2 in 2017. However, because of low scallop densities, these beds were omitted for the 2018 survey. For the 2018 survey, FI – 1 and FI – 2 were combined into a single large bed (Figure 1). The bed boundaries remained unchanged from the 2018 survey and the bed was resurveyed in 2019, 2021 and 2023, but not in 2022.
KI – 8a and KI – 8b	Examination of 2019 commercial catch and effort data revealed significant catches in a large area at approximately longitude 144° 10', latitude 39° 31'. Within the general area worked, there were three main patches of densely populated scallop beds separated by areas of low density and an underwater cable. The two largest of these small areas were selected to survey in that year. They were not surveyed in 2021 or 2022.
KI – 9	Examination of 2019 commercial catch and effort data revealed significant catches within a large area at approximately longitude 144° 21', latitude 39° 35'. The final boundaries were set based on a combination of fishing effort by the survey vessel in the previous year and exploratory fishing. This bed was resurveyed in 2021, 2022 and 2023.
KI – JH	An industry member provided two marks defining a line of exploratory tows that contained relatively high densities of juvenile scallops (~50 mm). Being the most recent sign of significant recruitment there was interest in tracking the growth of scallops within this bed. However, there was concern of potential disturbance to the bed by surveying it. As a compromise, a relatively small survey area was established with only 20 sampling sites. Based on advice from industry, the bed was extended to the south-east for the 2021 survey. This bed was not surveyed in 2022
KI – BDSE	Examination of 2019 commercial catch and effort data revealed significant catches in a large area at approximately longitude 145° 00, latitude 39° 49. The final boundaries were set based on a combination of fishing effort by the survey vessel in the previous year and exploratory fishing. This bed was resurveyed in 2021, 2022 and 2023.
KI – Mid	This bed remained unchanged from 2015, 2016, 2017 and 2018. In accordance with RAG recommendations, five exploratory tows were conducted at this bed during 2021 revealing low densities (no scallops were caught). Accordingly, KI – 7 was surveyed instead. This bed was not surveyed in 2022
KI – 10	Significant catches were taken from an area to the south-east of the KI-BDSE site during 2020. KI – 10 was subsequently established and was surveyed in 2021, 2022 and 2023.
AB – The Hill North	Industry members provided marks about 17 nm to the south-east of Apollo 2 where significant amounts of scallops were caught in 2020. Based on commercial effort reported from the area, and notes made on a fishing vessel's plotter, a bed was defined and surveyed in 2021 and 2022.

Name	Description
AB – Five hours	Industry members provided marks about 19 nm to the south-east of AB – Apollo 2 where significant amounts of scallops were caught in 2020. Based on commercial effort reported from the area, and notes made on a fishing vessel's plotter, a bed was defined and surveyed in 2021 and 2022.
FI – North - The Sisters	Significant catches were taken from an area about 11 nm to the east of the FI site. Based on commercial effort reported from the area, and notes made on a fishing vessel's plotter, a bed was defined. This bed was surveyed in 2021 and 2023, but not in 2022.
FI – South – North of Babel	Significant catches were taken from an area about 31 nm to the south-south-east of the FI site. Based on commercial effort reported from the area, and notes made on a fishing vessel's plotter, a bed was defined and surveyed in 2021, 2022 and 2023.
FI – The Wreck A	Significant catches were taken from an area to the north-west of the FI South – North of Babel site during 2021. FI – The Wreck A was a new bed in 2022 that together with FI – The Wreck B, surrounds that catch. It was also surveyed in 2023.
FI – The Wreck B	Significant catches were taken from an area to the north-west of the FI South – North of Babel site during 2021. FI – The Wreck B was a new bed in 2022 that together with FI – The Wreck A, surrounds that catch. It was also surveyed in 2023.
KI – Three Hummocks West	An industry-led survey in December 2021 (as part of a FRDC project) revealed high densities of undersized scallops. The bed was not surveyed in 2022 as many scallops remained undersized. It was surveyed in 2023, and together with KI – Three Hummocks East and, on request of the RAG, the boundaries were re-defined based on bathymetry which appeared to delineate densities and size of scallops.
KI – Three Hummocks East	An industry -led survey in December 2021 (as part of a FRDC project) revealed high densities of undersized scallops. The bed was not surveyed in 2022 as many scallops remained undersized. It was surveyed in 2023, and, on request of the RAG, the boundaries were re-defined based on bathymetry which appeared to delineate densities and scallop size.
FI – The Sisters East	For the 2023 survey, the previously agreed FI – North bed was replaced with an eastern extension to FI – North - The Sisters. This new bed is based on VMS data and commercial fisher input (Figure 5).
FI – Babel North East	An exploratory area was foreshadowed between FI and FI – South North of Babel. This area revealed few scallops, but it was discovered that the FI – South North of Babel extends to the north-east. This area was mapped out and surveyed in 2024.
KI – Lavinia North	Industry noted that there was a very large bed of scallops to the west and south of KI – 9. The boundaries of this very large bed were set in consultation with Industry, and divided into two areas at approximately the half way point. KI – Lavinia North is the north-western half of this bed.
KI – Lavinia East	Industry noted that there was a very large bed of scallops to the west and south of KI – 9. The boundaries of this very large bed were set in consultation with Industry, and divided into two areas at approximately the half way point. KI – Lavinia East is the south-eastern half of this bed.
KI – Three Hummocks South	Based on the 2023 KI – Three Hummocks East and KI – Three Hummocks West beds and information from Industry, a new bed along the southern boundary of KI – Three Hummocks East and extending north-west to just below KI – Three Hummocks West was established and surveyed.
KI – Three Hummocks south-east	Industry observed that the KI – Three Hummocks East bed extended to the south-east. Based on this information, KI – Three Hummocks South East was established and surveyed.

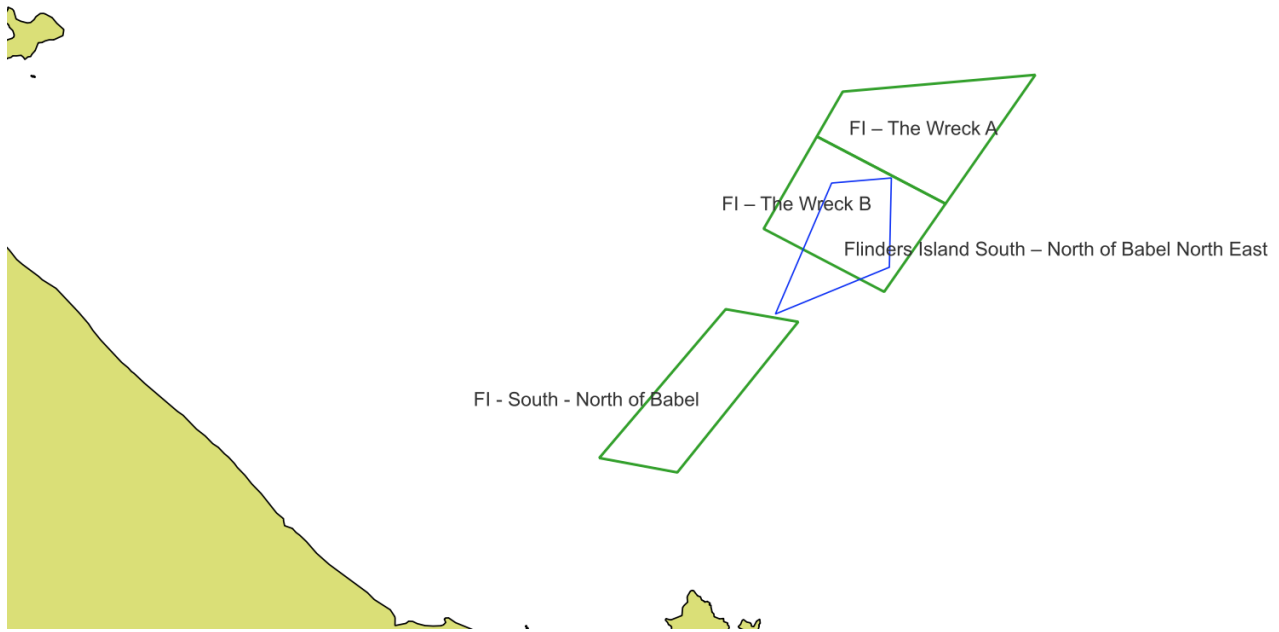


Figure 4. New bed surveyed in 2024 off Flinders Island (blue - FI – Babel North East) in relation to 2023 beds (green).

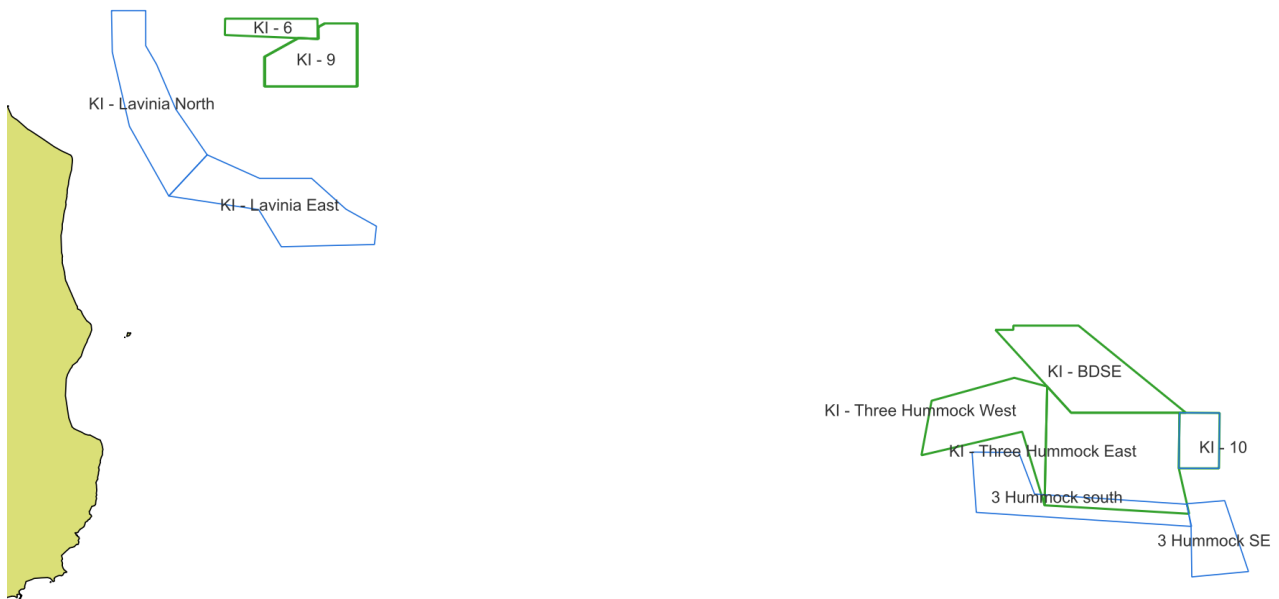


Figure 5. New beds surveyed in 2024 off King Island (blue) and 2023 survey beds (green).

2.2 Survey Design

Survey methods follow those of Knuckey *et al.* (2015, 2016, 2017, 2018) and Koopman *et al.* (2019, 2021, 2022, 2023), modified from those described in Harrington *et al.* (2008). Five vessels were selected to undertake the survey. A procedures manual (Fishwell 2024) guided vessel-based conduct of the survey. This manual was updated for the 2024 survey by including a more detailed species identification guide.

The number of survey points allocated to each bed was largely guided by sampling effort during past surveys, with consideration given to the maximum number of tows that can be achieved in a 12-hour

sampling block¹. Primary sampling sites within each bed were randomly allocated using the QGIS Random Points in Polygons Tool. Additional survey points were allocated to each bed as “backup sites”, to be used where “primary sites” were unfishable.

During 2024, surveys were conducted onboard the fishing vessels *Rachel Maree* (Scientific Permit# 1005944), *Shandara* (Scientific Permit# 1005945), *Odette C* (Scientific Permit# 1005946), *Dell Richey II* (Scientific Permit# 1005943) and the *Northern Star* (Scientific Permit# 1005942), which were selected by an independent panel. To be considered a valid tow, the vessel must dredge within 100 m of the tow location provided.

2.2.1 Sampling methods

For each tow, estimates were made of weight of: total live scallop catch, dead shell and all bycatch by species / species group. Dead commercial scallop shell was separated into:

- Clappers (both valves still connected at the hinge)
- Old single shell (single valve – inside appears old and overgrown with epiphytes / epifauna)
- New single shell (single valve – inside appears new without any epiphytes / epifauna)

A random sample of at least 35 scallops (where available) was collected from each tow before sorting. The observer measured the length of those scallops using an electronic measuring board. Either the first or last (or both) scallop from each tow measured using the measuring board was also measured by hand using digital callipers or a metal ruler. This was done to ensure accuracy and consistency of the measuring board throughout the survey. The sample weight of scallops measured was also recorded.

From every fifth tow, an additional 10 random scallops were taken to collect biological information. First, the whole scallop was weighed, then split and the gonad condition staged according to the scale based on Semmens, *et al.* (2018) (Table 10). Adductor meat and gonad were removed from the shell and weighed together to calculate number of meats per kg. Shell height and width were also measured for morphometric analyses (Fishwell 2024).

2.2.2 Data analysis

All data processing and analysis was undertaken in R (R Core Team 2024). Estimates of biomass followed the methods of Semmens and Jones (2014).

2.2.3 Biomass estimates

The internal widths of the dredges used during the survey were measured in accordance with Semmens and Jones (2014). Dredge widths used by the *Shandara*, *Odette C*, *Northern Star*, *Del-Richey II* and *Rachel Maree* were 4.87 m, 3.905 m, 3.583 m, 3.930 m and 3.875 m (Table 2). A dredge efficiency of 33% was assumed.

Swept area (S) of each tow was calculated as follows:

$$S = L \times W$$

Where L is the tow distance (m) and W is the width of the dredge (m). Tow distance was calculated from the straight-line distance between start and end tow positions.

¹ For OHS reasons, observers are restricted to a maximum of 12 hours of sampling in a 24-hour period.

Scallop catch in each tow ($C^{\text{standardised}}$ in kg/1000 m²) was calculated as follows:

$$C^{\text{standardised}} = (C/S) \times 1000$$

Where C is the estimated catch in a tow (kg).

Assuming a 33% dredge efficiency, biomass (B) in tonnes and 95% confidence interval (CI) were estimated for each stratum (bed) as follows:

$$B = \text{mean}D * A * 3.03 / 1000$$

$$\text{Upper 95\% CI} = ((\text{mean}D + (t_{n-1} \times SE_{\text{mean}D})) \times A) * 3.03 / 1000$$

$$\text{Lower 95\% CI} = ((\text{mean}D - (t_{n-1} \times SE_{\text{mean}D})) \times A) * 3.03 / 1000$$

Where $\text{mean}D$ is the mean density (kg) of scallops per m² swept, t_{n-1} is the t -value for the number of tows (n) -1, $SE_{\text{mean}D}$ is the standard error of $\text{mean}D$ and A is the total stratum area (m²). The area of each bed was calculated using the R package “Simple Features” (Pebesma 2018).

Biomass and upper and lower 95% confidence intervals (CI) of scallops greater than 85 mm (shell length) were calculated as follows:

$$B_{>85 \text{ mm}} = B * (1 - \text{discard rate})$$

$$\text{Upper 95\% CI}_{>85 \text{ mm}} = \text{Upper 95\% CI} * (1 - \text{discard rate})$$

$$\text{Lower 95\% CI}_{>85 \text{ mm}} = \text{Lower 95\% CI} * (1 - \text{discard rate})$$

where the discard rate was calculated using catch weighted length frequencies converted to weight.

An estimate of density in individuals per square metre (I) was obtained as follows

$$I = \sum_{len} W L f / S$$

Where $W L f$ is the weighted length frequency for each length class len , and S is the swept area (m²).

All densities (kg / m² and individuals per m²) reported have been adjusted for the 33% assumed dredge efficiency (see Harrington *et al.* (2008) for origin of the 33%).

2.2.4 Biologicals

The length-weight relationship was calculated for each area separately, and the parameters of the relationship are provided in the results. The length-weight relationship was applied to catch-weighted size frequencies to calculate the discard rate at 85 mm. The discard rate was used in calculations of biomass of scallops greater than 85 mm shell length. Number of meats per kg was calculated separately for each bed by dividing 1,000 by the mean meat and gonad weight in grams.

2.2.5 Quality Assurance

The survey was undertaken following Standard Operating Procedures (Fishwell 2024). All tow and scallop catch data were recorded in ORLAC Dynamic Data Logger (DDL), which contains quality assurance protocols including automatic data capture (time, date and position), field restrictions, range checks, mandatory fields and lookup tables. These data are maintained in the ORLAC Dynamic Data Manager (DDM) database on a cloud-based server from which data are extracted for analyses. Data were manually error checked against data sheets. Analyses were undertaken using R (R Core Team, 2024), and a subset of outputs were reproduced and compared using an alternative software package. Scallops were measured using electronic

measuring boards, or callipers in the event of measuring board failure. The first or last (or both) scallop from each tow was measured by both the measuring board and by hand using either digital callipers or a metal ruler. This was done to ensure accuracy and consistency of the measuring board throughout the survey.

Results and their interpretations and conclusions were discussed amongst the research team, and draft reports were reviewed by co-authors and AFMA managers. Where required, comments were addressed in preparation of the final report.

3 Results

3.1 Survey order

The 2024 BSCZSF survey was undertaken during April and May of 2024. Commencing April 19, the *Dell Richey II* surveyed the FI – FI1 and FI – South – North of Babel beds off Flinders Island. Commencing April 25, the *Rachel Maree* surveyed KI – Lavinia North, KI – 6 and AB – the Hill. Commencing, April 29, the *Northern Star* surveyed FI – North – The Sisters and FI – South – North of Babel North East (see Table 2 for bed nicknames). The *Shandara* surveyed KI – 9, KI – Lavinia East and half of KI – 3 Hummock South commencing April 6. Commencing 16 April, the *Odette C* surveyed the KI – 3 Hummock South East, KI – 10 and half of KI – 3 Hummock South. Commencing, 1 June, the *Northern Star* surveyed FI-the sisters (see Table 2 for bed nicknames). The total area of each bed is shown in Table 2.

3.2 Biomass, size and potential commercial catch rates

The mean biomass estimate for AB – The Hill was 3,304 t (95%CI 1,750 t – 4,859 t) (Table 4). The percentage of scallops >85mm at each of that bed was 52.7% (Table 5), and consequently the mean biomass of scallops > 85 mm was 1,742 t (Table 5).

Mean biomass estimates for KI – 10, KI – Three Hummock South KI – Three Hummock South-East, KI – 9, KI – 6, KI – Lavinia East and KI – Lavinia North were 2,056 t (95%CI 1,190 t – 2,923 t), 9,435 t (95%CI 5,891 t – 12,978 t), 7,837 t (95%CI 6,124 t – 9,550 t), 20 t (95%CI 3 t – 36 t), 1,352 t (95%CI 614 t – 2,091 t), 7,932 t (95%CI 4,641 t – 11,223 t) and 17,760 t (95%CI 13,197 t – 22,322 t), respectively (Table 4). The percentage of scallops >85mm was more than 97% at KI – Lavinia East and KI – Lavinia North and was lowest at KI – 9 (48.74%), (Table 5), and consequently mean biomasses of scallops > 85 mm were much lower than total biomass estimates: 1,444 t, 7,075 t, 6,732 t, 12 t, 658 t, 7,707 t and 17,290 t respectively (Table 5).

Mean biomass estimates for FI – FI1, FI – South – North of Babel, FI – South – North of Babel North-East, FI – North – The Sisters were 1,125 t (95%CI 622 t – 1,628 t), 517 t (95%CI 216 t – 819 t), 20 t (95%CI 0 t – 41 t) and 269 t (95%CI 145 t – 393 t) respectively (Table 4). The percentages of scallops >85 mm were highest at FI – FI1 (88.4%) and FI – North – The Sisters (87.2%), and lowest at FI – South – North of Babel (54.6%) and FI – South – North of Babel North-East (62.1%), (Table 5), resulting in mean biomasses of scallops > 85 mm of 995 t, 283 t, 13 t and 234 t respectively (Table 5).

Low to medium density tows were also recorded throughout AB – The Hill, with the highest densities in the south (Figure 6). Densities at KI – 10 were also lowest in the north with very high densities in the south-west (Figure 8). Very high densities were recorded throughout KI – Three Hummock South and KI – Three Hummock South-East. KI – 9 had medium to high densities in the south, but density decreased in the north, extending into KI – 6 where most tows yielded no scallops. Medium and very high densities were observed throughout KI – Lavinia North except for a small band with low densities about the half-way mark. Densities at KI – Lavinia East were medium to very high throughout most of the bed, decreasing in the

south. At FI – North of Babel, shots undertaken in the south-west to north-west were lower than that on the opposite side of the bed, where medium-low densities were observed (Figure 9). Very low to zero scallop catches were recorded from throughout FI – North of Babel North-East, FI – The Wreck A and FI – The Wreck B. Low densities were recorded with many zero catches, particularly in the west (Figure 9). Densities at FI – North – The Sisters were medium to low but generally higher in the north. Densities at FI – FI1 were lowest in the south-west with some zero catches of scallops and were otherwise medium to low throughout.

Estimated densities in numbers of commercial scallops >85 mm ranged from 0.005 individuals per m² at FI – North of Babel North-East to 3.44 individuals per m² at KI – Lavinia North (Table 4).

Comparisons of biomass estimates, percent catch composition and size distributions of beds that have been repeatedly surveyed and surveyed in 2023 are shown in Appendix 2. Although the sampling methods have been consistent, the areas of the beds have changed considerably. Care should be taken when interpreting those results, and consideration of changes in bed areas over time should be made.

3.3 Biologicals

Mean length of scallops measured ranged 76 mm at FI – North of Babel to 95 mm at the two Lavinia beds (Table 6). Length frequency distributions from all sites are shown in Figure 11. Some recruitment was observed FI – South – North of Babel. Scallop meats were much smaller at the KI and AB beds compared with FI (Table 6, Figure 12). Overall, most meats weighed less than 20 g, and meats per kg ranged from 51 at FI – North of Babel to 151 at KI – 9. Maturity states varied greatly across beds (Figure 13, Table 10). More than 80% of scallops examined had stage one gonads at KI – 9, KI – 6, KI – Lavinia East and AB – The Hill. The highest percentage of stage two gonads were recorded from FI – North of Babel, FI – North of Babel North-East, FI – North – The Sisters and KI – Three Hummock South, whereas the highest percentage of stage three gonads (about 25%) was recorded from KI – Three Hummock South-East.

Comparison of length-weight regressions revealed that the interaction term was significant ($p < 0.001$). Similarly, the p -value for the indicator variable was also significant ($p < 0.001$) suggesting a difference in intercepts and, more generally, differences in the length-weight relationships of scallops among beds. Similar results ($p < 0.001$ to $p < 0.05$) were obtained when beds were grouped into the areas FI and KI and for most beds within each group and for beds within sub areas.

Separate length-weight relationships were calculated for each bed (Table 7). Scatterplots of each combination of size measurements (including total weight) are shown in Figure 10.

3.4 Bycatch

A total of 81 different species / groups were identified during the survey (Table 8), and catch composition varied greatly among beds (Figure 14 and Figure 15). Overall, live commercial scallops comprised 18% of the catch, whereas broken shell (35%), old single shell (24%), doughboy scallops (4%) and new single shell (4%) comprised the largest other components of the catch. Sponge comprised relatively high proportions of the catch at KI-Lavinia East, KI-Lavinia North and FI-NB, whereas oysters comprised large components of the catch at FI-NBNE and KI – 10. A number of different species of gastropod molluscs were caught but given the large number of species within each family, and the lack of time available to observers, these were generally only identified to the family or genus level and included Volutidae, Cassidae and Cypraeidae.

Two high-risk species were recorded. Southern blue-ringed octopuses were recorded at FI-FI1 and FI-NB. Black and White Seastars were recorded from KI-Lavinia East.

Considering only the four different scallop “groups” (commercial Scallops, old single, new single, and clappers), FI-NBNE and KI – 6 had a much higher percentage of old single shell (more than 90%) than other beds (Figure 16). KI – Three Hummock Sout East, KI – Lavinia East and KI – Lavinia North had the highest proportion of live commercial scallop (>50%). Clappers were reported from most beds, but only in small percentages.

Table 2. Names, nicknames (used in this report) surveyed in 2024 and area of polygons (km2).

Bed	Nickname	Total Area (km2)
Flinders Island – Flinders Island 1	FI-FI1	40
Flinders Island South – North of Babel	FI-NB	31
Flinders Island South – North of Babel North East	FI-NBNE	21
Flinders Island North – The Sisters	FI-TS	13
Apollo Bay – The Hill North	AB – The Hill	60
King Island – 10	KI – 10	17
King Island – 9	KI – 9	36
King Island – 6	KI – 6	13
King Island – Three Hummock South	KI-3 Hummock S	52
King Island – Three Hummock South East	KI-3 Hummock SE	26
King Island – Lavinia East	KI-Lavinia East	67
King Island – Lavinia North	KI-Lavinia North	60

Table 3. Total commercial catch (t) and the number of vessels that fished within each 2024 survey bed during the 2022 fishing season based on logbook data. Records coloured red are confidential – they were used in the analyses but removed for final report. *Note: Although 9 different vessels fished outside of the 2022 beds, the catch cannot be reported because it allows the catch from FI – The Wreck A and FI – The Wreck to be derived from the total catch.

Bed	Catch (t)	Number of vessels
FI-FI1	Confidential	<5
FI-NB	0	0
FI-NBNE	0	0
FI-TS	Confidential	<5
AB – The Hill	0	0
KI – 10	0	0
KI – 9	0	0
KI – 6	0	0
KI-3 Hummock S	0	0
KI-3 Hummock SE	0	0
KI-Lavinia East	1423	9
KI-Lavinia North	437	7
Outside of beds	146	8
Total	Confidential	9

Table 4. Biomass estimates, 95% confidence intervals and number of tows included in analyses. Note that both densities have been adjusted for a 33% assumed dredge efficiency.

Area	Bed	Number of tows	Mean density (kg/1000 m2)	Standard deviation (kg/1000 m2)	Lower 95% CI (t)	Estimated biomass (t)	Upper 95% CI (t)	Density (ind/m2 >85mm)
Apollo	AB–The Hill	25	54.6	62.3	1,750	3,304	4,859	0.33
Sub-total		25				3,304		
King	KI-10	25	120.2	122.7	1,190	2,056	2,923	1.09
	KI-3 Hummock S	25	180.7	164.4	5,891	9,435	12,978	1.55
	KI-3 Hummock SE	25	303.4	160.6	6,124	7,837	9,550	3.23
	KI-6	25	1.5	3.1	3	20	36	0.01
	KI-9	25	37.2	49.2	614	1,352	2,091	0.24
	KI-Lavinia East	25	118.4	119	4,641	7,932	11,223	1.46
	KI-Lavinia North	25	293	182.4	13,197	17,760	22,322	3.44
Sub-total		175				46,392		
Flinders	FI-FI1	25	27.8	30.1	622	1,125	1,628	0.28
	FI-NB	25	16.5	23.3	216	517	819	0.10
	FI-NBNE	20	1	2.1	-1	20	41	0.005
	FI-TS	25	19.9	22.2	145	269	393	0.18
Sub-total		95				1,931		
Total		295				51,627		

Table 5. Percent weight of scallops > 85 mm (catch-weighted by weight), and biomass estimates 95% confidence intervals for scallops greater than 85 mm.

Area	Bed	% weight > 85 mm	Lower 95% CI (t)	Estimated Biomass > 85 mm (t)	Upper 95% CI (t)
Apollo	AB–The Hill	52.7	923	1,742	2,561
Sub-total				1,742	
King	KI-10	70.3	836	1,444	2,053
	KI-3 Hummock S	75	4,418	7,075	9,731
	KI-3 Hummock SE	85.9	5,261	6,732	8,204
	KI-6	58.9	2	12	21
	KI-9	48.7	299	658	1,018
	KI-Lavinia East	97.2	4,509	7,707	10,905
	KI-Lavinia North	97.4	12,848	17,290	21,732
Sub-total				40,978	
Flinders	FI-FI1	88.4	550	995	1,439
	FI-NB	54.6	118	283	448
	FI-NBNE	62.1	0	13	26
	FI-TS	87.2	127	234	342
Sub-total				1,525	
Total				44,185	

Table 6. Number of length measurements (N), median, mean and standard error (SE) of scallops measured, and % of scallops measured (catch weighted by weight) less than and greater than 85 mm and mean number of meats per kg of scallops greater than 85 mm from each bed.

Bed	N	Length (mm)			85 mm		Meats / kg
		Median	Mean	SE	%<	%>	Mean
AB-The Hill	756	89	89	0.4	47.3	52.7	97
KI-10	1,042	88	89	0.2	29.7	70.3	90
KI-3 Hummock S	1,053	89	90	0.2	25	75	83
KI-3 Hummock SE	1,250	90	90	0.2	14.1	85.9	86
KI-6	69	89	89	1.0	41.1	58.9	111
KI-9	320	83	83	0.3	51.3	48.7	151
KI-Lavinia East	940	95	95	0.2	2.8	97.2	115
KI-Lavinia North	1,071	96	95	0.2	2.6	97.4	80
FI-FI1	855	92	92	0.3	11.6	88.4	74
FI-NB	923	79	76	0.4	45.4	54.6	51
FI-NBNE	69	90	89	1.6	37.9	62.1	61
FI-TS	584	92	92	0.3	12.8	87.2	78

Table 7. Number of scallops retained for biological sampling, and parameter estimates for length-weight relationships.

Sub Area	N	a	b	Adjusted R ²
AB-The Hill	46	-5.5696	2.1951	0.8599
KI-10	51	-8.5816	2.8538	0.7627
KI-3 Hummock S	50	-7.335	2.577	0.7728
KI-3 Hummock SE	46	-5.1852	2.1018	0.5911
KI-6	41	-8.0640	2.7417	0.9088
KI-9	44	-9.3066	2.9721	0.7165
KI-Lavinia East	46	-1.4950	1.2559	0.2017
KI-Lavinia North	49	-6.3933	2.3661	0.7208
FI-FI1	48	-7.3007	2.5763	0.8971
FI-NB	36	-6.9510	2.5075	0.8972
FI-NBNE	35	-8.4932	2.8365	0.8651
FI-TS	44	-9.922	3.144	0.7473

Table 8. Catch of each species in each bed. (u) refers to undifferentiated species recorded at a higher taxonomic level.

SPECIES	AB-THE HILL	FI-FI1	FI-NB	FI-NBNE	FI-TS	KI-10	KI-3 HUMMOCK S	KI-3 HUMMOCK SE	KI-6	KI-9	KI-LAVINIA EAST	KI-LAVINIA NORTH
Commercial Scallop	955.48	376.5	244.79	10.17	296.25	1,996	3,251.6	5,687.29	25.7	724.2	2,471.3	4,579.2
Clappers	91.09	9.4	13.96		10.94	116.4	27.71	6.84	13.99	38.18	9.24	238.49
New Single	145.1	41.3	41.54	1.72	8.04	801	1,970.54	916.55	4.5	155.2	397.19	171.42
Old Single	5,448.62	1,694.7	1,032.18	675.93	2,364.14	2,948.4	2,680.78	600.09	2,322.21	2,523.65	1,356.66	3,664.83
Algae - Phyllospora		1	0.05									0.1
Banded Stingaree			0.7				1.5		2.25		0.2	14.48
Barred Grubfish		0.1										
Beaked Salmon		0.2										
Black And White Seastar											22.52	
Brittlestars (U)		0.11			9.96				0.01			
Brown Algae											0.6	
Brownstriped Leatherjacket						1						
Bulldog Stargazer				2.3	7.4							
Butterfly Gurnard							11.12			2.27	2.18	
Cassidae (U)		0.8										
Cockle		71.76	59.78									
Common Bellowsfish		0.05										
Common Gurnard		0.05	0.1									8.12
Perch												
Common Stargazer	5.5	2	104.26				3					
Common Stinkfish		0.05	0.81	0.01								
Conger Eels (U)		0.05										
Cowrie (U)		1.94										
Crab (U)		0.1	1.47		0.94				0.08			
Crested Flounder							0.05				2.18	
Doughboy Scallop		426.46	1.81		61.94	837.15	53.9	60.44	8.95	1853.8	658.89	939.99
Draughtboard Shark							1.5					13.2
Eastern Balmain Bug		0.3										
Echinoderm (U)							2.5	9.1				
Electric Ray (U)						1.5		1.3				
Eleven-Arm Seastar	5.68	6.8	224.03	164.92	263.25	16.73	21			81	75.6	295.38
False Bailer Shell	14.36	0.2	7.16						6.48	2		
Flathead (U)			7.66					2.1				22.31
Flounder (U)		0.15							0.05			2
Gastropod (U)			7.5									

Hard Coral		4.3										
Hermit Crab	0.25	41.65	21.5	64.6	228.95	14.9	38.2	7.5	0.3		0.8	
Holothurian (U)	7.19											
King Island Thickshell-Clam						1.63			7.24	0.46		
Leatherjackets (U)	0.05										0.12	
Lefteye Flounder (U)			0.01									
Live Shell							1.38		16.6			
Longnose Skate											7	
Maori Octopus		7.8										
Mollusc (U)			11.89	4.46								
Moreton Bay Bug (U)	0.06	0.3										
Mosaic Leatherjacket						1.5						
Octopus (U)	26.88	0.8	37.47	2		2.96			2.17			
Oysters		9.9	65.26	2,059.02		1,429.69	1.74	36.68		126.7		
Pale Octopus	2	5.2	6.4	0.2		6.6	0.85	0.55	4.53	4.76	15.96	
Pen Shell			3.7									
Polychaete Worm (U)	0.62	0.1									0.01	
Pufferfish (U)											0.2	
Razorfish (U)		3.9	12.74	26.85				0.2				
Red Gurnard							4	0.3				
Righteye Flounder (U)		0.05										
Roundsnout Gurnard	1.19		0.2						0.2		1.85	
Sandyback Stingaree			1.5									
Scallops-Undifferentiated							2.04					
Scorpionfish		0.1		0.6	0.8							
Sea Robin							2					
Sea Urchin (U)	8.8	53.98	8.23	10.79	4.65				0.2			
Seapen (U)		0.7										
Seastar (U)		2.9	8.24	3.04	11				0.5		3.16	
Sergeant Baker											5	
Shark Egg (U)				0.4								
Skate (U)							1.5	0.5			7.84	
Soft Coral (U)			4.86									
Southern Blue-Ringed Octopus		0.3	0.43									
Southern Sand Flathead			1.2									
Sparsely-Spotted Stingaree		0.4	6.9	7	1	1	2.8	5.41		2.92		
Spider Crab (U)	0.83	0.01	33.14	17.14	9.75	0.1		0.8		1.46	0.5	9.55

Sponge	620.6	702	1,829.18	55.75		970.17	38.33	177.15	12.75	511.48	1,206.08	3,109.94
Starfish	0.94		2.48						2.55			
Stingray (U)	1.07		0.2	10			10					23.54
Substrate - Broken Shell	2,773.28	10,762.1	4,144.42	3,655.81	3,452.98	848.48	113.76	26.85	8,498.55	2,745.45	86.76	3,089.75
Substrate - Rock							13.4			48.75		
Triggerfish & Leatherjacket (U)				0.2								
Triton Shells		1.36	36.89									
Volute (U)		1.75										
Whelk	17.6	10.19	44.29	41.02	14.24	68.25	70.43	53.82	57.14	38.34	24	49.77
Whitespotted Skate		0.6										

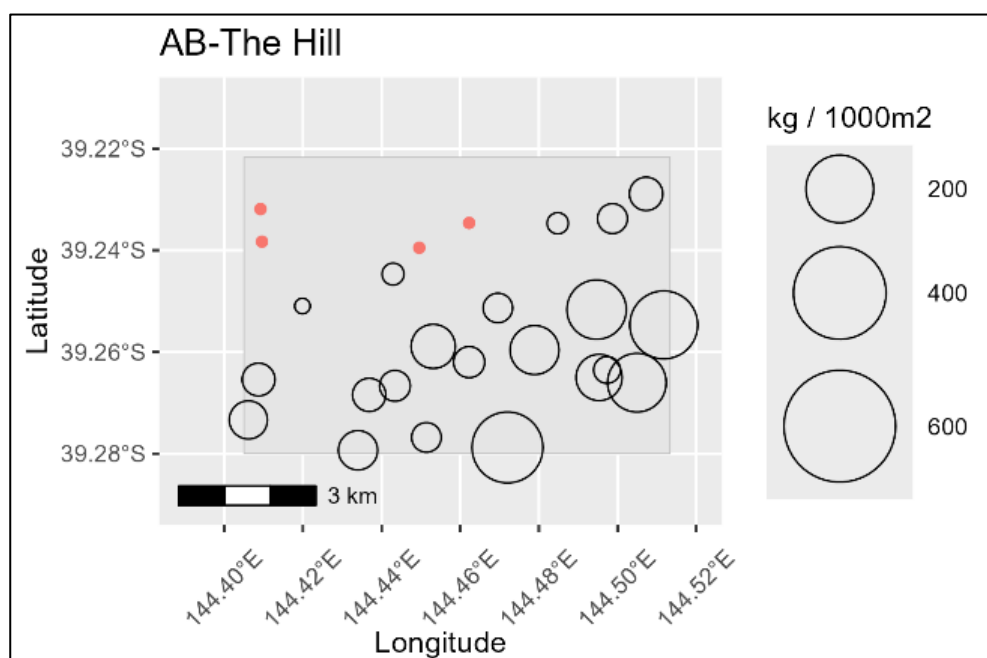


Figure 6. Scallop density (kg / 1,000 m²) within the AB – The Hill. The top right scale bubbles reflect the estimated scallop density of each tow assuming a dredge efficiency of 33%. Red circles denote zero catches.

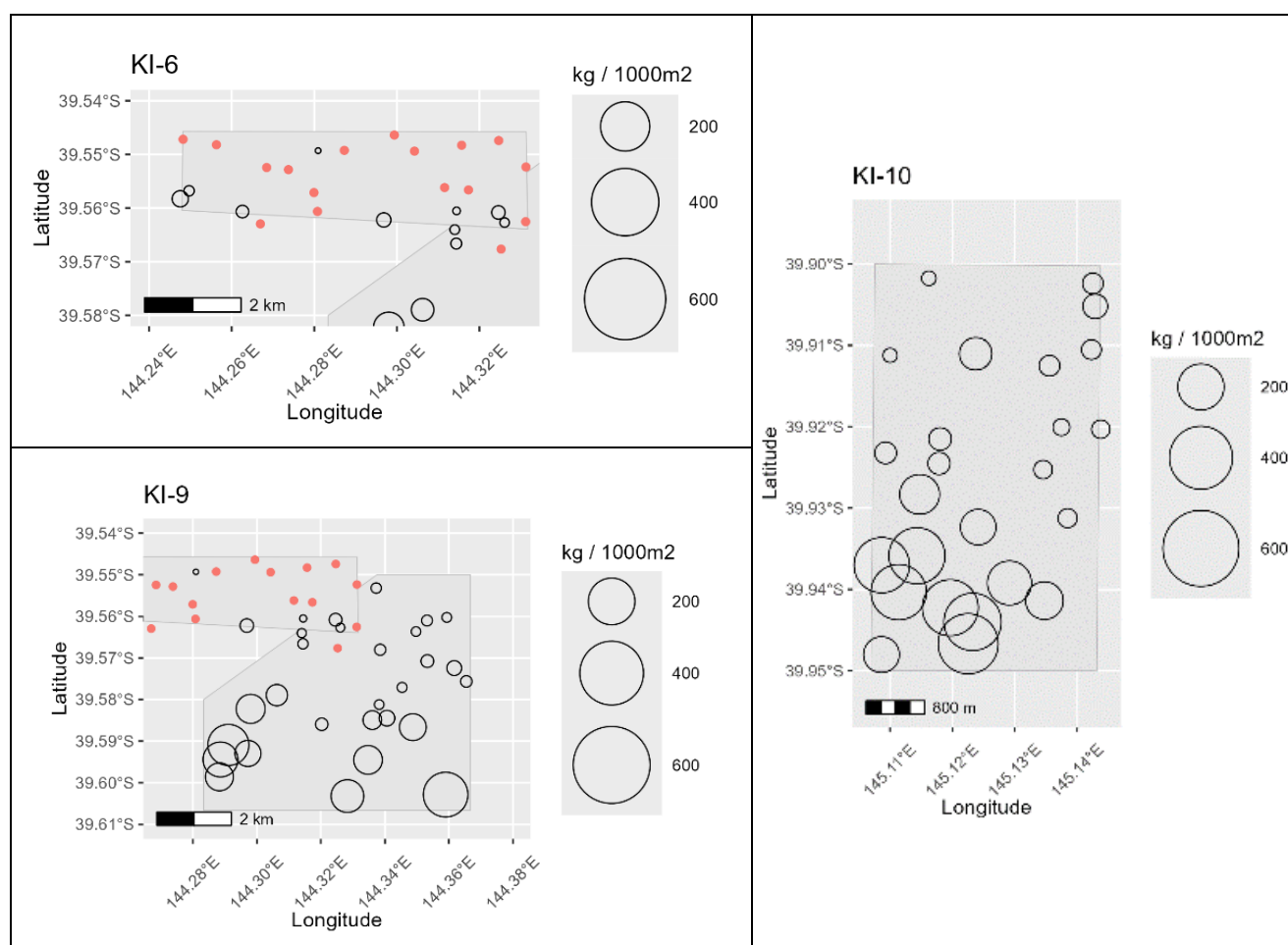


Figure 7. Scallop density (kg / 1,000 m²) within KI-6, KI-9, and KI-10. The scale bubbles on the right reflect the estimated scallop density of each tow assuming a dredge efficiency of 33%. Red circles denote zero catches.

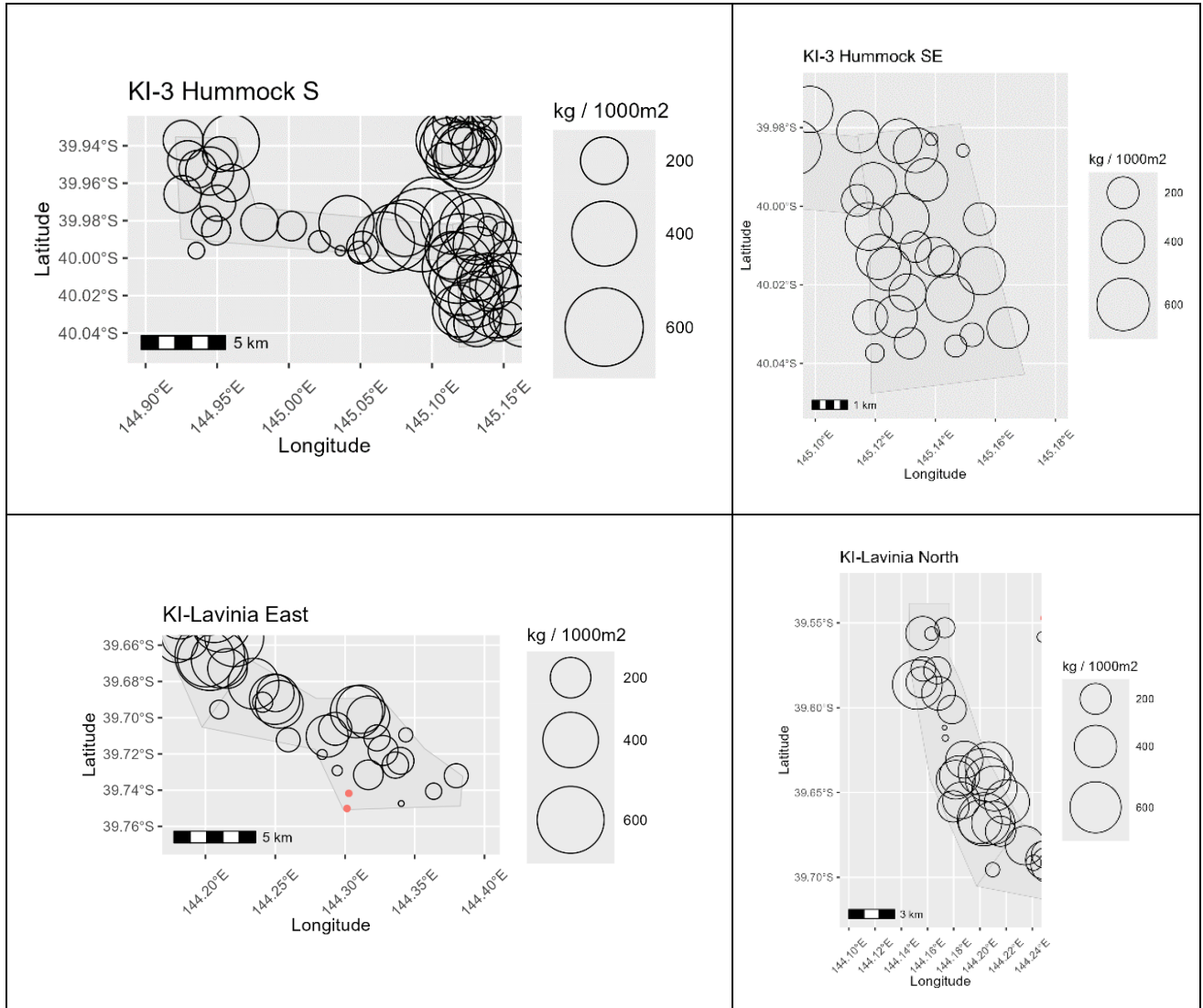


Figure 8. Scallop density (kg / 1,000 m²) within KI-3 Hummocks South, KI-3 Hummocks South, KI-Lavinia East and KI-Lavinia North. The scale bubbles on the right reflect the estimated scallop density of each tow assuming a dredge efficiency of 33%. Red circles denote zero catches.

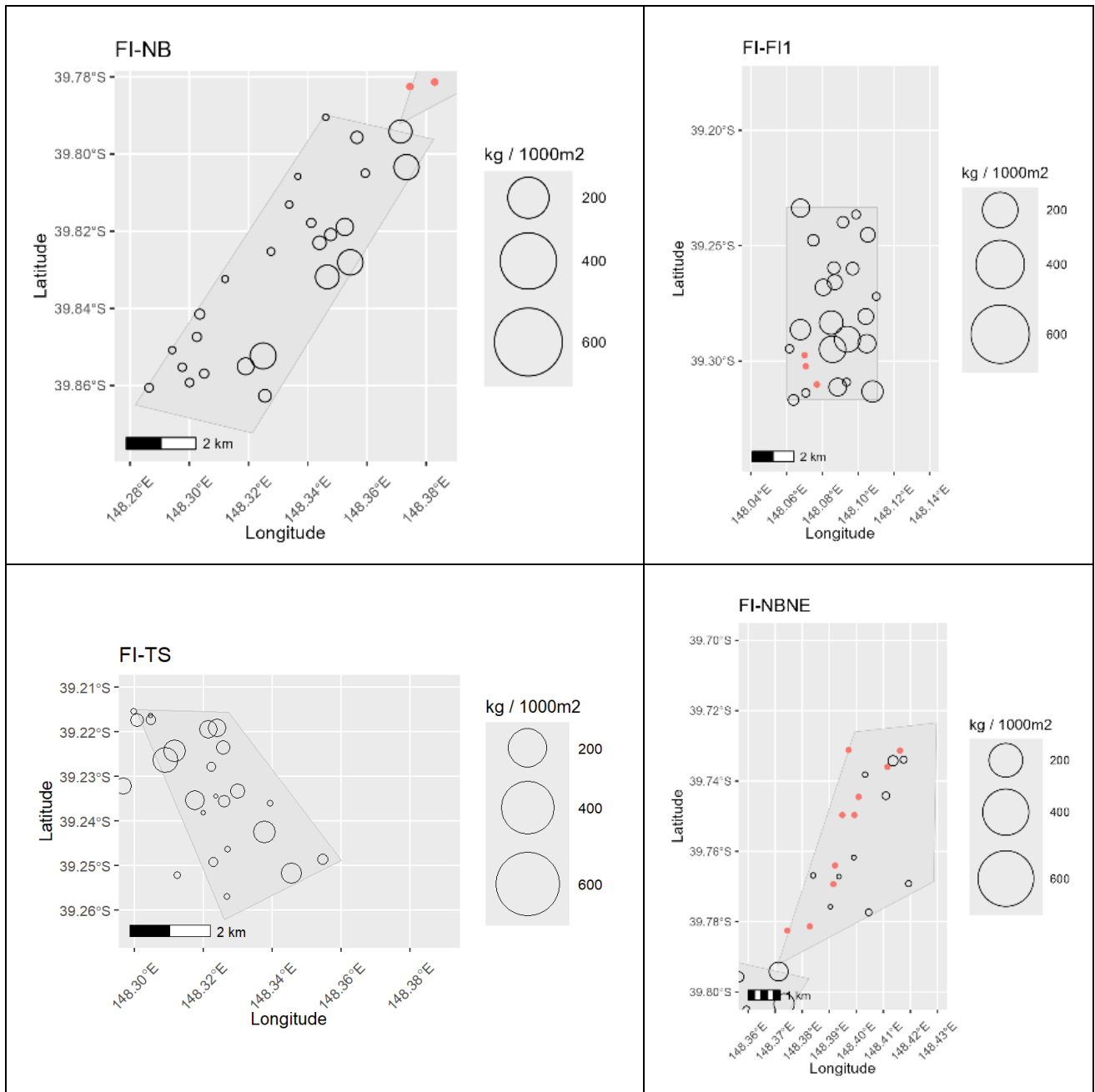


Figure 9. Scallop density (kg / 1,000 m²) within the FI – NB, FI – NBNE, FI – TS– FI1 beds near Flinders Island. The scale bubbles on the right reflect the estimated scallop density of each tow assuming a dredge efficiency of 33%. Red circles denote zero catches.

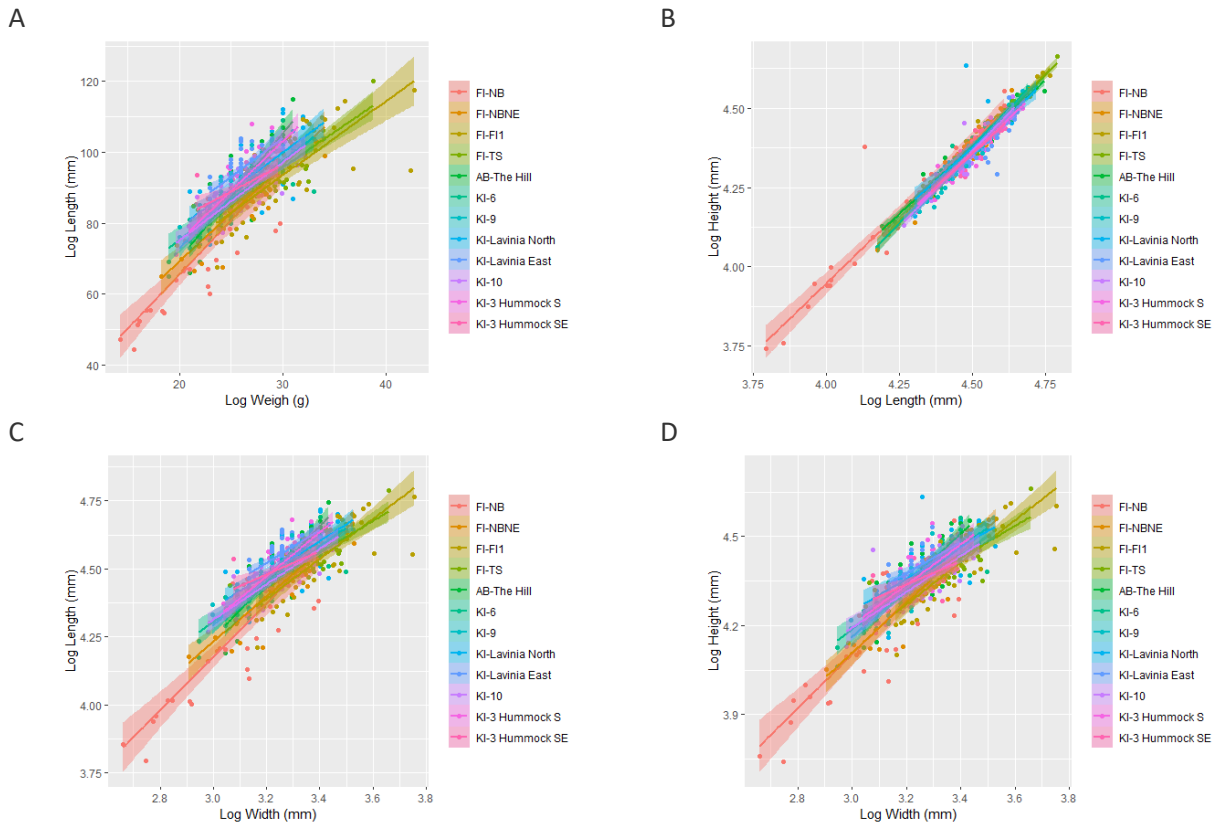


Figure 10. Log transformed A) length and weight, B) length and height, C) length and width and D) height and width from each area bed.

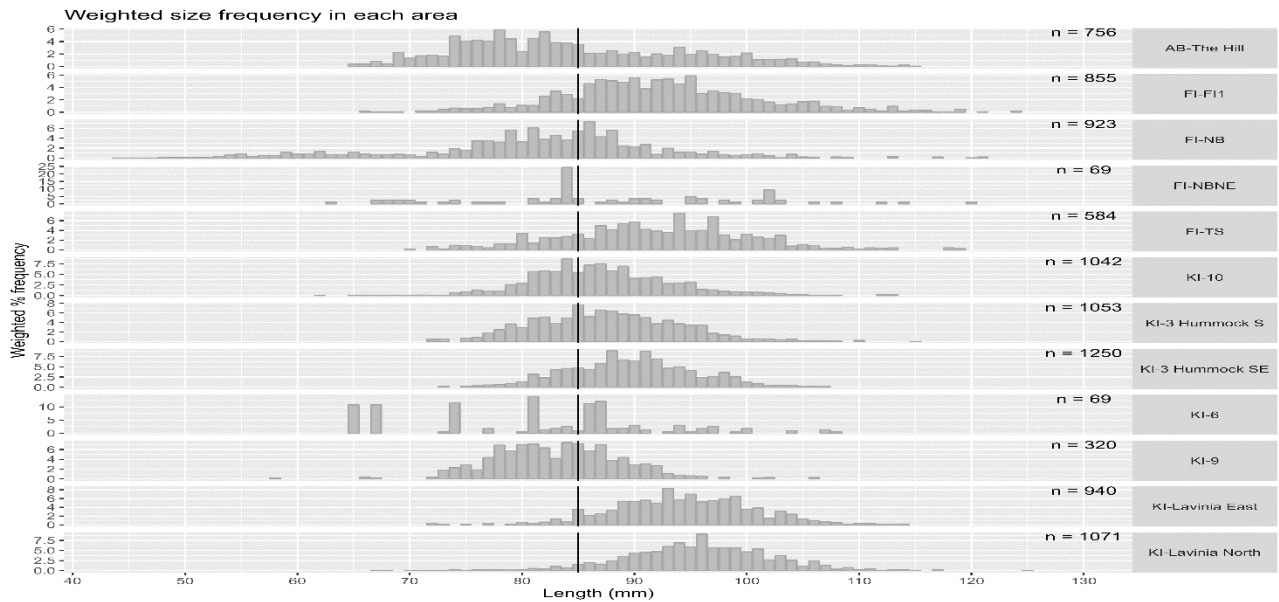


Figure 11. Catch-weighted size frequency from tows included in biomass estimates from each bed. The vertical line is at 85 mm.

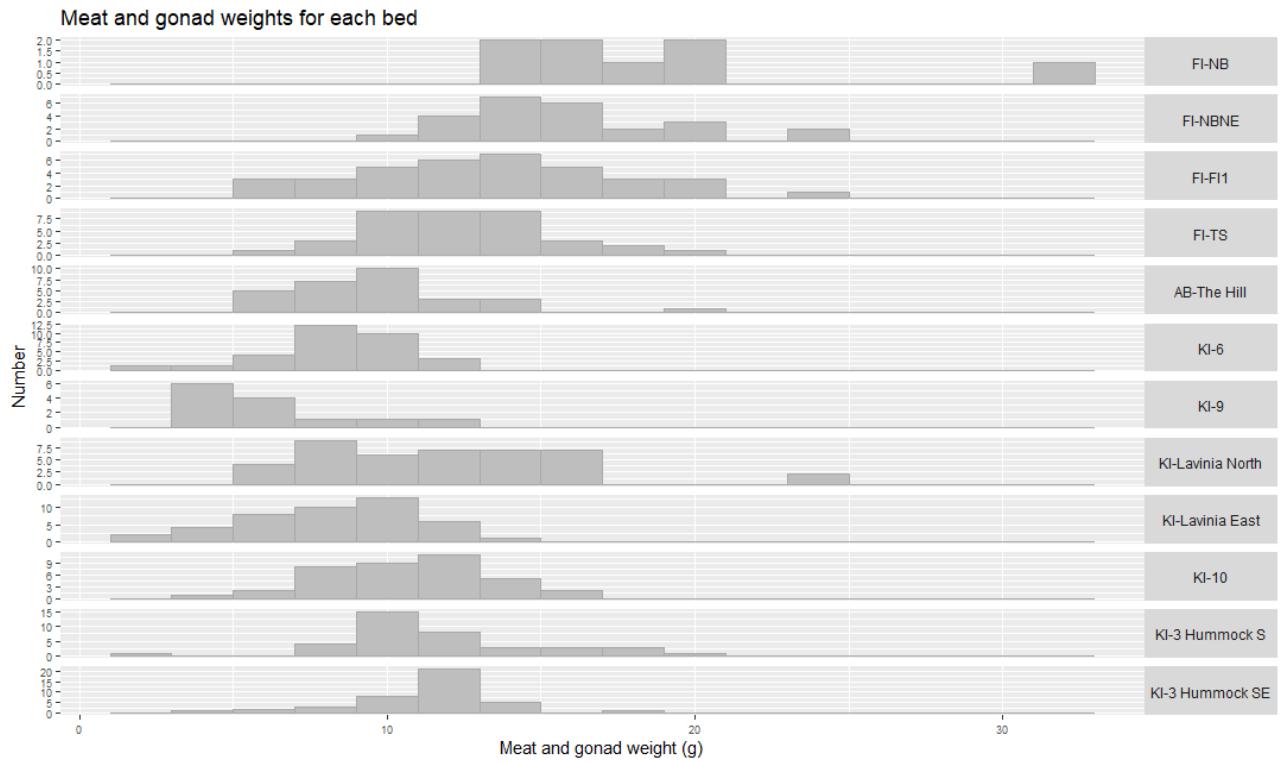


Figure 12. Frequency of combined meat and gonad weights of scallops >85 mm measured from each bed binned into 2 g weight categories.

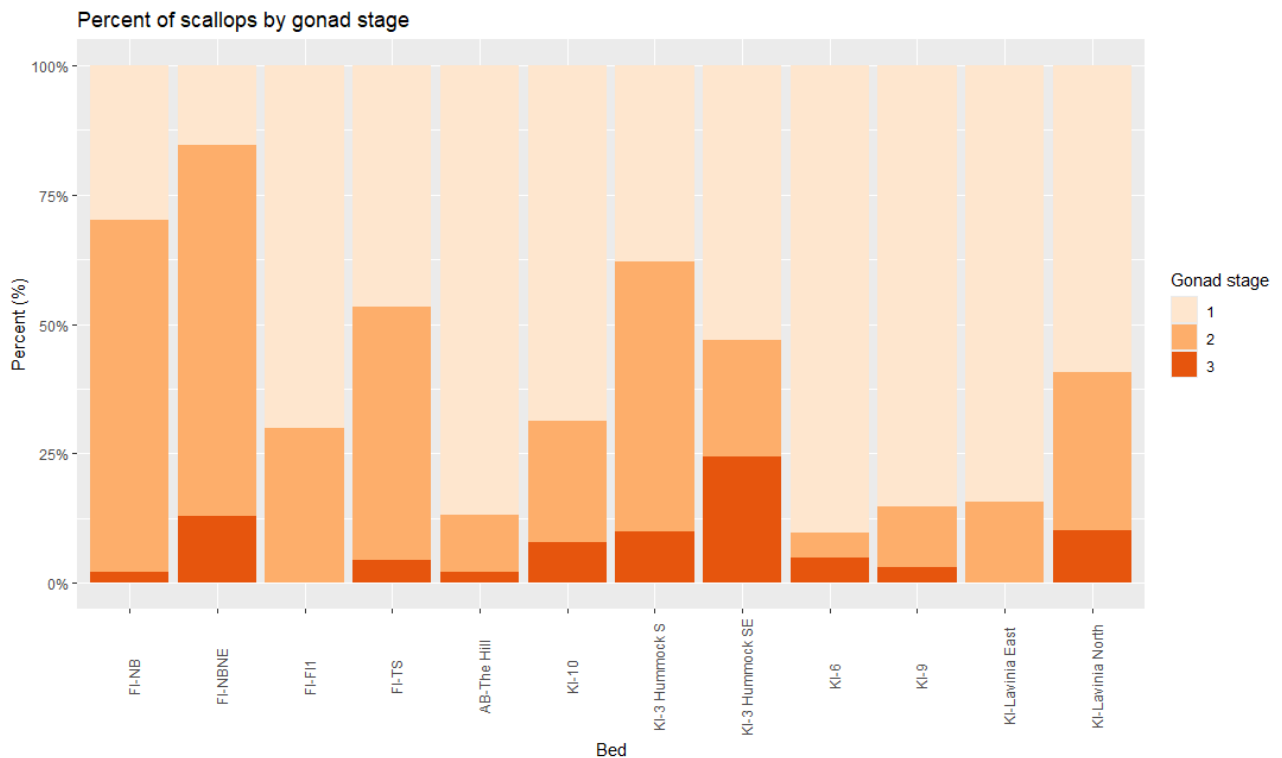


Figure 13. Percent of scallops at each stage from each bed based on macroscopic staging criteria shown in Table 10.

Catch of top 5 species

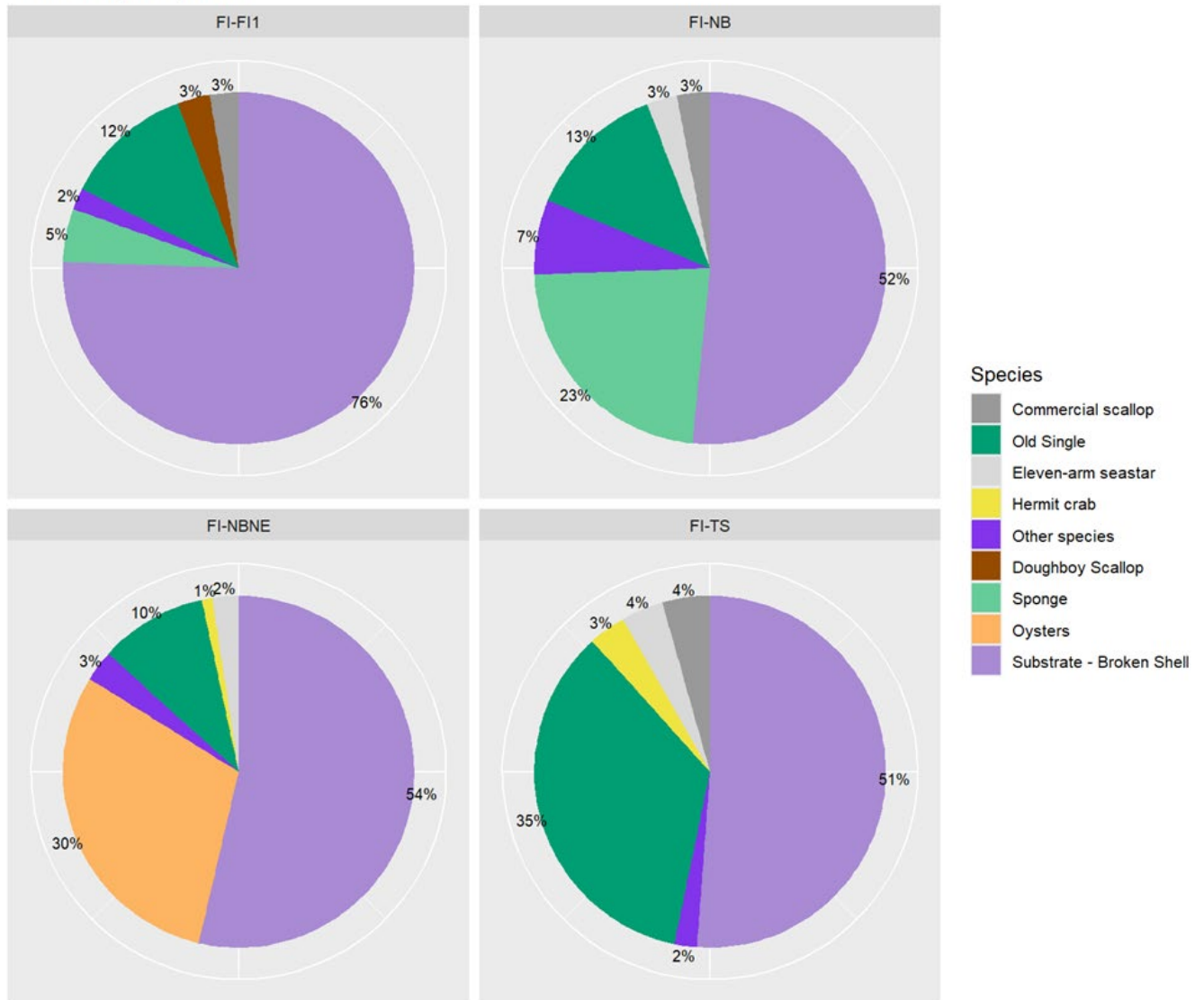


Figure 14. Percent catch composition by weight from beds near Flinders Island.

Catch of top 5 species

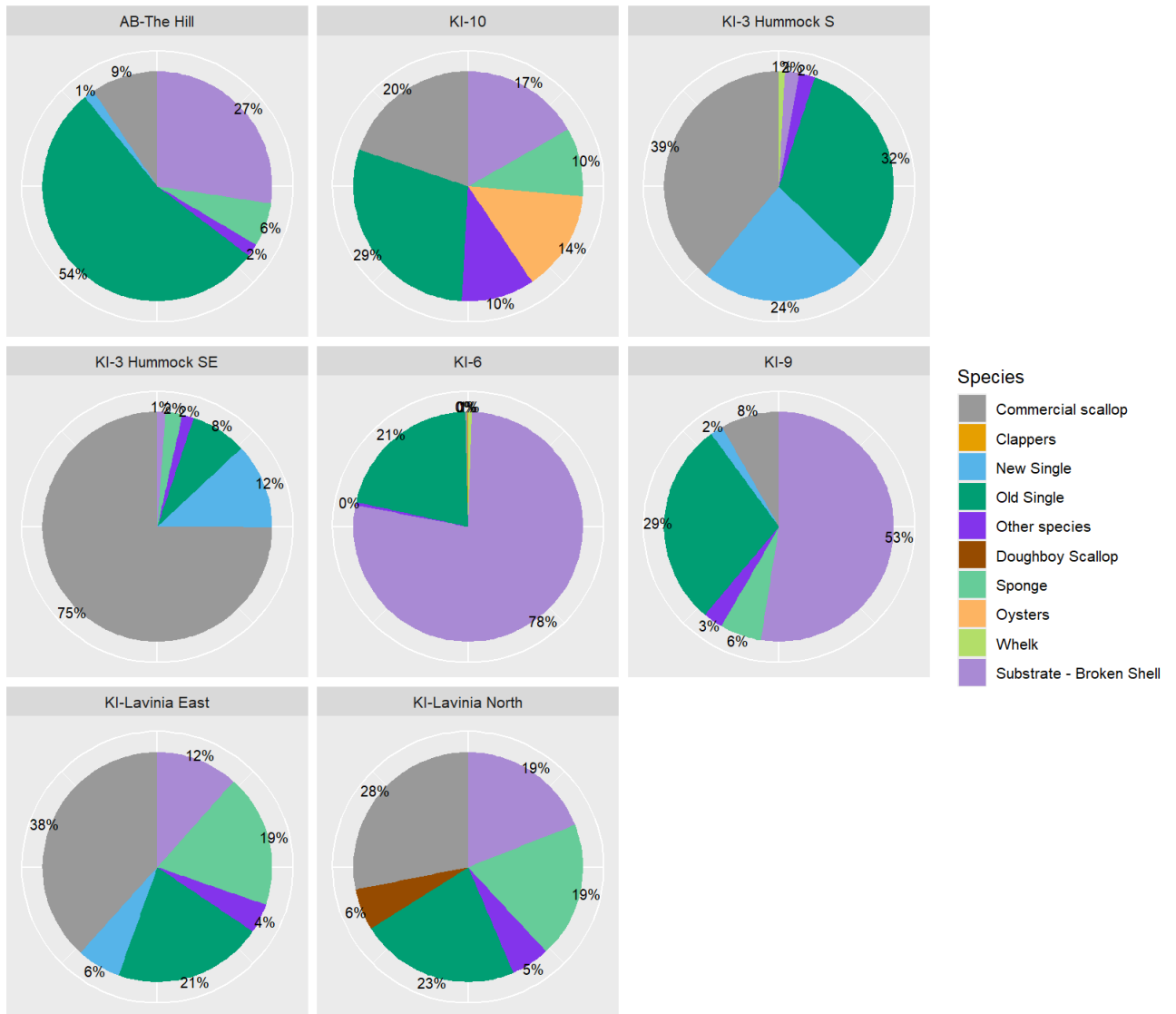


Figure 15. Percent catch composition by weight from beds near King Island.

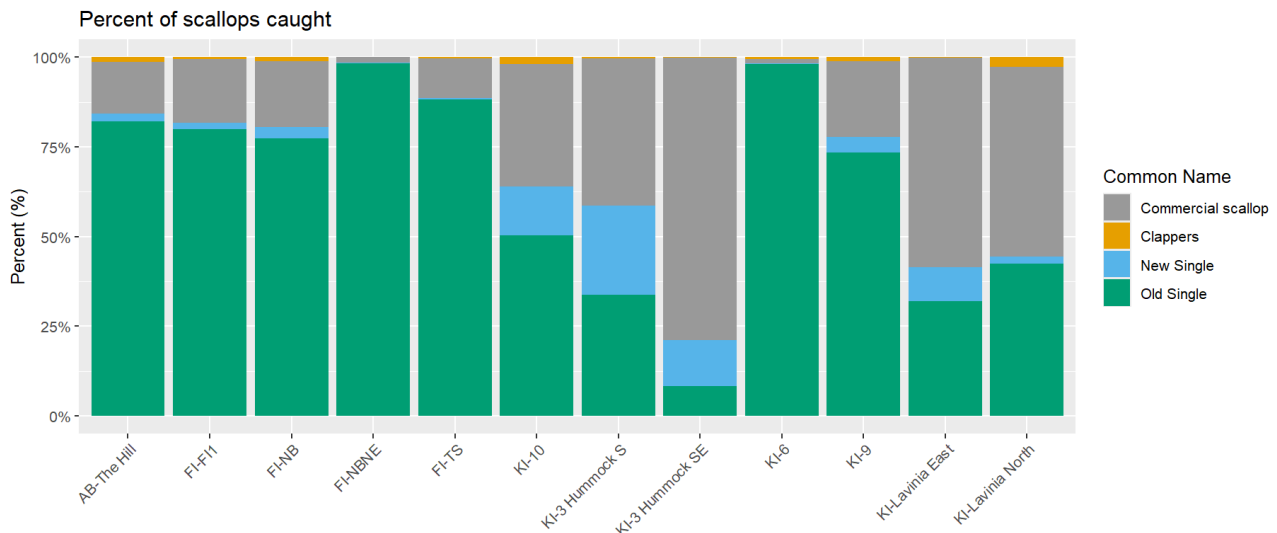


Figure 16. Percent composition of clappers, live scallop, new single and old single shell from each Bed.

4 Discussion

Random stratified surveys were successfully undertaken on twelve scallop beds off Flinders Island, King Island and Apollo Bay. Surveys reveal harvestable biomass and allow for spatial harvesting according to the density of large scallops. They also indicate interannual recruitment measurable as the density of undersized scallops. Such information is useful in forecasting future catches and provides valuable input into decision making for this co-managed fishery.

The current surveys reveal commercial quantities of scallops consistent with healthy populations within selected beds. The results provide greater certainty in targeting scallops without compromising future recruitment by fishing in beds dominated by undersized scallops. For a fast-growing, short-lived species, spatial surveys allow for optimal harvesting consistent with sustainable management of the fishery.

Results were presented at the ScallopRAG meeting on 6 June 2024 and at the ScallopMAC meeting on 7 June 2024.

Table 9. Summary of biomass, density and size data.

Area	Bed	Estimated biomass (t)	% weight ≥ 85 mm	Estimated biomass (t ≥85mm)	Density (ind/m2 ≥85mm)	Mean length (mm)
Apollo	AB-The Hill	3,304 t	52.7%	1,742 t	0.33	89 mm
Sub-total		3,304 t		1,742 t		
King	KI-10	2,056 t	70.3%	1,444 t	1.09	89 mm
	KI-3 Hummock S	9,435 t	75%	7,075 t	1.55	90 mm
	KI-3 Hummock SE	7,837 t	85.9%	6,732 t	3.23	90 mm
	KI-6	20 t	58.9%	12 t	0.01	89 mm
	KI-9	1,352 t	48.7%	658 t	0.24	83 mm
	KI-Lavinia East	7,932 t	97.2%	7,707 t	1.46	95 mm
	KI-Lavinia North	17,760 t	97.4%	17,290 t	3.44	95 mm
Sub-total		46,392 t		40,978 t		
Flinders	FI-FI1	1,125 t	88.4%	995 t	0.28	92 mm
	FI-NB	517 t	54.6%	283 t	0.10	76 mm
	FI-NBNE	20 t	62.1%	13 t	0.005	89 mm
	FI-TS	269 t	87.2%	234 t	0.18	92 mm
Sub-total		1,931 t		1,525 t		
Total		51,627 t		44,185 t		

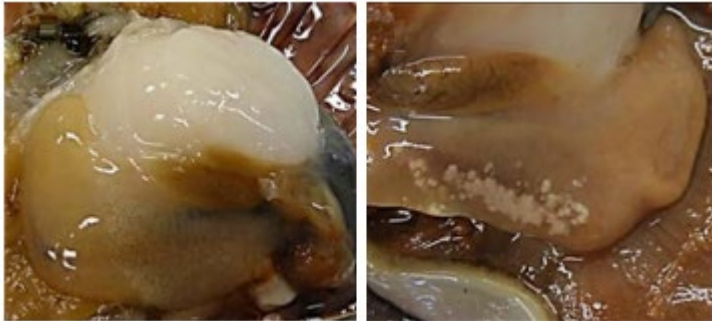


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6 Appendix 1 – Methods

6.1 Gonad Staging

Table 10. Gonad maturation scheme for macroscopic field staging of scallops (modified from Semmens *et al.*, 2019).²

Stages	Description
1 Developing or spent	Gonad is small, thin, translucent, brownish colour. Intestinal loop usually visible. Ovarian and testicular tissues difficult to differentiate. 
2 Maturing or atretic (reabsorbing eggs as spawning is delayed)	Separate acini clearly visible, male (white) and female (orange) part of gonad distinguishable. Gonad increases in turgor (rigidity) and becomes less granular in appearance as acini begin to fill until ovarian tissue appears uniform in colour. 
3 Partially spawned	Gonad reduced in size compared to previous stage. Ovary appears mottled, presumably due to some acini being voided. Intestinal loop usually visible, ovarian tissue uniform in colour, but interspersed with isolated specs of translucent (void) acini. Testicular tissues turn paler in colour. 

² Semmens, J.M., Mendo, Jones, Keane, Leon, Ewing, Hartmann., Institute for Marine and Antarctic Studies, 2019, Determining when and where to fish: Linking scallop spawning, settlement, size and condition to collaborative spatial harvest and industry in-season management strategies, University of Tasmania, Hobart, June. CC BY 3.0

6.2 Shell measurements

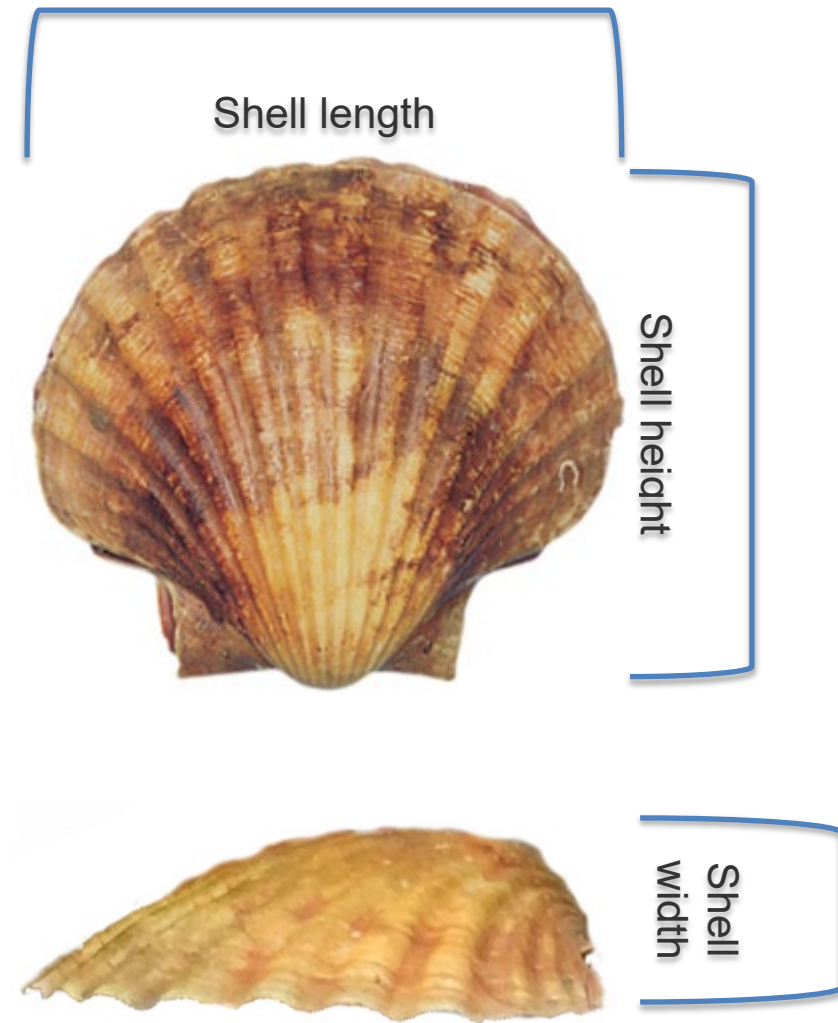


Figure 17. Scallop width, length and height to be measured.

7 Appendix 2 - Time-series data

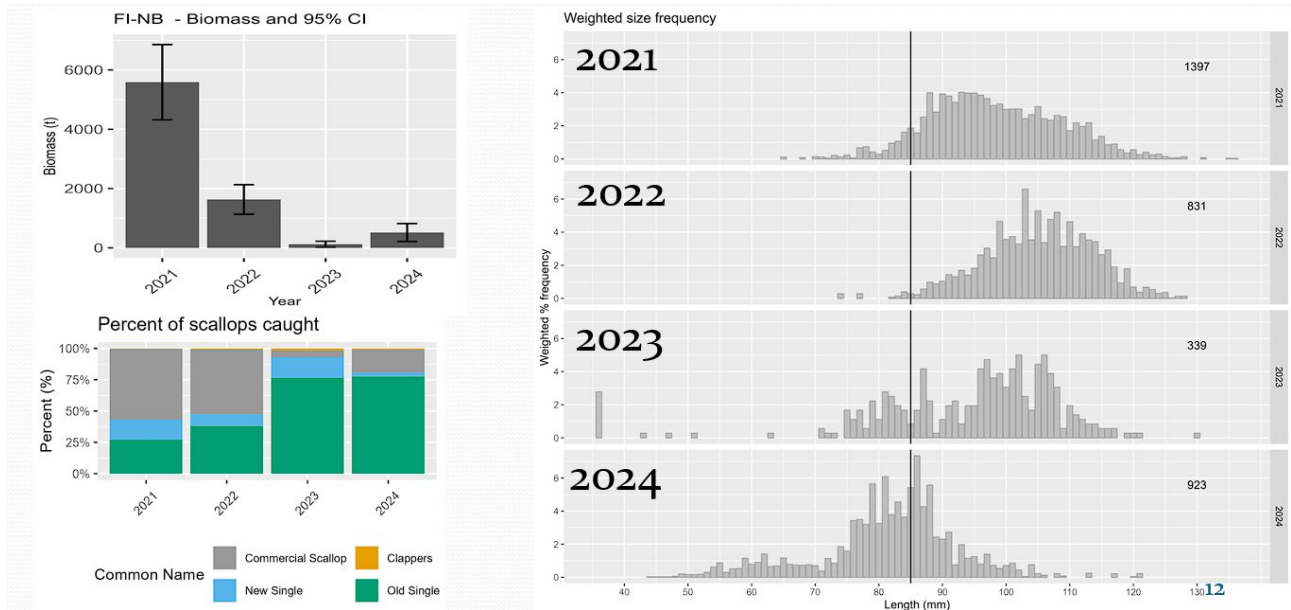


Figure 18. Time-series of biomass estimate, size frequency and percent of scallop (live/shell type) at the FI South – North of Babel.

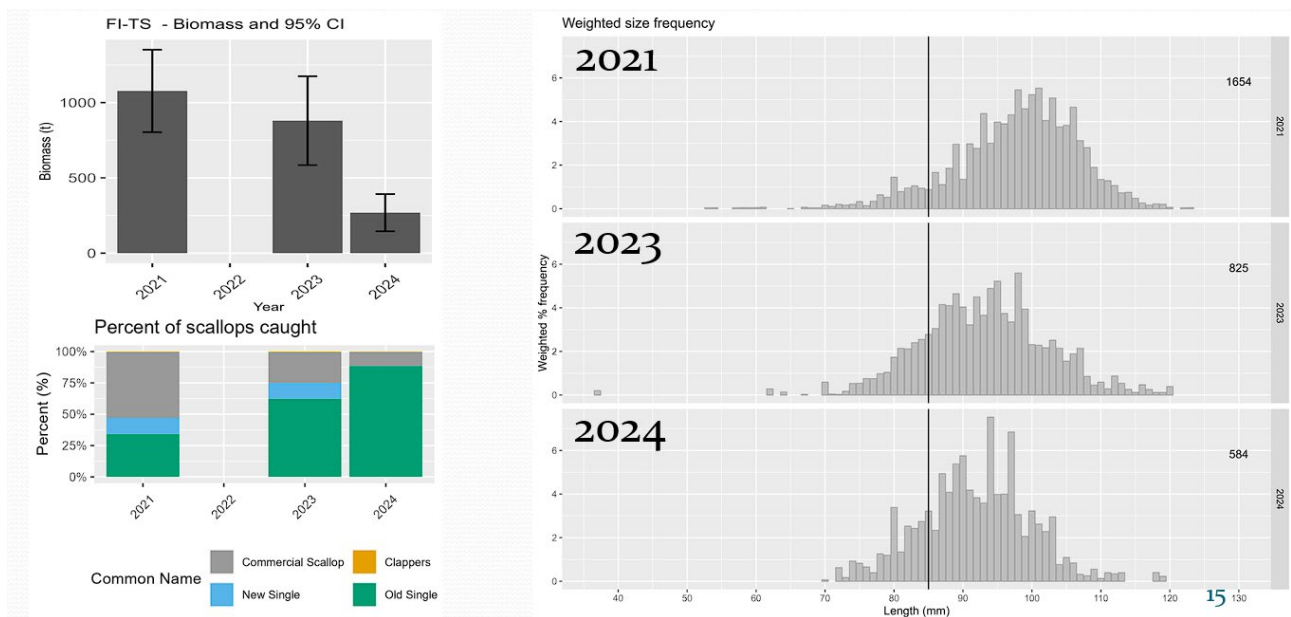


Figure 19. Time-series of biomass estimate, size frequency and percent of scallop (live/shell type) at the FI North – The Sisters bed.

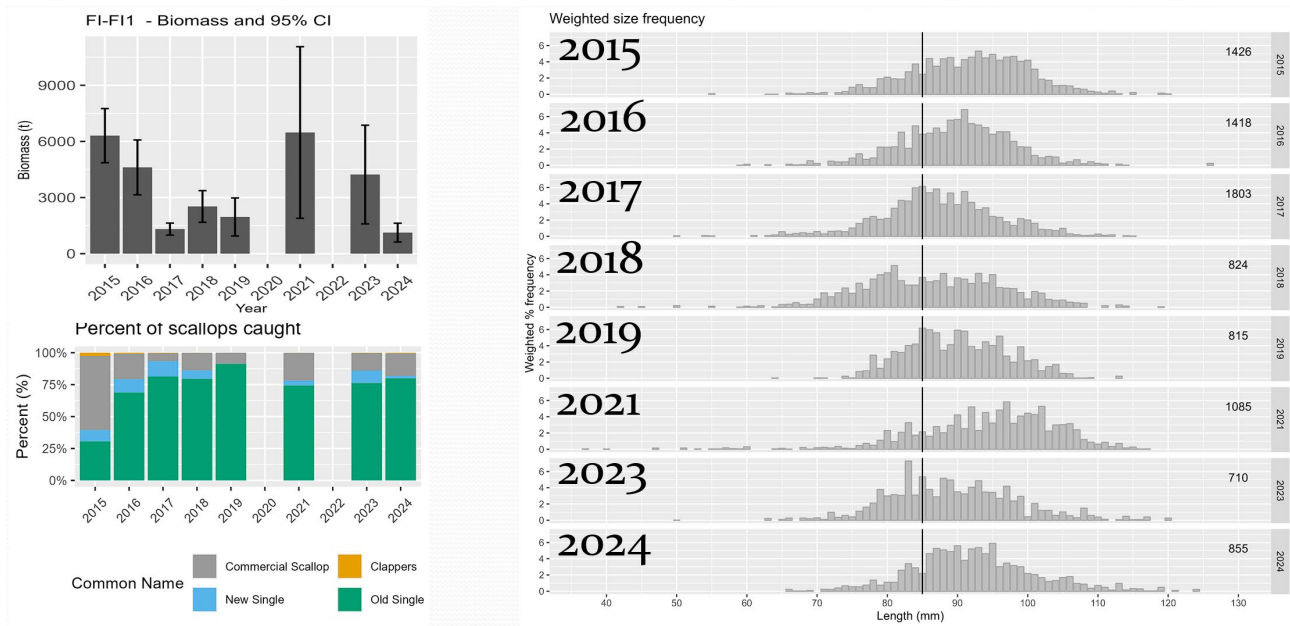


Figure 20. Time-series of biomass estimate, size frequency and percent of scallop (live/shell type) at the FI – FI1 bed. Note that the size of the beds used in the 2024 biomass estimate was 40 km² compared to the 107 km² surveyed in 2023.

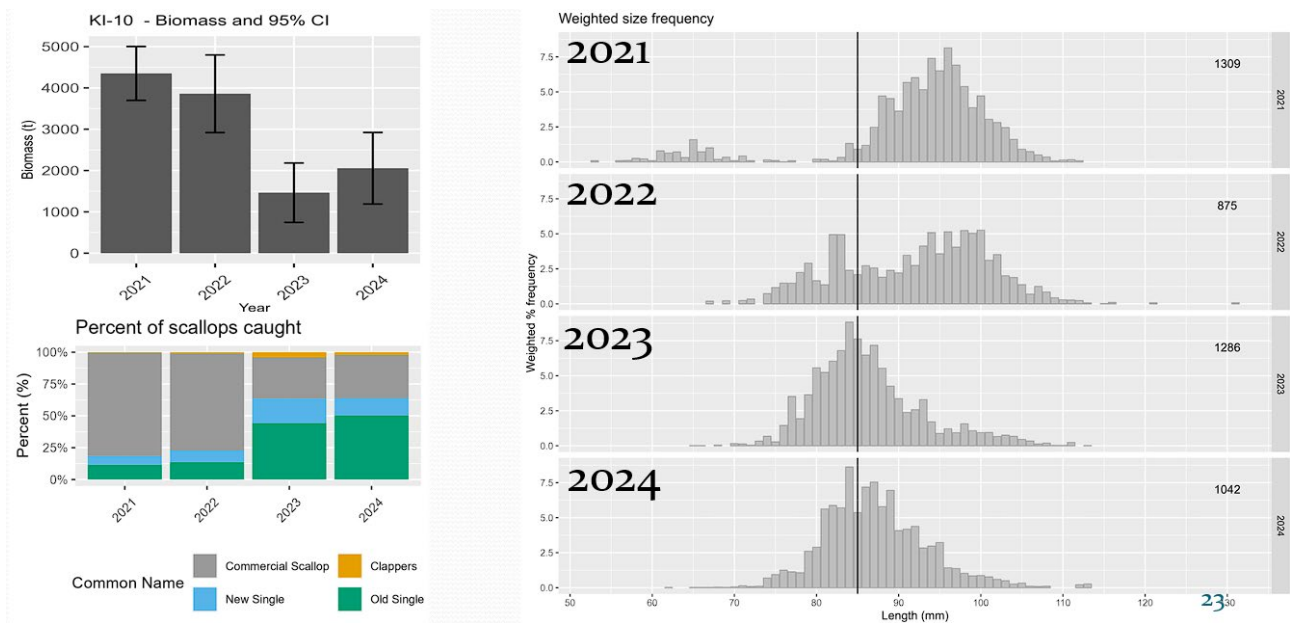


Figure 21. Time-series of biomass estimate, size frequency and percent of scallop (live/shell type) at the KI – 10 bed.

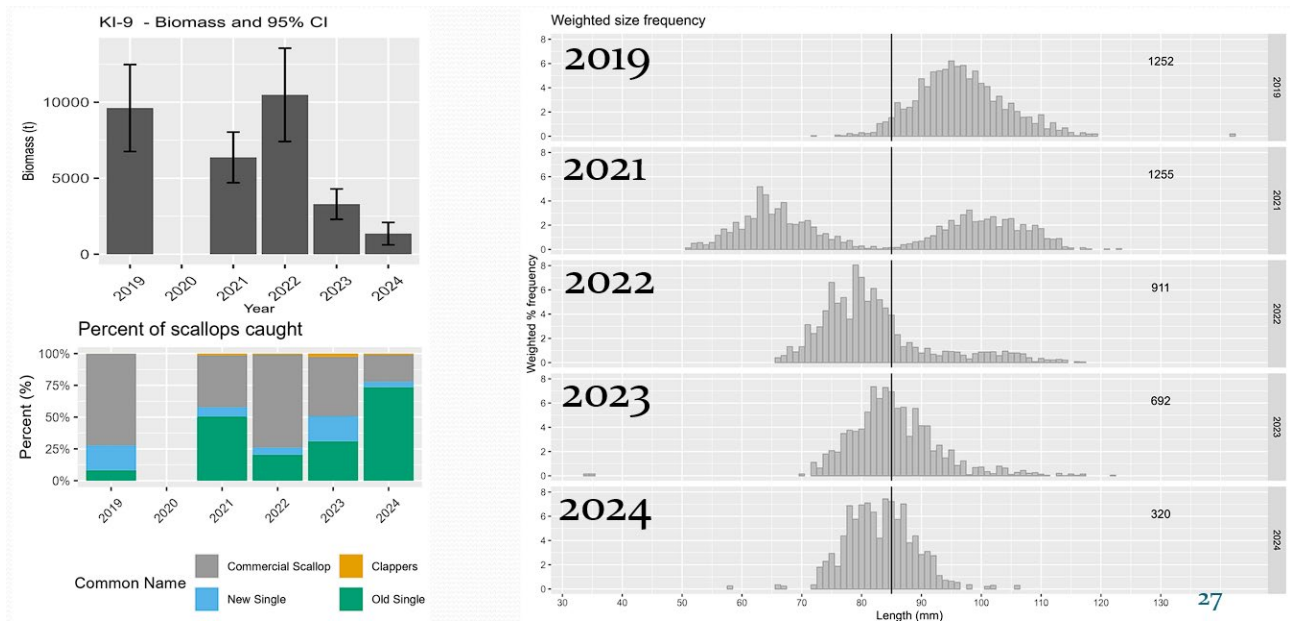


Figure 22. Time-series of biomass estimate, size frequency and percent of scallop (live/shell type) at the KI – 9.

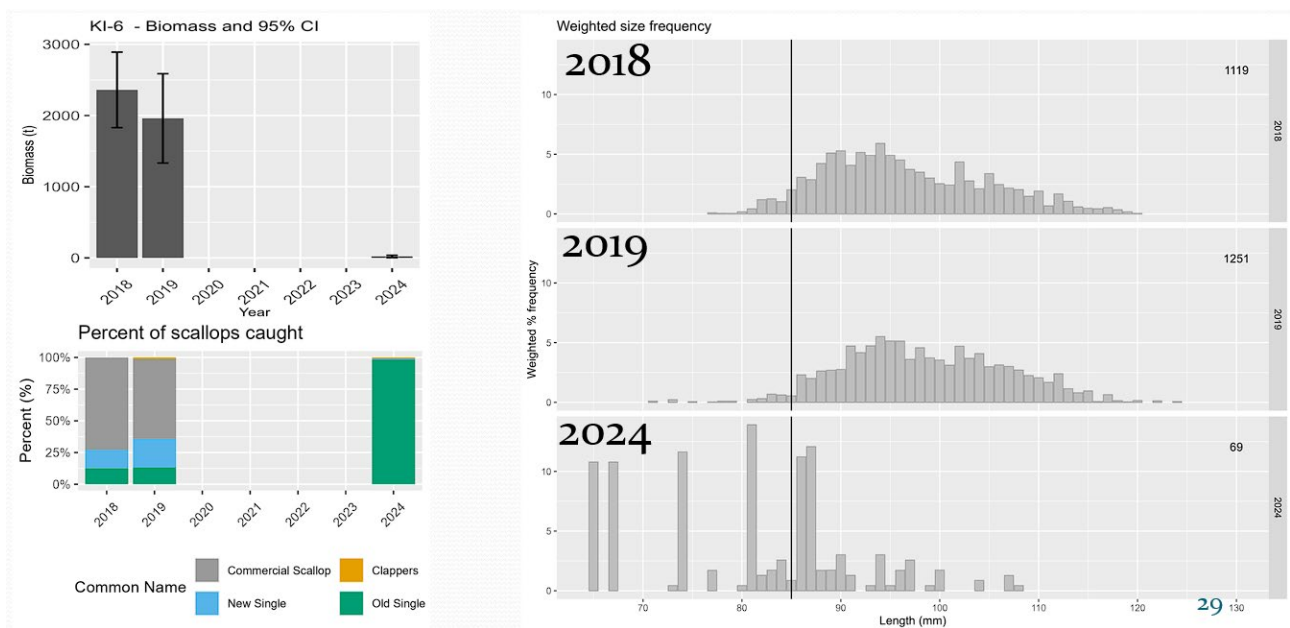


Figure 23. Time-series of biomass estimate, size frequency and percent of scallop (live/shell type) at the KI – 6 bed.

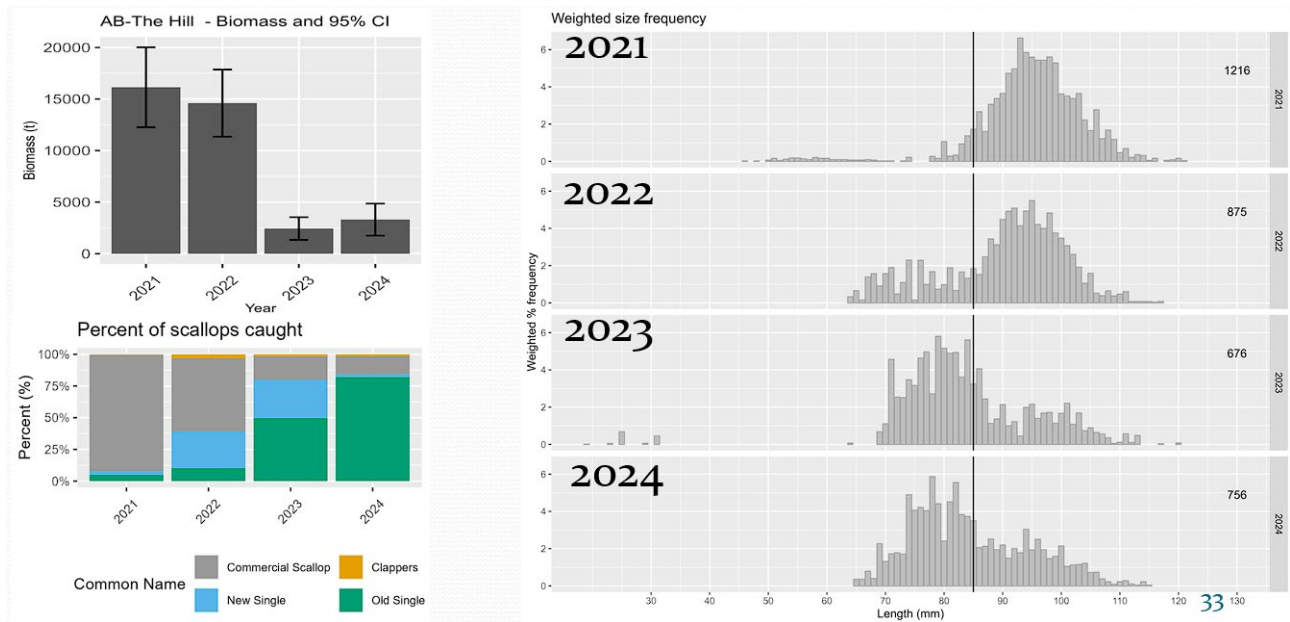


Figure 24. Time-series of biomass estimate, size frequency and percent of scallop (live/shell type) at the AB – The Hill North bed.

8 Appendix 3 - 2024 Survey bed vertices's

Bed	Order	Longitude	Latitude
FI - South - North of Babel	0	148° 20.748	-39° 47.388
FI - South - North of Babel	1	148° 22.950	-39° 47.770
FI - South - North of Babel	2	148° 19.278	-39° 52.338
FI - South - North of Babel	3	148° 16.908	-39° 51.900
FI - South - North of Babel	4	148° 20.748	-39° 47.388
FI - North - The Sisters	0	148° 18.030	-39° 12.900
FI - North - The Sisters	1	148° 19.638	-39° 12.930
FI - North - The Sisters	2	148° 21.600	-39° 14.930
FI - North - The Sisters	3	148° 19.570	-39° 15.730
FI - North - The Sisters	4	148° 18.030	-39° 12.900
FI	0	148° 03.600	-39° 19.000
FI	1	148° 03.600	-39° 14.000
FI	2	148° 06.640	-39° 14.000
FI	3	148° 06.640	-39° 19.000
FI	4	148° 03.600	-39° 19.000
KI-9	0	144° 22.000	-39° 33.000
KI-9	1	144° 22.000	-39° 36.400
KI-9	2	144° 17.000	-39° 36.400
KI-9	3	144° 17.000	-39° 34.800
KI-9	4	144° 18.823	-39° 33.790
KI-9	5	144° 19.900	-39° 33.835
KI-9	6	144° 19.887	-39° 33.201
KI-9	7	144° 20.250	-39° 33.000
KI-9	8	144° 22.000	-39° 33.000
KI - 6	0	144° 14.878	-39° 33.626
KI - 6	1	144° 14.892	-39° 32.742
KI - 6	2	144° 19.877	-39° 32.746
KI - 6	3	144° 19.900	-39° 33.835
KI - 6	4	144° 14.878	-39° 33.626
The Hill North	0	144° 30.800	-39° 13.302
The Hill North	1	144° 30.800	-39° 16.800
The Hill North	2	144° 24.300	-39° 16.800
The Hill North	3	144° 24.300	-39° 13.302
The Hill North	4	144° 30.800	-39° 13.302
KI - 10	0	145° 06.454	-39° 54.000
KI - 10	1	145° 08.623	-39° 54.013
KI - 10	2	145° 08.588	-39° 57.001
KI - 10	3	145° 06.418	-39° 57.000
KI - 10	4	145° 06.454	-39° 54.000
KI - Lavinia North	0	144° 13.923	-39° 40.088
KI - Lavinia North	1	144° 11.848	-39° 42.312
KI - Lavinia North	2	144° 11.848	-39° 42.312
KI - Lavinia North	3	144° 10.327	-39° 39.620
KI - Lavinia North	4	144° 09.723	-39° 38.550
KI - Lavinia North	5	144° 08.795	-39° 34.545
KI - Lavinia North	6	144° 08.753	-39° 32.309
KI - Lavinia North	7	144° 10.601	-39° 32.309
KI - Lavinia North	8	144° 10.602	-39° 34.203
KI - Lavinia North	9	144° 11.189	-39° 35.211

KI - Lavinia North	10	144° 12.229	-39° 37.632
KI - Lavinia North	11	144° 12.743	-39° 38.376
KI - Lavinia North	12	144° 13.923	-39° 40.088
KI - Lavinia East	0	144° 11.848	-39° 42.312
KI - Lavinia East	1	144° 13.923	-39° 40.088
KI - Lavinia East	2	144° 13.924	-39° 40.089
KI - Lavinia East	3	144° 16.757	-39° 41.359
KI - Lavinia East	4	144° 16.757	-39° 41.359
KI - Lavinia East	5	144° 19.565	-39° 41.359
KI - Lavinia East	6	144° 21.423	-39° 43.022
KI - Lavinia East	7	144° 23.067	-39° 43.937
KI - Lavinia East	8	144° 22.960	-39° 44.925
KI - Lavinia East	9	144° 17.929	-39° 45.047
KI - Lavinia East	10	144° 16.708	-39° 43.044
KI - Lavinia East	11	144° 16.708	-39° 43.044
KI - Lavinia East	12	144° 11.848	-39° 42.312
3 Hummock SE	0	145° 07.080	-40° 00.146
3 Hummock SE	1	145° 06.846	-39° 58.911
3 Hummock SE	2	145° 08.897	-39° 58.742
3 Hummock SE	3	145° 10.183	-40° 02.568
3 Hummock SE	4	145° 07.119	-40° 02.856
3 Hummock SE	5	145° 07.080	-40° 00.146
3 Hummock south	0	145° 06.851	-39° 58.937
3 Hummock south	1	145° 07.077	-40° 00.131
3 Hummock south	2	144° 55.478	-39° 59.377
3 Hummock south	3	144° 55.247	-39° 56.122
3 Hummock south	4	144° 57.774	-39° 56.149
3 Hummock south	5	144° 58.625	-39° 58.387
3 Hummock south	6	145° 6.851	-39° 58.937
Flinders Island South â€™ North of Babel North East	0	148° 22.257	-39° 47.533
Flinders Island South â€™ North of Babel North East	1	148° 23.964	-39° 43.562
Flinders Island South â€™ North of Babel North East	2	148° 25.778	-39° 43.408
Flinders Island South â€™ North of Babel North East	3	148° 25.717	-39° 46.116
Flinders Island South â€™ North of Babel North East	4	148° 22.257	-39° 47.533