Australian Government
Australian Fisheries Management Authority

Seventy fifth meeting of the Sub-Antarctic Resource Assessment Group (SARAG)

FINAL MINUTES
SARAG 75

19-20 AUGUST 2026

SUB- ANTARCTIC RESOURCE ASSESSMENT GROUP (SARAG)

CHAIR: Bruce Wallner

DATE: 19-20 August 2026

VENUE: Hadley's Orient Hotel, Hobart, Tasmania

ATTENDANCE

Members

Philippe Ziegler, AAD
Cara Masere, AAD
Rich Hillary, CSIRO
Tim Ward, IMAS (agenda items 1-10)
Brad Milic, Industry (ALF Pty Ltd)
Rhys Arangio, Industry (Austral Fisheries)
Danait Ghebrezgabhier, AFMA

Invited Participants

Heather Patterson, ABARES (agenda items 1-3,5-9)
Pia Bessell-Browne, CSIRO
Dale Maschette, IMAS/AAD
Steph Brodie, CSIRO
Nat Couchman, AFMA

Executive Officer

Rachel Downes, AFMA

Observers

Selina Stoute, AFMA
Anna Willock, AFMA
David Smith, Invited Observer
David Souter, AAD
Ryan Leadbetter, AAD
Liz Brierly, AAD
Jessica Tengvall, Austral Fisheries
Geoff Richardson, SouthMAC Chair (agenda items 5,6 and 8)
Lyn Goldsworthy, IMAS/UTAS (agenda items 5,6 and 8)
Megan Kybert, AAD (agenda items 5.1-5.3 and 8.1)

Agenda Item 1: Preliminaries

1.1 Welcome and Apologies

1. The seventy-fifth meeting of the Sub-Antarctic Resource Assessment Group (SARAG 75) was opened at 1:30pm on 19 August 2026 by the Chair, Bruce Wallner.

2. The Chair welcomed members, invited participants and observers to the meeting. The Chair acknowledged the Muwinina people as the Traditional Owners and custodians of the land SARAG 75 met on, including their ongoing connections to Land and Sea Country and paid respects to their Elders past, present and emerging.

3. Members **NOTED** that the meeting was being recorded for the purpose of developing the meeting minutes.

4. The members **NOTED** that there were no apologies for the meeting.

1.1 Declarations of Interest

5. The Chair reminded members and observers of the procedure for declaring and managing conflicts of interest as outlined in the *Fisheries Administration Act 1991* and AFMA Fisheries Administration Paper No. 12, including that all members must declare any actual or perceived conflicts of interest (not limited to pecuniary gain) in the fishery at the commencement of the meeting and as soon as they become evident during the discussion of relevant agenda items.

6. SARAG **NOTED** declarations of interest from members, invited participants and observers at the start of the meeting (**Attachment A**).

7. The Chair **NOTED** that industry has an interest in agenda items 5, 8, 9 and 10. SARAG **AGREED** that industry would retire from the meeting for any recommendations made under these agenda items.

1.2 Adoption of Agenda

8. The agenda (**Attachment B**) was adopted without change.

Agenda Item 2: Actions Arising

9. SARAG **NOTED** the written update on the status of actions arising from previous SARAG meetings at **Attachment C**.

Agenda Item 3: Member Updates

3.1 AFMA update

10. SARAG **NOTED** the written update as provided by AFMA (**Attachment D**).

11. SARAG **NOTED** the HIMI Ecological Risk Assessment (ERA) was last completed in 2018 and will be reviewed for reassessment in 2026/27.

3.2 Industry member updates

12. SARAG **NOTED** the following verbal updates since SARAG 74 (May 2026) from industry members:

Australian Longline Fishing Pty Ltd

- Fishing at HIMI has been exceptional with highest catch rates recorded. Within a week the boat will finish for the season and heading back to port.
- Crew have reported plenty of small fish all over, even in areas where fish haven't been for many years. Good size fish have been reported in shallower areas while some smaller fish have been reported in deeper waters. Have experienced less lice, stronger currents with the weather consistently bad. No whales were seen on the boats second trip.
- With regards to the voluntary Randomised Longline Survey, 11 lines were not completed. Some due to the multiple boats being in the area and some due to the need to avoid areas with high numbers of small fish which make fishing uneconomic.
- Observations at MITF have been different to usual seasons. The sea surface temperature has been warmer for longer compared to last season. Current flows were stronger for the first part of the season. Fish numbers have been different to previous season, with more in the north and less in the south. In the south currents at times made areas unfishable. In the north currents were as expected. Across the fishery catches were more consistent but with no days of high catch rates.

Austral Fisheries Pty Ltd

- Both vessels have been longlining since the start of May. Average catch rates have reflected the past 5 years.
- Many small fish have been observed at HIMI. The longline fishery has observed juveniles coming through.
- The Austral Odyssey is on its second trip and plans to return to port in a month.
- The Austral Odyssey will then prepare to fish in the CCAMLR Ross Sea and Amundsen Fisheries (Subareas 88.1 and 88.2)
- The Cape Arkona will unload from its current trip in the coming weeks and return to HIMI to complete a trawl trip. The Austral member reiterated the importance of the ability to trawl in the HIMI Fishery, noting the impact of the current seabird bycatch limits in the longline extension season. Maintaining access to trawling is of great importance to Austral.

- The Cape Arkona will fish for alfonsino in SIOFA over the austral summer. Austral have previous history of fishing in the SIOFA Area for Alfonsino.

3.3 AAD update

13. SARAG **NOTED** the following updates from AAD:

- AAD submitted the paper 'Review of southern elephant seal (*Mirounga leonina*) incidental mortality in Division 58.5.2 at Heard Island and McDonald Islands (HIMI), 2007-2025' (WG-IMAF-2026/15) to WG-IMAF 2026. The paper addressed a long standing workplan item regarding southern elephant seal bycatch at HIMI. The paper showed that distribution of southern elephant seal interactions across months was not statistically different from the monthly distribution of all hauls. The item remains on the WG-IMAF workplan.

Agenda Item 4: RSTS short term work plan identified from SARAG 74

14. SARAG **CONSIDERED** analysis by the AAD to address some of the short-term priority work recommended at SARAG 74 on the impacts of removing RSTS hauls from IUCN Ia and II zones as detailed in **Attachment E** and **Attachment F**.

Short term priority work item 1 – Summarise changes in biological indicator values and patterns with the removal of data collected in: a) the IUCN Ia and II zones; and b) IUCN Ia, II and IV zones.

15. SARAG **NOTED** the following findings of the AAD analysis (**Attachment E**):

- removal of RSTS hauls within IUCN Ia and II zones would reduce total survey effort by approximately 22%, despite these areas representing 41% of the current survey footprint, due to the way stratified sampling is undertaken. Average haul depth decreased by 42m as generally shallower depths are sampled within these reserve areas. The analysis demonstrated the complete loss of abundance and length composition information from Plateau West for all managed target and evaluated bycatch species, as the stratum lies entirely within IUCN Ia and II zones.

- the removal of data from IUCN Ia and II zones had the greatest impact on abundance indicators for bycatch species, particularly *Lepidonotothen squamifrons*, *Channichthys rhinoceratus* and *Bathyraja eatonii,* due to the loss of areas supporting relatively high densities of these species. It also had a significant impact on the abundance indicators of mackerel icefish. Lower CPUE estimates were observed for seven species in strata overlapping with the IUCN Ia and II zones of the marine reserve, and the loss of Plateau West resulted in a substantial reduction in the representativeness of abundance indices for several species;

- trends in abundance estimates and length composition information for Patagonian toothfish appeared to be the least affected. While some changes were observed in the representation of smaller fish in shallower strata and larger fish in deeper strata, the analysis indicated that similar population structures were present in other plateau strata, partially mitigating the

loss of information from Plateau West. However, further analysis is required to fully understand the implications for estimation of biological parameters and stock assessment outputs; and

- impacts on mackerel icefish were more pronounced. The analysis showed that Plateau West provides unique information on juvenile cohorts, particularly one and two-year-old fish, and that the highly mobile nature of icefish results in greater spatial variability in length composition between strata. The loss of Plateau West would therefore reduce the representativeness of length composition data and increase uncertainty in assessment outputs.

16. SARAG **DISCUSSED** that the impacts of removing RSTS sites from IUCN Ia and II zones on toothfish assessments may not be as severe as initially anticipated, although a further comparison of the abundance estimates without the IUCN Ia and II sites would be valuable additional analysis.

Short term priority work item 2 – Identify efficient and robust survey design options for redesigning the RSTS outside of closed areas (IUCN Ia and II, or IUCN Ia, II and IV zones)

17. SARAG **NOTED** that there is currently no low-impact survey method that could provide information equivalent to the RSTS across target and bycatch species. It was suggested that it may be possible for the current survey design to be maintained during a transition period while alternative survey designs and monitoring methods are rigorously tested. Such an approach would enable direct comparison of methodologies, quantification of impacts on stock assessments and the development of alternative assessment and management arrangements where required. SARAG noted that the cost of designing, testing and implementing alternative monitoring approaches would likely be significant. Industry commented that they are uncertain how any extra work associated with testing alternative approaches and methodologies, while maintaining the current survey design, would be funded. Industry further emphasised the operational importance of understanding expectations for the 2027 RSTS survey to support planning, including the total number of days required to undertake the survey and whether provision needs to be made for the testing of alternative approaches.

18. SARAG briefly discussed the option of proceeding with a reduced RSTS in 2027 and **NOTED** that ceasing the RSTS within IUCN Ia and II zones, without a formal redesign process, would interrupt the long-term consistency of the survey and reduce its ability to monitor fish stocks, ecosystem condition and climate-driven change across HIMI. Industry commented that they currently undertake the survey at significant cost and questioned whether the expense would be justified if the scientific value of the RSTS were compromised through ad hoc modifications to its design without appropriate testing. Industry also suggested that, rather than modifying the survey design, it may be preferable to reduce the survey frequency to a biennial basis, an option they have previously proposed to help manage the cost of the RSTS.

19. SARAG **NOTED** that opportunities may exist to further reduce the impacts of the survey on IUCN Ia and II values through modifications to survey design aimed at reducing sampling intensity, benthic impacts and lethality.

SARAG further **NOTED** that CCAMLR currently recognises bottom trawl surveys as the only agreed method for collecting assessment data for icefish stocks. While acoustic methods may offer future opportunities, these would require supplementary biological sampling and considerable methodological development before they could be incorporated into the assessment framework.

Short term priority work item 4 – Icefish retrospective analysis

20. SARAG **NOTED** the following results of the retrospective analysis of the previous ten mackerel icefish stock assessments with data from IUCN Ia and II zones excluded as detailed in **Attachment F**:

    - there were reductions in biomass estimates of approximately 12-38% when IUCN Ia data were excluded and 17-60% when both IUCN Ia and II data were excluded;
    - there was increased uncertainty in biomass estimates and stock status determination;
    - there was a reduced ability of the assessment model to fit and estimate cohorts, including the loss of some cohorts in certain years. Although not explicitly tested, this could also affect the current growth estimates for the fishery;
    - it resulted in biased age proportions, which is a key consideration in assessment, due to poor cohort fits;
    - there were reductions in model-derived catch limits ranging from 55-1,383 tonnes (~10-53%) without IUCN Ia data (with the exception of 2016) and 100-1,324 tonnes (~17-66%) without IUCN Ia and II data; and
    - the analysis highlighted the particular importance of Plateau West to the icefish assessment, given its substantial contribution to survey coverage and its importance for sampling younger (1–2-year-olds) age classes.

Industry representatives expressed concern and disappointment regarding the potential impacts of reduced survey data from IUCN Ia and II zones on icefish catch limits and questioned whether adjustments to the current CCAMLR decision rule for icefish could be explored (lower escapement rate for example) to mitigate the impacts given part of the stock would be protected by the marine reserve. Industry expressed further concern on the impact that this will have on the value of the icefish Statutory Fishing Rights in the fishery and whether consideration has been given to who would pay for this loss in value.

SARAG advice

21. SARAG **AGREED** that the analyses provide compelling evidence for the retention of the current full RSTS design during a transition period to:

    - enable a comprehensive assessment of the impacts of reduced survey coverage on stock assessments and indicators;
    - support testing of alternative survey designs and monitoring approaches through MSE for toothfish (funded) and icefish (not funded);
    - facilitate exploration of alternative assessment methodologies and management arrangements (such as changes to the icefish CCAMLR decision rule); and
    - maintain continuity of long-term monitoring datasets.

22. SARAG **AGREED** that additional analysis is required before robust advice can be provided on redesign options for the toothfish component of the survey. SARAG further **AGREED** that redesign options for icefish are likely to be more complex given the importance of Plateau West and current CCAMLR assessment requirements. SARAG **AGREED** that a MSE would provide the most appropriate mechanism for assessing the full implications of reduced survey coverage for toothfish and icefish assessments and any changes to associated management arrangements.

23. SARAG **NOTED** that approval of the full RSTS for 2027 in the absence of a transition plan is unlikely and that a multi-year permit should be pursued within the transition plan. SARAG noted that the cost of designing, testing and implementing alternative monitoring approaches would be substantial and that identifying appropriate funding sources would be critical to support any transition process.

24. SARAG **RECOMMENDED** that AFMA and AAD jointly develop a multi-year (5 year) transitional plan which will include the full RSTS application for 2027 due by Nov 2026. In the event that the full RSTS is not approved, noting the insufficient time to undertake a comprehensive analysis and testing of an alternative RSTS design, SARAG **RECOMMENDED** that a re-design that still includes the icefish sites is developed on the basis of the scientific evidence showing the impacts on the icefish assessments. AAD is to provide advice on the number of icefish strata that would be included in this instance.

Agenda Item 5: HIMI toothfish stock assessment

Agenda Item 5.1: TWG report on progress and recommendations

25. SARAG **CONSIDERED** the report and recommendations from the sixth meeting of the TWG held on 19 August 2026 as presented by the TWG Chair, Dr David Smith. SARAG **ENDORSED** the recommendations of the TWG.

26. SARAG **RECALLED** the purpose of the TWG, which was to provide technical guidance on approaches to incorporate the available tagging data into the HIMI toothfish stock assessment and address the model misspecification apparent in the previous assessments. SARAG **RECOGNISED** the comprehensive work that had since been undertaken and successful development of a new robust stock assessment model for Patagonian toothfish in the HIMI Fishery.

27. SARAG **NOTED** that, consistent with previous TWG recommendations, the new stock assessment model has been implemented in Template Model Builder (TMB) and incorporates several significant structural changes including:

- the designation of two spatial areas (plateau and shelf), with length-dependent movement from plateau to shelf;
- disaggregation of male and female fish in catch composition data and biological estimates;
- the use of the Brownie tag recovery likelihood function, as well as a method to account for overdispersion in tag recapture data; and

- in numerous cases, calculations and estimates were undertaken using length rather than age (i.e. selectivity, maturity) and length frequencies along with conditional age-at-length data were included.

28. SARAG **NOTED** TWG advice that the 2026 stock assessment:

    - is a robust stock assessment model for the data available and stock specific characteristics of the HIMI Fishery; and
    - shows improved fits to the RSTS data without compromising fits to the tag recapture data. Recruitment deviations no longer exhibit trends through time, although higher uncertainty remains in the early recruitment deviation estimates (pre-1998).

29. SARAG **NOTED** that the TWG:

    - unanimously agreed the stock assessment can be used to inform TAC setting; and
    - supported the stock assessment team's plans for future model development, both in the short and longer term.

30. Further, SARAG **NOTED** the TWG's advice that the planned Management Strategy Evaluation (MSE) for the HIMI Fishery will allow exploration of aspects relating to trends in recruitment and data collection moving forward and will guide the development of a potential new harvest strategy and associated catch setting rules.

Agenda Item 5.2: HIMI toothfish spatially explicitly stock assessment

31. Having regard to the TWG advice, SARAG **RECOMMENDED** the 2026 stock assessment be adopted and used as a scientific basis for assessing the stock status and TAC recommendations for the 2026/27 and 2027/28 fishing season.

32. SARAG **NOTED** that the 2026 stock assessment estimates current spawning biomass to be 0.42 (0.41-0.44) and unfished biomass (B_0) to be 77,859t. Both estimates are above those from the 2024 assessment (SSB 0.38, B_0 64,083t). Like the TWG, SARAG **NOTED** that the base case and a number of sensitivity analyses estimate similar levels of depletion and a flat stock trajectory over the last few years (**Table 1**).

Table 1 MCMC results (median and 95% confidence intervals) for $\boldsymbol{B_0}$, SSB status and survey *q*

Model	B_0	Current SSB Status	Survey q
2023 Assessment	64,520 (60,419–69,241)	2023: 0.39 (0.39–0.40)	1.08 (0.95–1.24)
2024 Assessment	64,083 (60,139–68,635)	2024: 0.38 (0.38–0.38)	1.22 (1.04–1.43)
2026 Assessment	77,859 (75,738–80,280)	2026: 0.42 (0.41–0.44)	1.82 (1.71–1.95)

Agenda Item 5.3: Toothfish recruitment modelling in stock projections

33. SARAG **RECALLED** previous discussions and advice on the most appropriate approach to modelling recruitment in stock projections for the purposes of the CCAMLR decision rule for Patagonian toothfish.

34. SARAG **AGREED** with advice from the TWG (meeting 6) that, unlike the previous stock assessments, the 2026 stock assessment recruitment deviations no longer exhibit trends through time. However higher uncertainty remains in the early recruitment deviation estimates (pre-1998) and excluding these years from the recruitment series provides lower biomass projections than using the entire recruitment series. SARAG **NOTED** advice from some scientists that based on the lack of clear trends in estimated recruitment deviates, there is no evidence of change in the productivity of the stock over time.

35. SARAG **RECOMMENDED** that the entire recruitment series be used in future biomass projections and that departures from this approach should be informed by the exploration of recruitment trends under the MSE testing planned for the fishery.

Item 6 – Climate and Ecosystem Status Reports and framework– HIMI & MITF

36. SARAG **NOTED** the draft 2026 Climate and Ecosystem Status Reports for the Heard Island and McDonald Islands (HIMI) Fishery and Macquarie Island Toothfish Fishery (MITF) as presented by Dr Brodie of CSIRO. The final report cards are available at **Attachment G** and **Attachment H.**

37. SARAG **NOTED** the outlook included:

- El Niño is underway, forecast to strengthen, and could be one of the strongest events on record. During El Niño, the Southern Annular Mode (SAM) tends to shift to negative phases, bringing westerly winds further north. The direct impacts on this fishery are unclear, but El Niño conditions can elevate ocean temperatures on top of long-term warming trends.
- SAM events tend to last one to two weeks, and forecasts are updated regularly. SAM has been negative and is forecast to return to neutral conditions in the next fortnight.
- Forecasts of sea surface temperature anomalies for the next three months indicate anomalously warm conditions across the region. Forecasts are updated regularly.

Agenda Item 7: Climate Risk Framework (CRF) – HIMI species assessment

38. SARAG **NOTED** that:

- AFMA has finalised the CRF following an extensive development and trial process. Endorsed by the AFMA Commission at its September 2025 meeting. The CRF has been published on AFMA website alongside the Trial Implementation Report, which captures key outcomes and insights from its trial application across a range of Commonwealth fisheries, including the MITF.

- The CRF is being progressively implemented across Commonwealth fisheries. It is to be treated as core business by RAGs and MACs. This includes ensuring climate risk assessments are incorporated into the development of advice and that the CRF is used to guide the identification of adaptation measures and inform management responses.
- To support the implementation of the CRF, AFMA has convened an expert Working Group (the Working Group) – comprising Drs Beth Fulton, Alistair Hobday, David Smith, and Keith Sainsbury – to provide ongoing technical guidance and oversight.
- The CRF has been applied initially to Patagonian toothfish and mackerel icefish in the HIMI Fishery, however, the draft CRF assessments will be updated with the latest climate projections undertaken as part of the Futures of Seafood project. These updated CRF assessments together with a draft CRF assessment for Patagonian toothfish in the MITF will be tabled with SARAG for consideration in 2027.

Agenda Item 8: HIMI TAC Setting

Agenda Item 8.1: HIMI toothfish TAC recommendation

39. SARAG **NOTED** applying the CCAMLR decision rule for Patagonian toothfish to the outputs of the 2026 stock assessment results in a TAC of 3,503t.

Applying alternative projection periods

40. SARAG **NOTED** that for consistency with recent seasons, TAC calculations were also performed using two shorter projection periods, 20 and 25 years, than the 35-year period used in the CCAMLR decision rule (**Table 2**). SARAG recalled that the use of a shorter projection period had been proposed in 2022, 2023 and 2024, to strike a balance between maintaining catch levels at reasonable levels while minimising the projected future depletion of the stock and the length of time it is projected to spend below the target biomass level (B_{50}). The approach was also considered to be more robust to potential changes in future recruitment. As uncertainties in the stock assessment became more apparent, the AFMA Commission had set lower, more conservative TACs than that produced by the application of the CCAMLR 35-year projection period.

41. SARAG **AGREED** that, given the robustness of the new stock assessment, higher recent recruitment patterns, the flat current trajectory of the spawning stock, and the spawning stock being near target, any decision to set a catch limit-based projection other than over a 35-year period would be a matter of balancing factors such as desirable economic and operational outcomes. These are issues that require consideration by SouthMAC.

Table 2 Estimates of catch limits in tonnes based on MCMC sampling that satisfy the CCAMLR decision rules, with (i) the median escapement of the spawning biomass at the end of the 35-year projection period ('Target'), and (ii) the

risk of the spawning biomass dropping below 20% of its median pre-exploitation level at any time over the 35-year projection period ('Depletion').

Model	Time Frame (yrs)	Lambda 0.5	Catch limit	Target	Depletion
Reference	35	n/a	3503	0.5	<0.01
Reference	25	n/a	3325	0.5	<0.01
Reference	20	n/a	3206	0.5	<0.01
Reference	35	RSTS	3513	0.5	<0.01
Reference	25	RSTS	3338	0.5	<0.01
Reference	20	RSTS	3194	0.5	<0.01
Reference	35	LF	3329	0.5	<0.01
Reference	25	LF	3201	0.5	<0.01
Reference	20	LF	3103	0.5	<0.01
Reference	35	ALF	3648	0.5	<0.01
Reference	25	ALF	3472	0.5	<0.01
Reference	20	ALF	3304	0.5	<0.01
Reference	35	Tags	3568	0.5	<0.01
Reference	25	Tags	3432	0.5	<0.01
Reference	20	Tags	3304	0.5	<0.01
v7	35	n/a	3984	0.5	<0.01
v7	25	n/a	3930	0.5	<0.01
v7	20	n/a	3919	0.5	<0.01

Climate and ecosystem reports

42. SARAG **CONSIDERED** the latest Climate and Ecosystem Status Reports for HIMI prepared by CSIRO (**Attachment G**). SARAG also **NOTED** that the Climate Risk Assessment for Patagonian toothfish at HIMI has been postponed allowing for the consideration of the most recent work undertaken as part of the Futures of Seafood project. SARAG **AGREED** that based on the information available, there was no need to adjust its TAC advice at this time.

Management advice

43. SARAG **NOTED** that the catch limit calculated using the CCAMLR decision rule represents a large increase from the current CCAMLR catch limit of 2,120 tonnes, and the previous 2024 stock assessment estimated catch limit of 2,660 tonnes.

44. SARAG **DISCUSSED** the potential implications of such a change on the economic returns for the fishery, including advice from industry members about their concerns when large TAC changes occur (based on history of such changes), the operational preference for low volatility in TACs and current catching capacity of the fleet.

45. SARAG **CONSIDERED** the following:

- advice from industry that operationally, catches in the range of 2,700 tonnes to 2,900 tonnes are feasible with the current fleet setup and that volatile interannual TAC changes are not preferred;
- the CCAMLR decision rule can result in large TACs changes despite relatively minor changes in stock status and assessment specifications. This is generally considered a poor performance feature of the rule and part of the motivation for undertaking MSE of alternate decision rules both for the Macquarie Island Toothfish Fishery (MITF) and Patagonian toothfish at the HIMI Fishery. A common objective of contemporary management procedures is to avoid unnecessary interannual variability in catch limits while still meeting the fishery objectives. For the purposes of the MITF MSE currently underway by CSIRO, SARAG has requested that testing include imposing a 10% TAC change limiting rule; and
- MSE results for the Patagonian toothfish at HIMI Fishery are expected by the end of 2029. AAD has commissioned CSIRO to undertake the MSE as part of the multi-year project to also develop the new stock assessment.

46. For the purposes of agreeing management advice industry members and observers left the meeting.

47. Having regard to:

- industry advice on the economic efficiencies in relation to the current operational capacity of the fishing fleet and preference for low interannual volatility in catch limits; and
- work being undertaken to not only refine the stock assessment but to design and test alternative management procedures for the fishery.

The remaining SARAG members **RECOMMENDED** that a stepwise approach be taken with the TAC set at the mid-point between the current catch limit and the recommended catch limit derived from the application of the CCAMLR decision rule for the 2026/27 and 2027/28 fishing season (3,503t). The mid-way point being 2,812 tonnes.

48. SARAG **RECOGNISED** that the economic, operational, and other relevant factors highlighted by the SARAG require careful consideration by SouthMAC noting these issues relate more to management deliberations.

Agenda Item 8.2: HIMI mackerel icefish assessment and TAC recommendations

2026 annual random stratified trawl survey (RSTS) around HIMI

49. SARAG **NOTED** the results of the 2026 HIMI RSTS as presented by Dale Maschette and detailed in **Attachment I**. A total of 163 valid stations were completed for the survey between 1-27 March 2026. The survey was conducted on the *FV Cape Arkona* with sampling protocols similar to recent surveys, but with a new set of randomly selected haul stations.

50. As detailed in **Attachment I**, the catch of Patagonian toothfish was 63.9t. The catch of mackerel icefish (*Champsocephalus gunnari*) was 5t. Biomass estimates for most of the managed by-catch species were similar to the survey averages in recent years. Compared with the last survey, biomass estimates for *C. rhinoceratus* showed a decrease in biomass whilst *Macrourus* spp. showed a slight increase. Biomass estimates of *L. squamifrons* were similar to 2025 whilst estimates for the *Bathyraja* spp. were lower than last year. Length and weight measurements were taken for 13,990 fish.

Assessment and TAC recommendations

51. SARAG **NOTED** the updated stock assessment based on results from the 2026 RSTS for mackerel icefish at HIMI in CCAMLR Division 58.5.2 as presented by Dale Maschette and detailed in **Attachment J**.

52. SARAG **NOTED** the following:

- applying the CCAMLR decision rule for mackerel icefish using the 2026 assessment results, provided a recommended catch limit of 130t for the 2026/27 season and 112t for the 2027/28 season. The estimate for the 2026/27 season is an 88.5% decrease from the catch limit agreed previously for the season (1,126t);

- the age cohort analysis showed that a substantial 4+ cohort dominated the 2026 survey which was expected given the large 3+ cohort observed in the 2025 assessment. However, the biomass of 4+ cohort is not used in the projections to estimate catch limits; and

- its previous advice that the regular estimation of biological parameters in the icefish stock assessment ensures that long-term environmental changes (such as those predicted to occur due to climate change) that may impact population characteristics are accounted for.

53. For the purposes of agreeing management advice industry members and observers left the meeting.

54. The remaining SARAG members **RECOMMENDED**, in line with the application of the CCAMLR decision rule for mackerel icefish, TACs for mackerel icefish of 130t for the 2026/27 and 112t for the 2027/28 fishing seasons in the HIMI Fishery.

Agenda Item 9: HIMI bycatch assessment plan and 2026/27 bycatch limit recommendations

55. In forming its advice on recommended bycatch TACs for the HIMI Fishery for the 2026/27 fishing season, SARAG:

- **CONSIDERED** recent catches of bycatch for species taken in HIMI fishery, noting catches remained well below the bycatch limits (**Table 3**);

- **RECALLED** the ongoing work by AAD to better understand the population status of skate species that are bycaught in the fishery to help refine the population assessment model used to estimate the bycatch limit. The ultimate outcome of this work is to produce an updated stock assessment for skates (*Bathyraja* spp.).

- **NOTED** a presentation and report from Dr Masere on an overview of assessments that have been undertaken for bycatch managed species in HIMI together with an indicative workplan outlining the anticipated delivery of the next round of assessments for each of the bycatch managed species (**Attachment K**). The workplan meets commitments under the recently updated *Sub-Antarctic Fisheries Bycatch Strategy for the HIMI Fishery and MIT Fishery, 2026*. As part of the planned future work AAD advised there may be opportunities to explore other statistical methodologies that are tailored to data-limited species when assessing bycatch-managed species, noting the potential impact that the removal of RSTS hauls within IUCN Ia and II zones may have on abundance indicators. Such alternative approaches may better account for the protection afforded to species within these zones and reduce reliance on survey data collected from areas where future sampling effort may be reduced.

Table 3 HIMI Fishery bycatch from 2015/16–2024/25 fishing seasons. All catch presented in tonnes. Catch figures are total catch reported.

Year	Caml & Whitson's grenadier	Bigeye grenadier & ridge tailed rattail	Unicorn icefish	Skates and rays	Grey rockcod	Other (excl. violet cod and grenadier nei)	Violet cod*	Grenadier nei*	Total
Bycatch limit (t)	409	360	1,663	120	80	50 (per species)	50	50	
2015/16	79.50	217.53	127.55	49.73	3.21	32.96	7.31	2.56	520.36
2016/17	90.22	235.26	110.58	75.12	2.89	27.41	10.33	1.59	553.39
2017/18	103.99	252.84	38.98	48.56	3.81	29.74	8.27	0	486.19
2018/19	104.71	249.54	152.80	79.97	1.88	33.52	11.53	0.07	634.04
2019/20	48.45	59.27	236.30	43.04	4.94	38.21	5.82	0.68	436.72
2020/21	62.49	145.27	80.98	48.90	2.89	14.50	14.76	0.29	370.08
2021/22	43.41	111.07	167.52	80.93	3.21	19.56	10.93	0.32	436.95
2022/23	48.34	129.44	45.16	28.05	2.42	18.62	8.11	0	280.13
2023/24	50.47	97.61	5.17	8.52	4.53	17.86	11.35	0	195.51
2024/25	31.35	79.12	25.49	24.34	0.42	10.17	8.43	<0.01	179.34
Total	662.94	1,576.96	990.54	487.17	30.19	242.55	96.85	5.51	4,092.71

*Violet cod and grenadier nei fall under 'other.' Displayed separately for information.

56. For the purposes of agreeing management advice industry members and observers left the meeting.

57. The remaining SARAG members **RECOMMENDED** to maintain the same bycatch TACs for the HIMI Fishery from the 2025/26 season for the 2026/27 season as shown in **Table 4.** In making its recommendation SARAG **AGREED** there was no new information to warrant a change and

welcomed the development of a workplan by AAD to update several of the assessments over the coming years.

Table 4 SARAG recommended bycatch limits for the HIMI Fishery for the 2026/27 season.

Species	**Bycatch limit (tonnes)**
Caml grenadier (*Macrourus caml*) and Whitson's grenadier (*M. whitsoni*)	409
Bigeye grenadier (*M. holotrachys*) and Ridge tailed rattail (*M. carinatus*)	360
Unicorn icefish (*Channichthys rhinoceratus*)	1,663
Skates and rays (Bathyraja spp.)	120
Grey rockcod (*Lepidonotothen squamifrons*)	80
All other species (each)	50

Agenda Item 10: MITF MSE project update

58. SARAG **RECALLED** that it considered preliminary results of the Management Strategy Evaluation (MSE) of harvest strategy options for Patagonian toothfish in the Macquarie Island Toothfish Fishery update at SARAG 74 (May 2026). At its meeting SARAG provided a range of advice to support the completion of the project including to:

    - explore the effect of putting a catch limit (cap) on different areas. Options could include a cap on the south or the Aurora Trough, a cap on the whole south area (including Aurora Trough), or specifying a minimum percentage of catch that must come from the north. Where possible, the MP should avoid rigid, area specific TACs and should allow for operational flexibility.

59. CSIRO **ADVISED** that separating the southern area of the Operating Model into separate Aurora Trough and South Macquarie Ridge areas would be a substantial amount of work. Before undertaking this CSIRO investigated the available data to see if there is evidence in the data to support the approach, noting the assessment differences in areas area driven by differences in tag recapture rates and therefore movement differences.

60. SARAG **NOTED** the outcomes of the exploratory analysis as presented by Dr Bessell-Browne (presentation is at **Attachment L**):

    - Tag return rates per unit of catch show that while there is annual variability between the fleets in the assessment, overall trends show clear difference between north and south areas.
    - This data suggests much higher and similar tag-recapture rates between Aurora Trough (AT) and South Macquarie Ridge Line (SMRL) than with the north, suggesting that spatial separation of AT and SMRL will not have a material effect on the assessment and subsequent operating model if implemented.

- There is probably a gradual change in dynamics rather than one specific line in reality, further diagnostics investigating tag-recapture rates at 1 degree latitude bands across the fishery area will be undertaken. However, the data investigated to date suggests that there is no evidence that the split is in the wrong place.

61. Having considered the analysis and CSIRO's advice that creating an area for the AT would not change the assessment or operating model in the MSE, SARAG **AGREED** for the MSE to continue with a two-area model.

Agenda item 11: CCAMLR-45 papers

62. SARAG **NOTED** the following papers are planned to be submitted to the Working Group on Fish Stock Assessments 2026 (WG-FSA 2026):

- Integrated stock assessment for the Heard Island and McDonald Islands Patagonian toothfish (*Dissostichus eleginoides*) fishery in Division 58.5.2;
- Results from the 2026 random stratified trawl survey in the waters surrounding Heard Island in Division 58.5.2;
- A preliminary assessment for mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on results from the 2026 random stratified trawl survey;
- Overview of the status of research plan milestones for the *Dissostichus mawsoni* exploratory fishery in East Antarctica (Divisions 58.4.1 and 58.4.2) from 2022/23 to 2025/26;
- Report on exploratory fishing in Divisions 58.4.1 and 58.4.2 between the 2011/12 and 2025/26 fishing seasons;
- New plan for continuing research in the *Dissostichus mawsoni* exploratory fishery in East Antarctica (Division 58.4.1) from 2026/27 to 2029/30; Research plan under CM 21-02, paragraph 6(iii);
- New plan for continuing research in the *Dissostichus mawsoni* exploratory fishery in East Antarctica (Division 58.4.2) from 2026/27 to 2029/30; Research plan under CM 21-02, paragraph 6(iii);
- Coordination of research plans for the *Dissostichus mawsoni* exploratory fishery in East Antarctica (Division 58.4.1) from 2026/27 to 2029/30

Agenda item 12: Annual research statement 2027/28

63. SARAG **RECALLED** that SARAG 73 (August 2025) finalised the Antarctic Fisheries Five-Year Strategic Research Plan 2026-2030 and the Annual Research Statement for 2026/27.

64. SARAG **AGREED** that there was nothing new to add to the research statement for the next cycle AGREED to the 2027/28 annual research statement (**Attachment M**), on the basis that:

a) key research priorities were being addressed through existing projects including:

- development of a new Patagonian Toothfish stock assessment and MSE of alternate management procedure for setting TACs for the HIMI Fishery;
- MSE of alternate decision rules for Patagonian toothfish at MITF; and
- AAD works to update several bycatch assessments.

b) alternate government funding of the RSTS transitional plan would be explored.

65. SARAG **NOTED** a request for advice from industry on the need to continue with the voluntary randomised longline survey (RLS), noting that the reason for introducing it was to assist with the spatial biases unable to be resolved in the Casal2 stock assessment, which the TMB stock assessment appears to have mitigated. AAD advised that data from the most recent RLS was still being analysed but expects to be able to give guidance next year on whether there is value in continuing.

66. SARAG **AGREED** to the 2027-28 Annual Research Statement.

Agenda item 13: Priority list and other meetings

67. SARAG **RECALLED** that SARAG 74 agreed to establish a list of priorities to be considered at each meeting, to manage several open, longstanding action items considered more akin to management priorities or projects.

68. SARAG **CONSIDERED** the draft list of priorities presented by AFMA (**Attachment N**).

69. SARAG **AGREED** to continue with the approach for now however noted that it may simply duplicate current processes, for example research priorities, Bycatch Strategy and action arising.

Agenda item 14: Any other business

70. There was no other business. SARAG **AGREED** to tentatively hold the next SARAG meeting 4 to 6 May 2027.

71. The Chair closed the meeting at 4:00pm

Attachment A

Member, invited participant and observer declarations of interest as advised to date.

Name	Membership	Declared interests
Bruce Wallner	Chair	No pecuniary or other potential interests in sub-Antarctic fisheries.
Dr Philippe Ziegler	Scientific member	Employed by AAD and is the Fishery scientist responsible for Heard Island and McDonald Islands Fishery (HIMIF) work, including the HIMI stock assessments. Dr Ziegler has no pecuniary interest in the sub-Antarctic and his salary is not connected to any research grants noting that he is a principal and co-investigator on current FRDC projects. Dr Ziegler is also the scientific member of SouthMAC, and the Scientific Representative for Australia to CCAMLR.
Cara Masere	Scientific member	Member of the Fisheries team within the Southern Ocean Ecosystems Program at the AAD and has no pecuniary or other interests in the sub-Antarctic fisheries.
Rich Hillary	Scientific member	Employed by CSIRO and is the Principal Investigator of the Heard Island and McDonald Islands stock assessment and MSE project. He is a member of AFMA's Southern Bluefin Tuna Management Advisory Committee (SBTMAC) and Tropical Tuna RAG. Dr Hillary advised that he has no pecuniary interests in the sub-Antarctic fisheries.
Tim Ward	Scientific member	Associate Professor in Fisheries Science, Institute Marine and Antarctic Studies, University of Tasmania. Scientific Member, AFMA Small Pelagic Fishery Resource Assessment Group (SPFRAG) Principal Investigator (PI) on AFMA and FRDC research projects on SPF (e.g. Blue Mackerel DEPM) and other fisheries (Bass Strait Central Zone Scallop Fishery). Conservation Member, AFMA Great Australian Bight Management Advisory Committee (GABMAC) PI and Scientific Advisor, Department of Natural Resources and Environment Tasmania (Tasmanian Sardine Fishery). Conservation Member, South Australian Marine Scalefish Fishery Management Advisory Committee (MSFMAC). Member, MSFMAC Science Subcommittee. Chair, AFMA Tropical Rock Lobster RAG.
Brad Milic	Industry member	Senior Manager of Policy and Resource at ALFPL which holds various fishing rights in, and operates vessels in, the sub-Antarctic fisheries and New and Exploratory fisheries under the jurisdiction of CCAMLR. Mr Milic owns a consultancy business that undertakes work in the fisheries and maritime safety space.

Name	Membership	Declared interests
Rhys Arangio	Industry member	Employed by Austral Fisheries P/L (Austral Fisheries) as the General Manager of Science and Policy. Austral Fisheries owns Statutory Fishing Rights (SFRs) in the Australian sub-Antarctic fisheries, which include waters under the jurisdiction of CCAMLR. Noting no changes since the last meeting, Mr Arangio is the Executive Officer of COLTO, as well as being a member of SouthMAC. He was not aware of any investigation or prosecution action by AFMA against his Company, nor of any legal action taken by his Company against AFMA, and has an interest in all agenda items.
Danait Ghebrezgabhier	AFMA member	AFMA employee, no interests pecuniary or otherwise.
Rachel Downes	Executive officer	AFMA employee, no interests pecuniary or otherwise.
Heather Patterson	Invited participant	Employed by the Department of Agriculture, Fisheries and Forestry and is the author of the chapters relevant to SARAG in the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES) Fishery Status Reports. Dr Patterson noted that she has no pecuniary interest in the sub-Antarctic fisheries.
Pia Bessell-Browne	Invited participant	Employed by CSIRO and is the Principal Investigator of the Macquarie Island Toothfish Fishery (MITF) stock assessment and MSE project. She is also the PI on the AFMA project 'MSE testing of a novel SPR-based approach to determine stock status and set the bycatch TAC for School Shark'. Dr Bessell-Browne noted she has no pecuniary interests in the sub-Antarctic fisheries.
Dale Maschette	Invited participant	Employed by IMAS & AAD and is a fishery scientist responsible for HIMI work including the HIMI icefish stock assessments. They hold no pecuniary interest in the sub-Antarctic fisheries. Their salary is connected to two FRDC research grants related to Southern Ocean fisheries, one that they are the primary investigator on, another that they are a co-investigator on.
Steph Brodie	Invited participant	Employed by the CSIRO and through the organisation either has in the past or may in the future receive funding for research related to the fishery.
Natalie Couchman	Invited participant	AFMA employee, no interests pecuniary or otherwise.
Ryan Leadbetter	Invited participant	AAD employee, no interests pecuniary or otherwise.

Name	Membership	Declared interests
Selina Stoute	AFMA observer	AFMA employee, no interests pecuniary or otherwise.
David Smith	Observer	Dr Smith consults on the fisheries and marine resources research and assessment. Dr Smith is an observer of the AFMA Research Committee, AFMA Climate Risk Framework Working Group and Commonwealth Research Advisory Committee. Dr Smith is an Adjunct Professor at IMAS, University of Tasmania and an Independent Fisheries Scientist for the SA Marine Scalefish Fishery Management Advisory Committee (MSFMAC). Dr Smith is also the chair of the MSFMAC Science Subcommittee and a coinvestigator to the FRDC Project 2021-042 Impacts of COVID19 on the Australian Seafood Industry: Extending the assessment to prepare for uncertain futures and FRDC Project 2021-077 Development of "guidance" for conducting stock assessments in Australia.
David Souter	Observer	AAD employee, no interests pecuniary or otherwise.
Megan Kybert	Observer	AAD employee, no interests pecuniary or otherwise.
Jessica Tengvall	Observer	Employed by Austral Fisheries as a Science and Policy Officer. Austral Fisheries own SFRs in the Australian sub-Antarctic fisheries, which include waters under the jurisdiction of CCAMLR. Have an interest in all agenda items.
Liz Brierley	Observer	AAD employee, no interests pecuniary or otherwise.
Lyn Goldsworthy	Observer	Dr Goldsworthy is an Adjunct Researcher at the Institute for Marine and Antarctic Studies, University of Tasmania, and a Member of the Centre for Marine SocioEcology. Dr Goldsworthy also conducts contract work for the Deep-Sea Conservation Coalition (DSCC) and the Minderoo Foundation. Dr Goldsworthy has no pecuniary interest in sub-Antarctic fisheries.
Geoff Richardson	Observer	Mr Richardson is the Chair of the Sub-Antarctic Management Advisory Committee (SouthMAC), the Northern Prawn Fishery Management Advisory Committee (NORMAC) and the Torres Strait Prawn Fishery Management Advisory Committee (TSPMAC). Mr Richardson has no interests pecuniary or otherwise.

Attachment B

75th Meeting of the Sub Antarctic Fisheries Resource Assessment Group (SARAG)

Hadley's Orient Hotel, 19-20 August 2026

Draft Agenda

Chair: Bruce Wallner

Approx time	Item	Purpose	Presenter
	Day 1 –		
15:00 (30 mins)	**1. Preliminaries**		
	1.1 Welcome and apologies	For noting	Chair
	1.2 Declaration of interests	For action	Chair
	1.3 Adoption of agenda	For action	Chair
	2. Actions Arising	For noting	AFMA
	3. Member updates	For noting	All
15:30 (15 mins)	**Afternoon Tea**		
15:45 (1 hour 15 mins)	**4. RSTS short term work plan identified from SARAG74**	For advice	AAD
17:00	**Day 1 Meeting Close**		

Approx time	Item	Purpose	Presenter
	Day 2 –		
9:00 (1 hour 30 mins)	**5. HIMI toothfish stock assessment** **5.1** TWG report on progress and recommendations **5.2** HIMI toothfish spatially explicit stock assessment **5.3** Toothfish recruitment modelling in stock projections	For advice	TWG Chair/CSIRO
10:30 (15 mins)	**Morning Tea**		
10:45 (45 mins)	**6. Climate and Ecosystem Status Reports and framework– HIMI & MITF**	For discussion	CSIRO/AFMA
11:30 (45 mins)	**7. Climate Risk Framework – HIMI species assessment**	For advice	AFMA
12:15 (30 mins)	**8. HIMI TAC Setting** **8.1** HIMI toothfish TAC recommendation **8.2** HIMI mackerel icefish assessment and TAC recommendations	For advice	AAD/AFMA
12:45 (45 mins)	**Lunch**		
13:30 (30 mins)	**9. HIMI bycatch assessment plan and 2026/27 bycatch limit recommendations**	For advice	AAD
14:00 (1 hour)	**10. MITF MSE project update**	For advice	CSIRO
15:00 (30 mins)	**11. CCAMLR-45 papers**	For advice	AAD
15:30 (15 mins)	**Afternoon Tea**		
15:45 (45 mins)	**12. Annual research statement 2027-28**	For advice	AFMA
16:30 (15 mins)	**13. Priority list and other meetings**	For advice	AFMA
16:45 (15 mins)	**14. Any other business**	For advice	All
17:00	**Day 2 Meeting close**		

Attachment C

Item	Action arising	SARAG meeting raised	Status as at SARAG 75
1	**Climate and Ecosystem Report updates** CSIRO to add in EEZ and marine park boundaries for sea surface and bottom temperature graphs on the Climate and Ecosystem Status Report Cards for next year.	**SARAG 73 – August 2025**	**Complete** Dr Steph Brodie (CSIRO) presented updated 2026 climate report cards under agenda item 6.
2	**Bycatch assessment timing** AAD to confirm timing of the skate bycatch assessment, grey rockcod, and both Macrourus spp at SARAG 75 (scheduled for August 2026)	**SARAG 73 – August 2025**	**Complete** Bycatch assessment timing discussed and confirmed under agenda item 9.
3	**RLS line data capture** AFMA to confirm how RLS lines were being recorded to help ensure that all relevant data is being included.	**SARAG 74 – May 2026**	**Complete** Following SARAG 74, AFMA management emailed members on 4 June 2026 confirming that the Antarctic Aurora RLS lines are identified by a comment in the monthly C2 forms.
4	**MITF SPRFMO recapture data** AFMA to investigate MITF tag-recaptures in SPRFMO and share available data with SARAG to determine if the recaptures have originated from the north or south regions	**SARAG 74 – May 2026**	**Complete** SPRFMO SC 12 NZ FOP identifies four toothfish from MITF recaptured in EU – George V Fracture Zone (GVFZ). Recaptures were tagged in 2004, 2008, 2013 and 2019. SPRFMO SC 12 – DW 03 identifies six MITF tag recaptures in the GVFZ, tagged from 2004-2021. Data was sent to AAD. CSIRO and AAD will liaise going forward.
5	**MITF north:south split** CSIRO to analyse updated tag-recapture data to determine the N:S split line	**SARAG 74 – May 2026**	**Complete** Dr Bessell-Browne presented an MSE project update under agenda item 10, including an update on analysis of tag-recaptures to determine the N:S split line.

Australian Government
Australian Fisheries Management Authority

Attachment D

Sub-Antarctic Resource Assessment Group (SARAG)

Meeting 75 19-20 August 2026

Agenda Item 3 Member Updates

Purpose: FOR NOTING

Recommendation

That SARAG:

1. **NOTE** verbal updates from Industry and Scientific Members;
2. **NOTE** the written update from AFMA in this paper, including the summary of gear loss and wildlife interactions at **Attachment A**.

AFMA update

Sub-Antarctic Fisheries Electronic Monitoring trial

1. The EM trial is ongoing, with concession holders continuing to voluntarily operate EM systems. EM data is being routinely collected and provided to CSIRO for artificial intelligence (AI) model training, validation and performance assessment.

2. Edge AI equipment (CSIRO-owned laptop) was deployed on the Antarctic Discovery in July 2026 while in port at Hobart. Deployment of Edge AI capability supports near real-time EM analysis onboard vessels. CSIRO have been successfully receiving daily reports to test functionality. The vessel will resume fishing at the end of the year.

3. CSIRO is providing regular progress reports based on reviews of complete fishing trips, enabling assessment of EM data quality, vessel practices and AI model performance.

4. With significant outcomes close to being achieved, AFMA and CSIRO have agreed to extend the project, with CSIRO to provide a final report in December 2026. AFMA intends to use the outcomes of the trial and final report to progress an EM implementation decision in early 2027.

Export approval under the EPBC Act

5. The HIMI Fishery was declared eligible for listing on the List of Exempt Native Specimens (LENS) under Part 13A of the EPBC Act for a period of 10 years until 16 July 2036. The LENS listing requires AFMA to inform DCCEEW of any changes to relevant fisheries legislation and/or

management arrangements, as well as meeting the condition to provide regular annual reports. The outcome of the report can be found on the HIMIF DCCEEW website.

6. AFMA Management has submitted applications to DCCEEW for the assessment of the Macquarie Island Toothfish Fishery and Australia's high seas fisheries under the EPBC Act. The current accreditations expire on 9 October 2026. Both submissions were published on the DCCEEW website. Public comment was open from 15 May – 19 June and 14 May – 18 June 2026 for the MITF and high seas respectively. AFMA Management will notify SARAG of the re-assessment outcome when available.

CCAMLR Working Group on the Incidental Mortality Associated with Fishing - Southern Elephant Seals

7. Australia submitted the paper 'Review of southern elephant seal (*Mirounga leonina*) incidental mortality in Division 58.5.2 at Heard Island and McDonald Islands (HIMI), 2007-2025' (**Attachment B**) to WG-IMAF-2026 in June 2026. The paper notes that between 2007 and 2025, there were 93 recorded interactions of southern elephant seals (SES; *Mirounga leonina*) with longline gear in the HIMI toothfish fishery, of which 79 were confirmed mortalities. Since 2007, the number of interactions per year has increased, however when accounting for number of hooks, no increasing trend was identified.

8. The paper showed that interactions were spatially spread out across the entire fished area but occurred most commonly in the shelf area. Haul depths associated with SES interactions were highest around 1,000m depth and less likely in deeper waters. Haul soak times associated with SES interactions were longer than all hauls without interaction, although this was likely to be only a small effect and associated with an exposure effect.

9. Hauls per month were somewhat even between April to November, with a slight increase in interactions in August (late winter/early spring more broadly) when adult SES have moved to foraging at sea after fasting during breeding. Distribution of SES interactions over the months was not found to be statistically different from the monthly distribution of all hauls.

10. The preliminary report for the meeting is available here: WG-IMAF-2026. The relevant paragraphs commence at 3.11. The WG-IMAF also noted paper WG-EMM-2026/81, which highlighted the recent IUCN reassessment of the SES from 'Least Concern' to 'Vulnerable', and the Antarctic fur seal from 'Least Concern to Endangered' because of steep population declines. The remaining Antarctic seal species remain as 'Least Concern'.

Sub-Antarctic Fisheries AFMA Observer Deployments and tagging update

11. Between 1 December 2024 and 30 November 2025 AFMA deployed observers on 15 voyages using trawl or auto longline method, achieving 619 fishing days spread across HIMI, MITF, SIOFA, SPRFMO (Macquarie Ridge Continuation Research Block) and CCAMLR exploratory fisheries (**Table 1**). For more information, please contact Justine Johnston, Antarctic Observer Coordinator, justine.johnston@afma.gov.au.

- Eight HIMI voyages.
- Two MITF voyages.
- Three CCAMLR exploratory fisheries voyages.

- One SIOFA voyage.
- One SPRFMO (Macquarie Ridge Continuation Research Block) voyage.

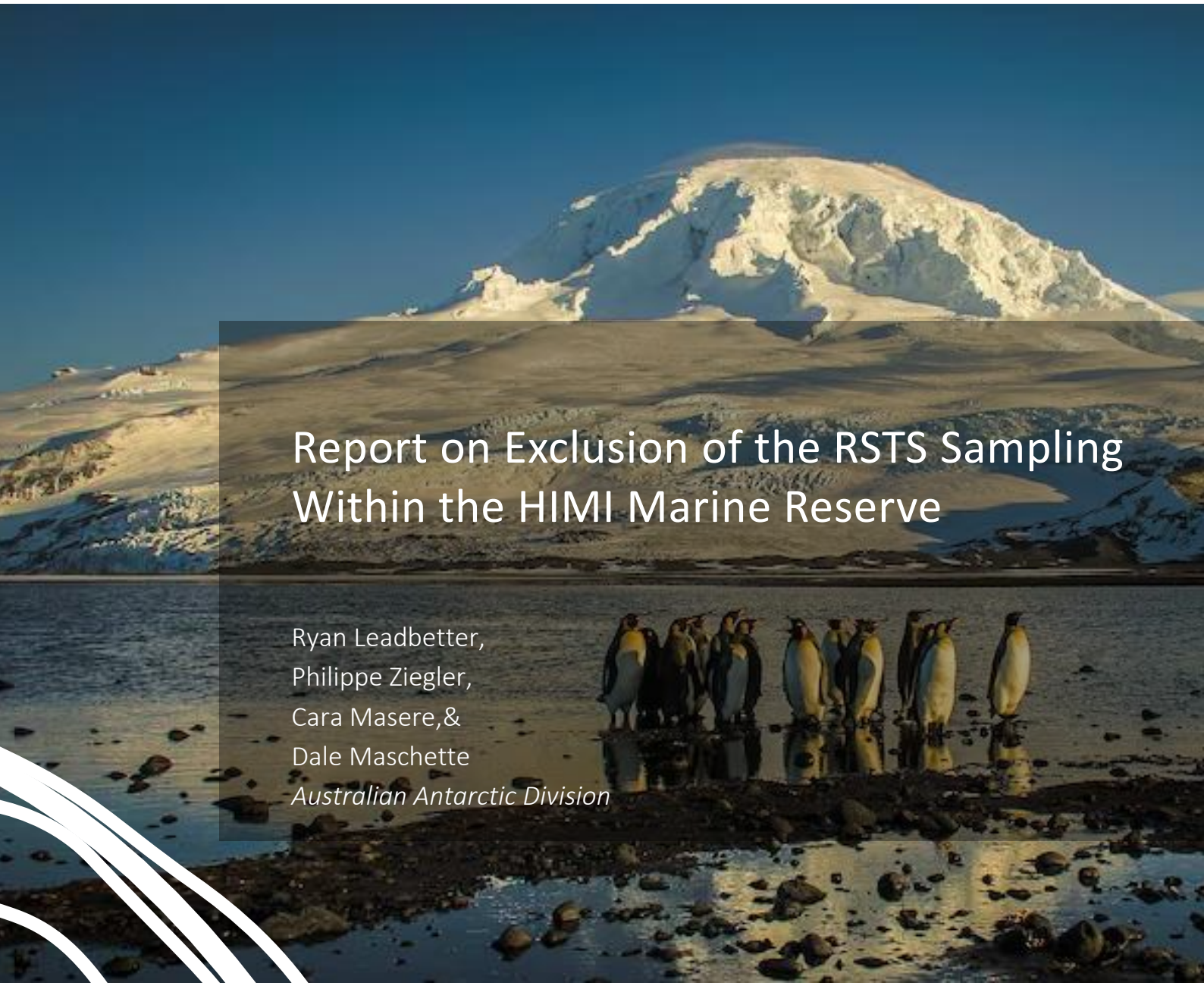
Table 1 Number of fishing days and tagging data for toothfish and skates per fishery between 1 December 2024 and 30 November 2025

Fishery	Fishing days	Toothfish Tagged	Toothfish Recaptured	Skate Tagged	Skate Recaptured
HIMI	419	4352	1160	564	35
MITF	101	971	235	0	0
SIOFA	17	198	13	0	0
CCAMLR Exploratory (Ross Sea)	41	837	35	284	1
CCAMLR Exploratory (East Antarctic)	37	737	21	0	0
SPRFMO (Macquarie Ridge Continuation Research Block)	4	10	0	0	0

Attachments

Attachment A ETP interactions and gear loss for previous fishing seasons

Attachment B WG-IMAF-2026/15 paper 'Review of southern elephant seal (Mirounga leonina) incidental mortality in Division 58.5.2 at Heard Island and McDonald Islands (HIMI), 2007-2025'



Report on Exclusion of the RSTS Sampling Within the HIMI Marine Reserve

Ryan Leadbetter,
Philippe Ziegler,
Cara Masere,&
Dale Maschette
Australian Antarctic Division

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1 Background

The random stratified trawl survey (RSTS) is a fisheries-independent, scientific survey that has been in operation since 1997 around Heard Island and McDonald Islands (HIMI). It is a valuable scientific tool for monitoring targeted fish stocks, bycatch species, and general biodiversity in a remote area of the Southern Ocean. Data from initial exploratory scientific trawls and the RSTS provided an important foundation used for the designation of the HIMI marine reserve in 2002, its review in 2014, and the expansion in 2024.

The areas of the RSTS overlap with that of the marine reserve, although the RSTS has not sampled areas with known high densities of benthic communities such as the tops of Aurora and Coral Banks. RSTS stations which have been located within the area of the marine reserve have been sampled under permit over the past few years. With the recent expansion of the marine reserve in 2024, there has been an intention to more closely align the management of the HIMI marine reserve with that of the broader Commonwealth Marine Park system, and any trawl activity, even for scientific purposes, has been questioned.

This report investigates the impact of removing data collected inside of the IUCN 1a and II zones of the marine reserve on abundance indices of managed species and length-composition signals of target species. It also explores alternative ways in which the RSTS could align more closely with the IUCN conservation values of the HIMI marine reserve and how any redesign of the survey methodology could be planned to maintain the utility of the survey for fishery management and ecosystem monitoring.

1.1 Random stratified trawl survey (RSTS)

Scientific trawl surveys around HIMI started in 1997. Initial surveys were exploratory in nature, with the primary aim to understand the distribution of key species; particularly Mackerel Icefish (*Champsocephalus gunnari*), Patagonian Toothfish (*Dissostichus eleginoides*), and Grey Rockcod (*Lepidonotothen squamifrons*). After a few changes in the first few years, the design of the RSTS has remained largely consistent. The overarching objectives of the RSTS is to assess the abundance of:

1. Juvenile and adult Toothfish on the shallow and deep parts of the Heard Island Plateau, and
2. Icefish on the Heard Island plateau.

The survey is also used for bycatch assessments and biodiversity analyses. The data from the RSTS has played a significant role in informing management of the marine ecosystem around HIMI, including the proposals to expand of the marine reserve.

The RSTS is an important component of the HIMI monitoring program. It primarily addresses the requirements to have: a) an adequate program of monitoring to ensure that reliable fisheries stock estimates can be made for each target species; and b) adequate monitoring of the direct impact of the fishery on non-target species and the ecosystem in the area of the fishery. The RSTS provides abundance indices for the managed species, length and age composition for the managed species, and contributes to biological information (e.g. length-at-age, weight-at-length and maturity) used in assessments.

The RSTS is designed with nine strata; Evitas Patch, Gunnari Ridge, Plateau West, Plateau North, Plateau Southeast, Plateau Deep West, Plateau Deep East, Plateau Deep Northeast, and Plateau Deep

Southeast (Figure 1). These strata and their boundaries were selected mainly with focus on Toothfish and Icefish, so that the area within each is relatively homogeneous and catch per unit effort from hauls within that stratum can be assumed representative of the overall area and therefor confidently extrapolated by the size of the stratum to get an estimate of the total abundance.

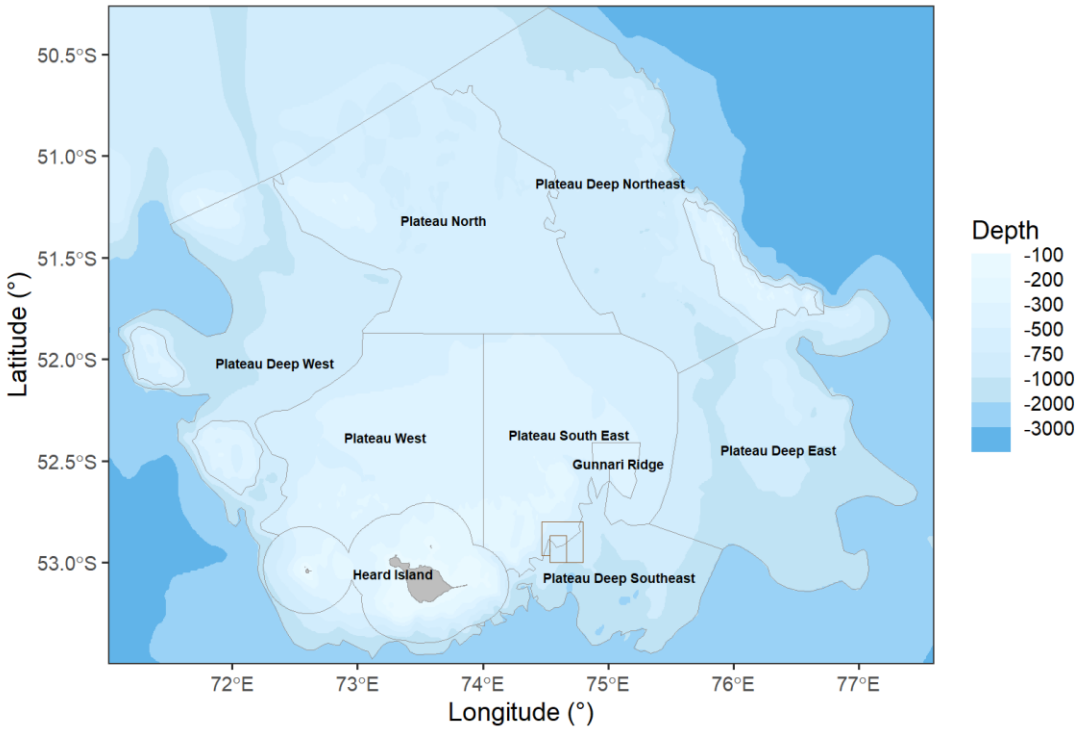


Figure 1: Map of the Heard Island Plateau showing the strata of the random stratified trawl survey (RSTS) along with other key habitat areas and islands. Note: The small and highly productive strata of Evitas is shown in brown.

1.2 HIMI marine reserve

The HIMI marine reserve was declared in 2002 to protect the conservation values of Heard Island and McDonald Islands and their adjacent unique and vulnerable marine ecosystems. The marine reserve was expanded in 2014 and classed as an IUCN zone 1a (Figure 2). In 2024, the marine reserve was expanded, with three different classifications of IUCN zones 1a (Strict Nature Reserve), II (National Park) and IV (Habitat/Species Management Zone) assigned within the HIMI EEZ (Figure 3).

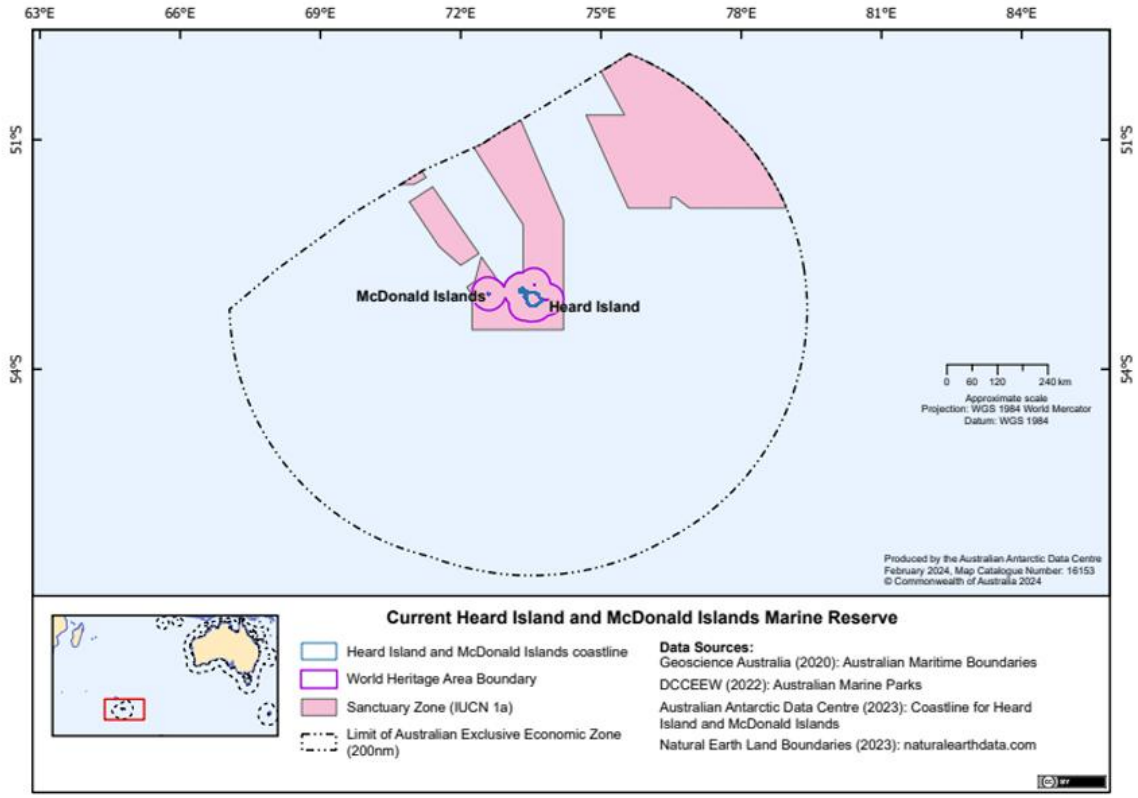


Figure 2: Map of the 2014 Heard Island and McDonald Islands marine reserve.

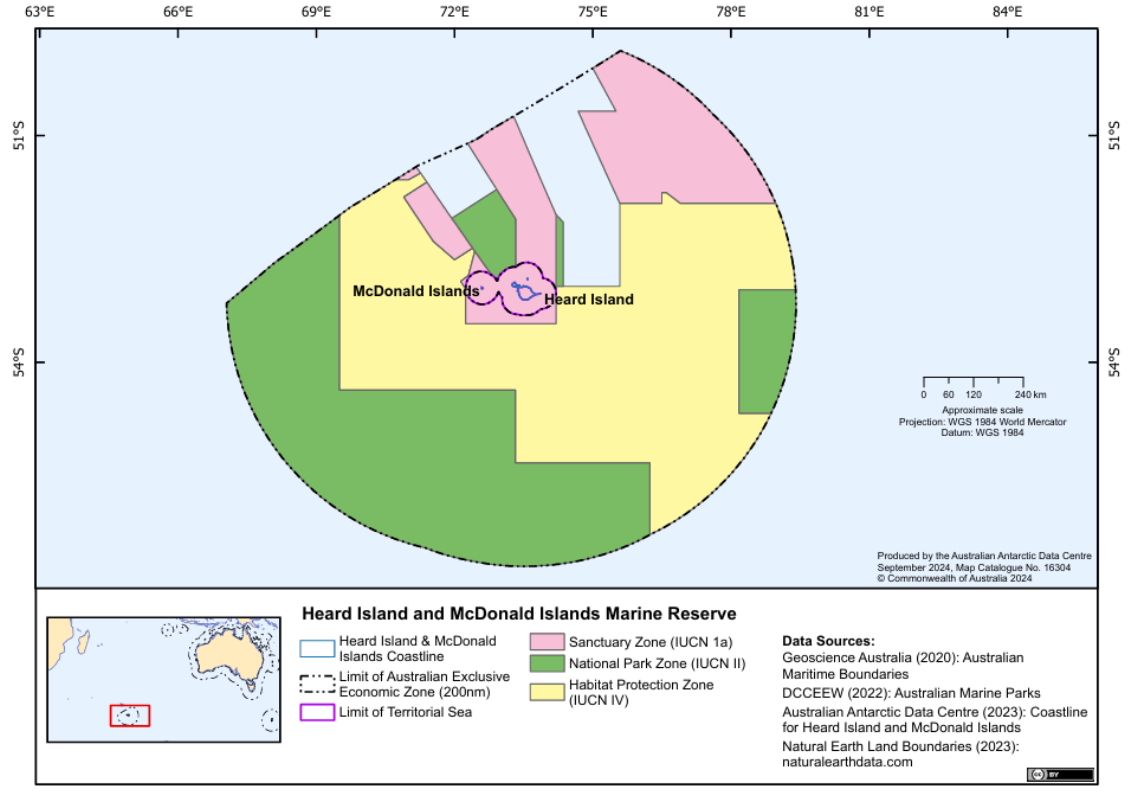


Figure 3: Map of the 2024 Heard Island and McDonald Islands marine reserve.

1.3 Overlap of the RSTS and marine reserve

Seven of the nine strata of the RSTS overlap the IUCN zones 1a and II of the HIMI marine reserve (**Error! Reference source not found.** and Table 1) with roughly 41% of the RSTS area sitting inside of these two zones. However, because of the way stratified sampling is performed, only 22% of historic hauls are located within the IUCN zones 1a and II (Table 2). Exclusion of the IUCN zones 1a and II also results in decrease in average haul depth of 42m since hauls in these areas generally cover slightly shallower grounds of the plateau (Table 2).

Table 1: Area overlap of the IUCN zones 1a and II with the RSTS strata.

Stratum	Area total (km^2)	Area overlap (km^2)	Overlap (%)
Evitas	349	0	0.00
Gunnari Ridge	523	0	0.00
Plateau Southeast	10416	2649	25.43
Plateau North	15343	7221	47.06
Plateau West	10335	10273	99.39
Plateau Deep Southeast	5100	27	0.53
Plateau Deep East	13169	1077	8.18
Plateau Deep West	13187	6924	52.50
Plateau Deep Northeast	15151	5910	39.01
Total	**83573**	**34081**	**40.78**

Table 2: Change in effort, number of hauls and depth, with and without the inclusion of the IUCN zones 1a and II.

Stratum	All		No 1a and II	
	Hauls (N)	Depth (m)	Hauls (N)	Depth (m)
Evitas	603	729 (320, 1298)	603	729 (320, 1298)
Gunnari Ridge	440	364 (305, 529)	440	364 (305, 529)
Plateau Southeast	742	430 (212, 820)	564	463 (246, 820)
Plateau North	350	630 (336, 913)	204	646 (411, 913)
Plateau West	257	426 (281, 741)	0	-
Plateau Deep Southeast	243	1128 (307, 1550)	241	1135 (653, 1550)
Plateau Deep East	683	1042 (360, 1676)	641	1074 (432, 1676)
Plateau Deep West	234	1035 (349, 1547)	125	1092 (364, 1547)
Plateau Deep Northeast	346	935 (447, 1515)	227	978 (685, 1515)
Overall	**3898**	**718 (212, 1676)**	**3045**	**760 (246, 1676)**

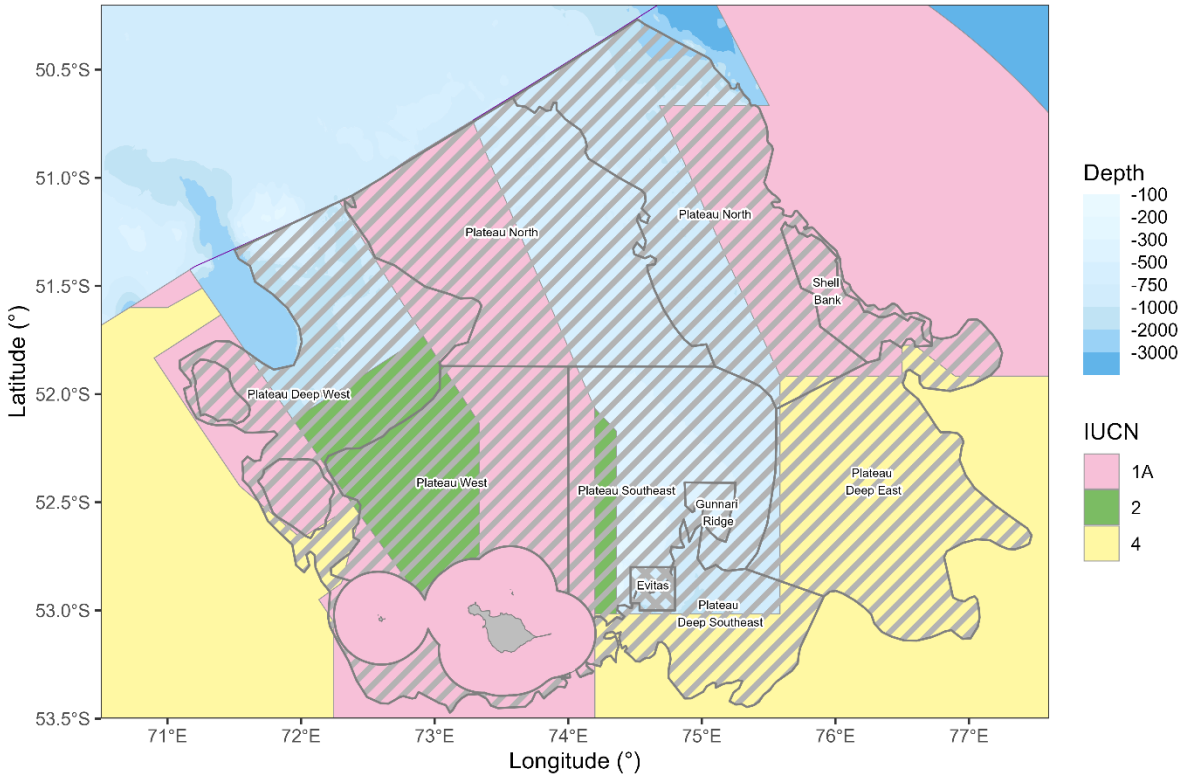


Figure 4: Overlap of three IUCN zones 1a (pink), II (green), and IV (yellow), and boundaries of the RSTS strata (grey lines).

2 Abundance indicators of managed species

The RSTS is used to construct abundance/biomass indices for eight managed species (Coghlan et al. 2025); two target species of fish (Patagonian Toothfish and Mackerel Icefish), three fish bycatch species (Unicorn Icefish, Grey Rockcod, and Macrouridae sp.), and three species of skate (*Bathyraja eatonii, B. irrasa, & B. murrayi*). *Macrouridae sp.* includes both shallow and deep species.

Here, we look at the effect of excluding historic RSTS hauls inside of the IUCN zones 1a and II on model-based abundance indices (Leadbetter et al. 2025) of all of these managed species excluding *Macrouridae sp.* The standardised catch data from the RSTS is summarised in Figure 5. Alongside of a complete loss of information from Plateau West, there is a general loss of hauls with larger catches for a number of bycatch species (shaded points); for example, *B. eatonii* in Plateau Deep Northeast, *C. rhinoceratus* in Plateau North, and particularly *L. squamifrons* in Plateau North.

Figure 6 shows the estimated CPUE trends for seven species across the nine RSTS strata. There are generally lower estimates for the strata that overlap with the marine reserve when data from inside of the IUCN zones 1a and II are excluded, however this is very much species dependent. In some cases, there is also less annual variability when the IUCN zones 1a and II are excluded; this is particularly the case for Toothfish in the deep strata. The loss of Plateau West is significant for the two Icefish species

(*C.s gunnari* and *C. rhinoceratus*), while overall *L. squamifrons* is the species with the biggest general impact from excluding the IUCN zones 1a and II.

Of the nine managed species, *B. eatonii*, *C. gunnari*, and *C. rhinoceratus* occur in greatest densities at Gunnari Ridge, while *B.irrasa* and *B. murrayi* occur in greatest densities on the northern part of the plateau (Plateau North). *D. eleginoides* occur in greatest abundance in Evitas and *L. squamifrons* on the lower latitude eastern parts of the plateau and shelf (Plateau Southeast and Plateau Deep East). However, the high abundance of *L. squamifrons* on Plateau Deep East is driven by the habitat inside of the IUCN zone 1a.

To derive an overall abundance index for each of the managed species from the model estimates of CPUE, the CPUE in the stratum is multiplied by the area of the stratum. However, we do not compare the overall change in abundance indices with and without hauls from the IUCN zones 1a and II here because (i) we are not confident that hauls in a given stratum that are outside of the IUCN zones 1a and II are representative of the area from that same stratum that are inside, and (ii) the alternative of using reduced areas (i.e. only the area of a stratum that sits outside of the 1a and II zones) to scale CPUE would naturally downscale the overall abundance index.

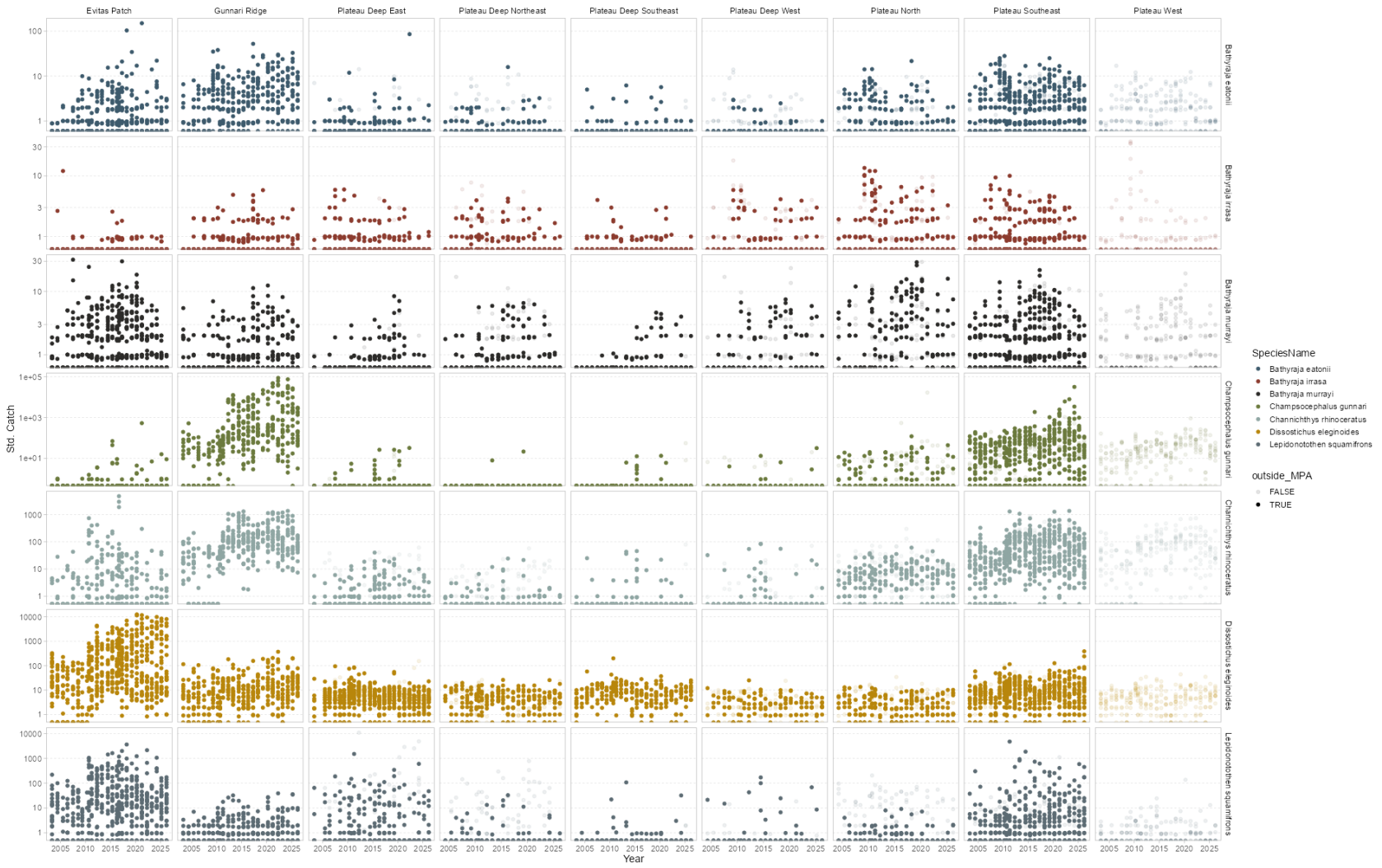


Figure 5: RSTS catch data for the seven managed species across the nine RSTS strata. Hauls within the IUCN zones 1a and II of the marine reserve are shown in silhouette. The catch data has been adjusted for the distance covered by a haul relative to the design distance.

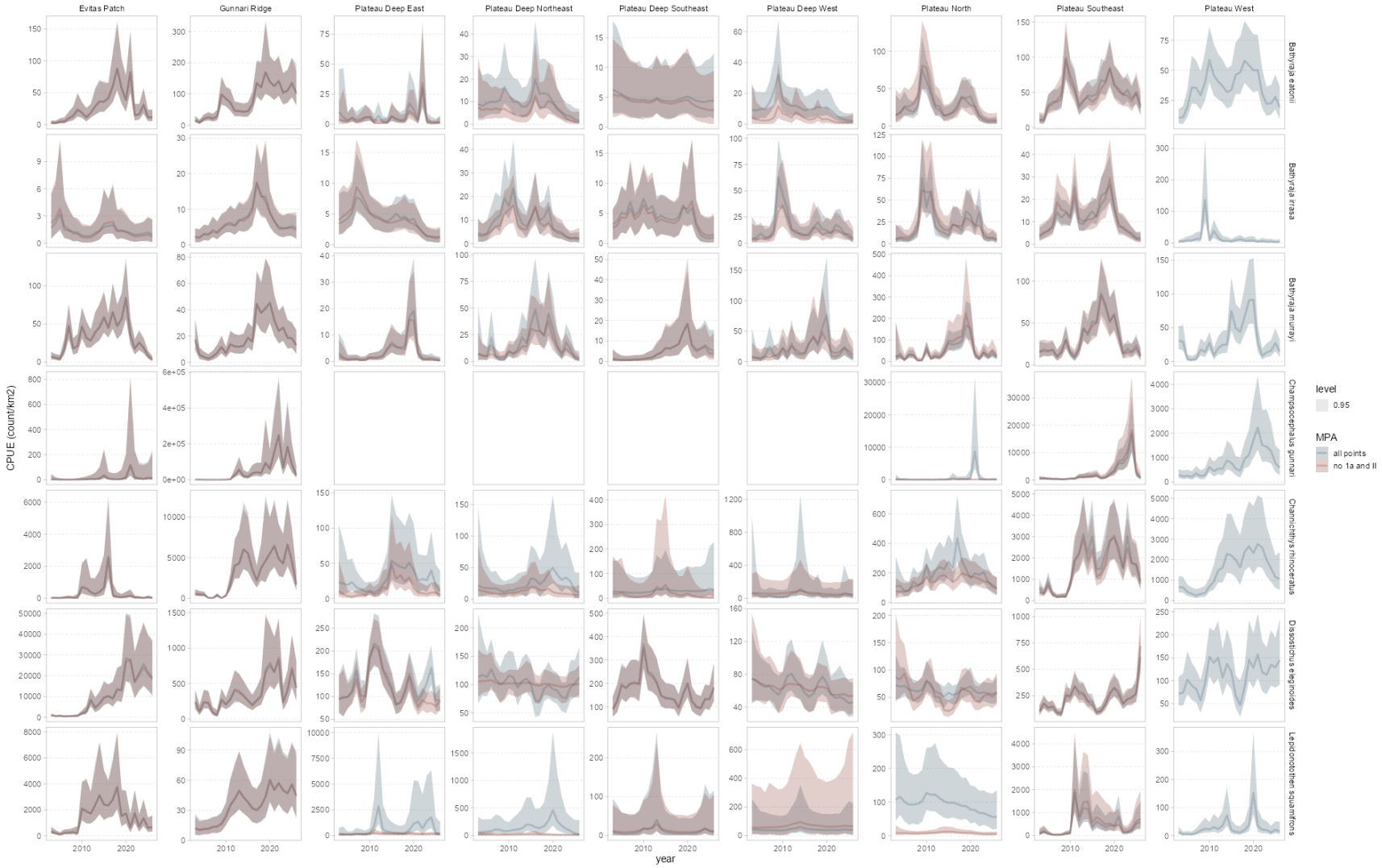


Figure 6: The model estimated CPUE (and 95% intervals) of each managed species in the RSTS strata for all data (blue) and when excluding IUCN zones 1a and II of the marine reserve (red).

3 Length composition of targeted species

For the two target species, Mackerel Icefish and Patagonian Toothfish, the RSTS is also used to collect length composition information about the population on the plateau for the stock assessments. In the assessment for Mackerel Icefish, 10mm length bins are used and only Gunnari Ridge, Plateau Southeast, and Plateau West are considered. Whereas, for Patagonian Toothfish, both 50mm and 100mm length bins and all strata are used. Figure A 1 and Figure A 2in the appendix show the catch weighted length proportions for each year and strata for Mackerel Icefish and Patagonian Toothfish respectively. This information is summarised in Figure 7 and Figure 8 by showing the average, minimum, and maximum values for each length bin.

For Mackerel Icefish, there are large changes in the inter-annual length-proportions (Figure 7). This is a well-known characteristic of Mackerel Icefish, since they are fast growing and short lived (Maschette and Welsford 2019). Typically, longer cohorts (>300mm; indicative of 3+ year-olds) are detected in all three strata but most strongly represented at Gunnari Ridge; whereas smaller cohorts (<300mm; indicative of one- and two-year-olds) are more frequently found in Plateau Southeast and Plateau West. However, this split between 1- and 2-year-olds and 3+ year-olds amongst the strata varies between years (see e.g. 2016 in Figure A 1), which confirms the general understanding that the Mackerel Icefish population is mobile within this area of the plateau. The smallest cohorts (one-year-old) can be difficult to detect, but are typically found in Plateau West, which is completely inside of the IUCN zones 1a and II.

For Patagonian Toothfish, exclusion of the IUCN zones 1a and II has little effect on the overall length composition across the strata. For Plateau North, Deep East, Deep Northeast, and Deep West there is a slight drop in the representation of smaller length classes since the Marine Reserve typically covers the shallower areas of these strata (Figure 8). In Plateau Deep West there is also a slight drop in the representation of larger length classes (Figure A 2), presumably due to the exclusion of hauls from the area where the IUCN zone 1a overlaps the western slope of the plateau. Plateau West is completely inside of the IUCN zones 1a and II, but the population length-composition is similar to that on Gunnari Ridge and the two other shallow plateau strata (Plateau Southeast and Plateau North).

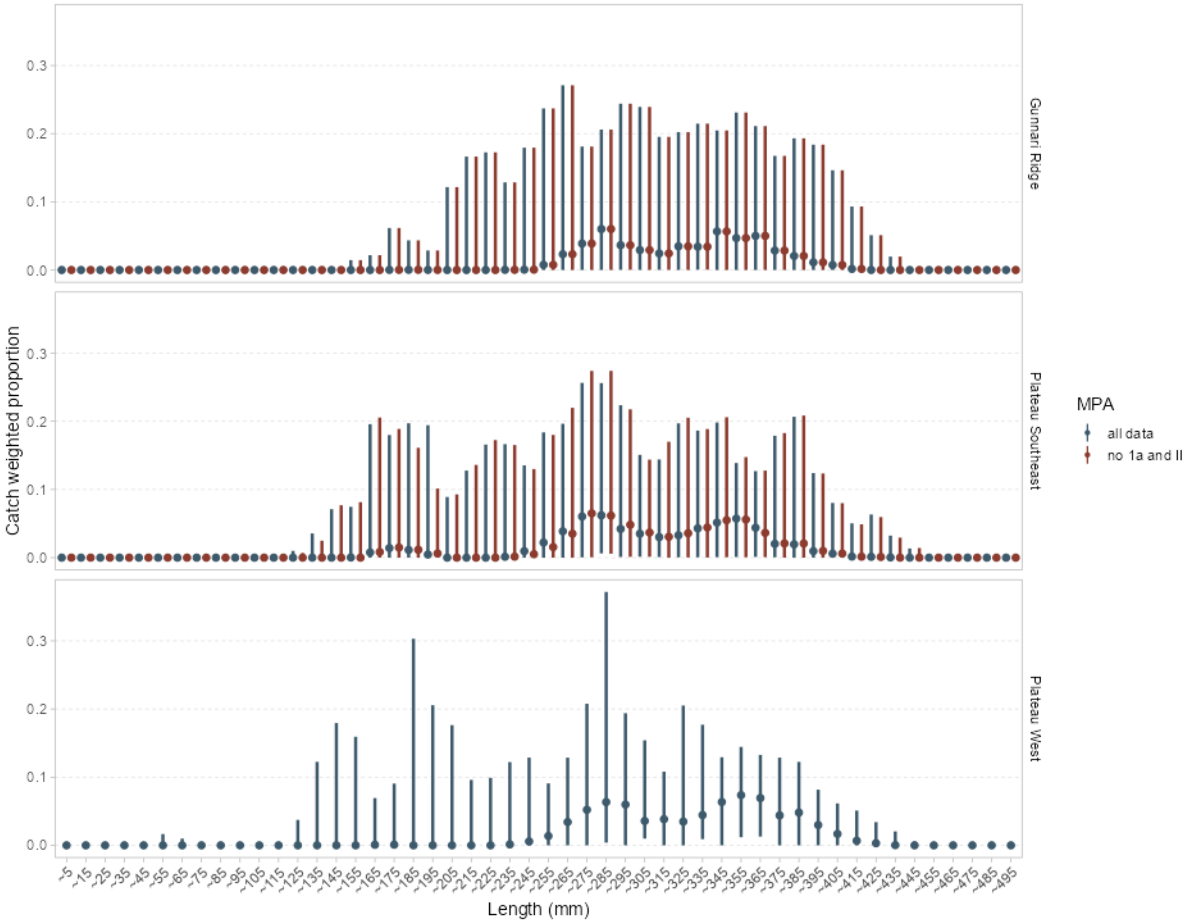


Figure 7: The summarised catch-weighted length-proportions for Mackerel Icefish across all years by RSTS strata Gunnari Ridge, Plateau Southeast and Plateau West for the entire stratum (blue) and outside of the Marine Reserve only (red). The average values of the length bin are indicated by points, and the minimum-maximum range is shown by the intervals.

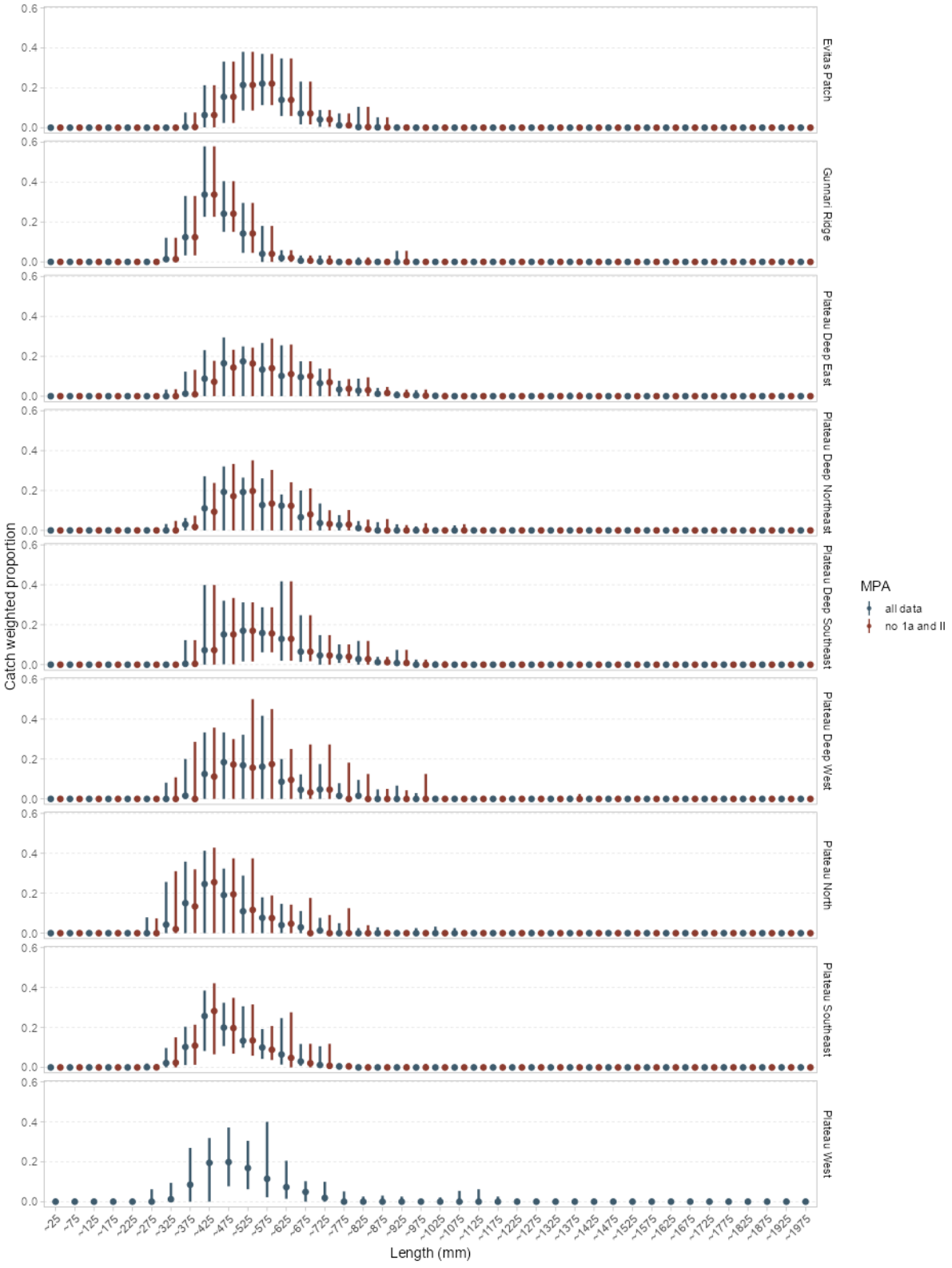


Figure 8: The summarise catch-weighted length proportions for Patagonian Toothfish across all years by RSTS strata for the entire stratum (blue) and outside of the Marine Reserve only (red). The average values of the length bin are indicated by points, and the minimum-maximum range is shown by the intervals.

4 Alternatives for future survey design

The RSTS has been a highly valuable tool to monitor the ecosystem both outside and within the marine reserve. A key contribution to the value of fishery independent surveys is the duration and consistency of the time series (Kotwicki et al. 2026). Ceasing the RSTS inside the marine reserve without a formal redesign approach risks interrupting the consistency of this exceptionally long-term survey that is unique in the Southern Ocean. The closure of IUCN zones 1a and II of the Marine Reserve to the survey would affect a large part of the area sampled by the survey and therefore diminish the representativeness of the survey and ability to monitor the ecosystem within the Marine Reserve. It would also affect the ability to monitor the impacts of climate change on the HIMI ecosystem which are expected to become increasingly pronounced.

To maintain the HIMI monitoring program while addressing the values of the IUCN areas, possible approaches are:

> **Reducing the environmental impact of the trawl survey:** Quantify and reduce the impact of the RSTS on vulnerable benthic ecosystems within the reserve and explore sampling design changes that reduce the density of trawl samples inside of the marine reserve.
>
> **Develop a alternative survey methods:** Explore alternative monitoring methods via a rigorous design process.

We also review the best practice for implementing modifications to a fishery independent survey design.

4.1 Quantifying and reducing the environmental impact of the current survey

Possible sampling design changes to reduce the impact of the RSTS on species within the IUCN zones 1a and II fall into three groups: reducing sampling density inside these areas, by reducing the number of stations, reducing the frequency of sampling, or reducing the length of trawls; isolating the effect of sampling, by using fixed stations or smaller subareas that are representative of the wider area, or focusing station locations in areas with low density of vulnerable marine ecosystem (VME) species; and reducing the lethality of the survey, e.g. by using an open trawl codend.

Error! Reference source not found. highlights these possible changes, their expected effect, and expected impact on the analysis of a trawl survey. Most of these approaches are likely to require a transition period to test and evaluate the impact of the change in methodology on the informativeness of the survey results. There are also inherent trade-offs between these options. For example, a simulation study conducted by Bryan and Thorson (2023) suggested that decrease in number of sampling stations is better (i.e. results in a smaller increase of uncertainty) than a decrease in sampling frequency and simulation study by Oyafuso et al. (2023) showed that randomly stratified design is the most robust option for design-based indices, compared to fixed sampling stations or cluster sampling designs. Since a number of these options involve selectively constraining sampling stations to areas that

minimise interactions with benthic vulnerable marine ecosystems, below provide some background on the current understanding of benthic diversity within the marine reserve.

Table 3: Possible changes to the RSTS design to reduce the impact on the IUCN zones 1a and II in the Marine Reserve.

Action	Aim	Consequences/Risk
(1) Reduce number of sampling stations inside marine reserve.	Reduce survey footprint within year	Higher uncertainty in estimates derived from survey. Explore concurrently increasing stations numbers outside of the Marine Reserve to reduce uncertainty
(2) Reduce survey frequency inside marine reserve from annual to e.g. biennial.	Reduce survey intensity across years	Higher uncertainty in estimates derived from survey in Marine Reserve (lack of data from some years) Survey could be conducted annually outside of the Marine Reserve
(3) Shorten haul duration	Reduce survey footprint within year	Higher uncertainty in estimates derived from survey (noisier haul data)
(4) Focus the effect of sampling, by either by using fixed stations, or concentrating stations in subareas	Reduce impact on VME species on seafloor	Limitations of using fixed stations for abundance estimates Potential poor representation of species in Marine Reserve
(4) Focusing station locations in reduced areas with low density of vulnerable marine ecosystems (VME) species	Reduce impact on VME species on seafloor	Potential poor representation of species associated with VME
(5) Open trawl codend (in some hauls or survey years)	Reduce impact on fish catch	No physical samples Mortality of some fish species (e.g. Icefish) is still likely to be high Will likely miss small individuals.

Understanding of benthic habitat:

Previous research has identified areas of highest benthic diversity around HIMI and the RSTS has been designed to minimise the overlap with such areas. In addition, during sampling of RSTS hauls skippers avoid complex bottom types, which support vulnerable ecosystems, due to operational safety issues. There are however further approaches to quantify and monitor possible impacts on benthic habitats due to RSTS operations, and to modify and mitigate interactions of RSTS operations with vulnerable marine ecosystems.

Welsford et al. (2014) conducted quantitative benthic sampling and analysis across HIMI to characterise the distribution of key vulnerable benthic taxa. Sessile, suspension-feeding vulnerable taxa were most abundant above 300 m, particularly on western banks, south-facing slopes, and around Heard Island, where physical conditions favour attachment and feeding; biomass declined with depth and became patchier between 500–1000m and was largely absent below 1000m (Figure 9 and Figure 10). Biota distribution correlated strongly with depth and geomorphology: bank tops (e.g. Aurora, Coral and Pike Banks) supported the highest predicted biomass of sponges, gorgonians, ascidians, serpulids and pencil urchins, while the shallow central plateau supported the highest predicted biomass of hydrozoans, bryozoans, alcyonaceans and actiniarians. This pattern aligns with cobble and boulder substratum, favourable for attachment, which dominate the bank tops to the west and the slopes south of HIMI, where most vulnerable taxa occur, while sand and silt dominate from the central plateau to the abyssal plains, favouring sediment-dwelling infauna over sessile benthic megafauna. Welsford's analysis however focused most of the sampling effort on the banks and the shallow plateau (Figure 10), and results were less confident for the deeper plateau. Under the current design, the RSTS primarily operates in area of the plateau >300m (Table 2) and avoids the Aurora, Coral, Shell, and Pike Banks.

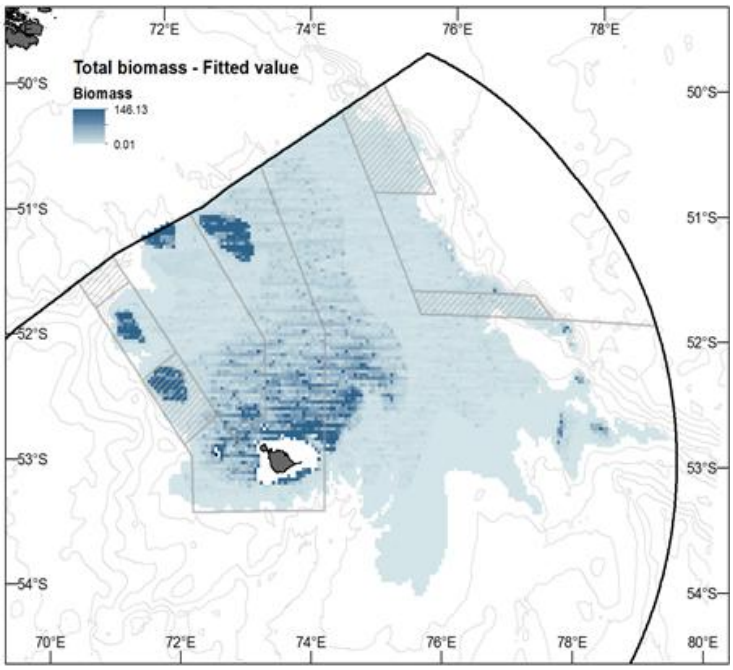


Figure 9: Predicted distribution of biomass (g.m-2) of vulnerable taxa across the HIMI seascape (Welsford et al. 2014**).**

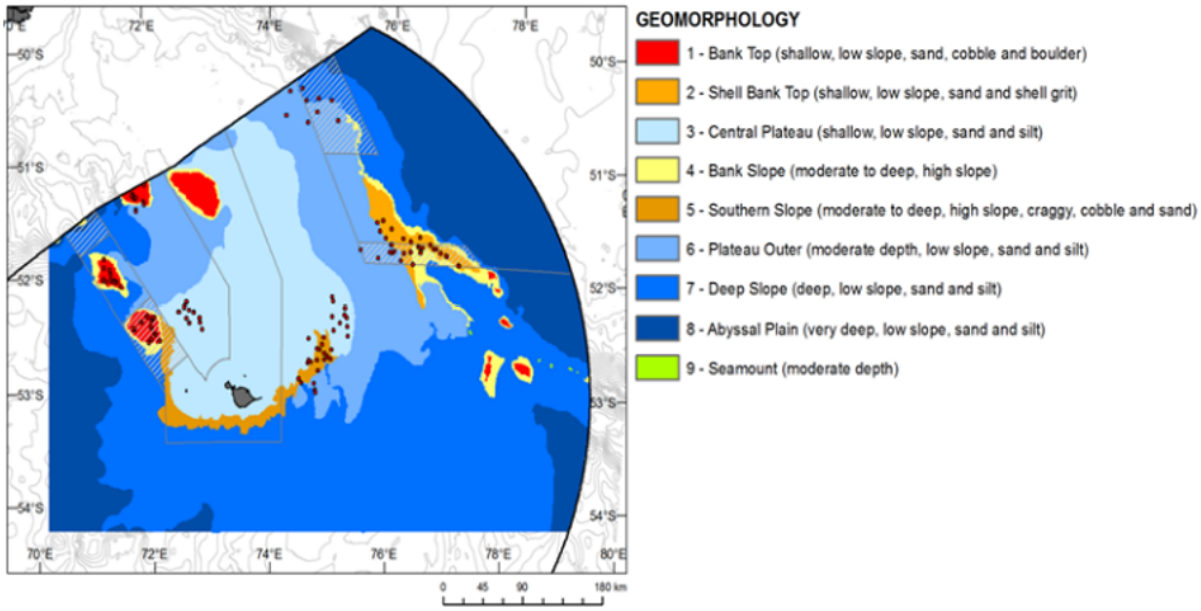


Figure 10: Geomorphic units across the model study area characterised depth, slope and broad-scale substratum types. Biological sample or video data was available for all geomorphs except the abyssal plain (8) and the small seamounts southeast of Shell Bank (9). From Welsford et al. (2014).

In the recent visit to HIMI on the RSV Nuyina, benthic trawl and camera tows around the island indicated that the sand and silt in the shallow parts of the plateau near Heard Island did not support a high density of vulnerable taxa abundance (see Figure 11 for an example of bottom type sample around Heard Island via a beam trawl). This suggests that the predictions of high biomass of vulnerable taxa in waters <300m in shallow parts of the plateau by Welsford et al. (2014) is primarily driven by the species richness of the banks and so extrapolating this relative level of biodiversity to the other shallow parts of the plateau with sand and silty bottoms may not be suitable. This would not be entirely surprising, as seafloor composed of sand and silt are often highly dynamic, with strong water currents causing a high level of perturbance.

For the survey, a set of random 'first' locations and trawl directions are provided to the skipper, along with reserve stations if a haul cannot be performed in the first location. Trawl hauls can only be successfully conducted on relatively flat bottom, i.e. typically with sand or silt, and the skipper will avoid stations with complex bottoms that are unsuitable for towing gear as they may cause entanglement or potential loss of the trawl gear. Therefore, this fishing behaviour inherently avoids complex bottom types that typically support vulnerable benthic ecosystems (Field et al. 2006). In addition, the net design used in the RSTS uses rock hoppers (Coghlan et al. 2025), which allow the net to bounce over the bottom, unlike some benthic beam trawl where a chain is used to stir up the sediment.

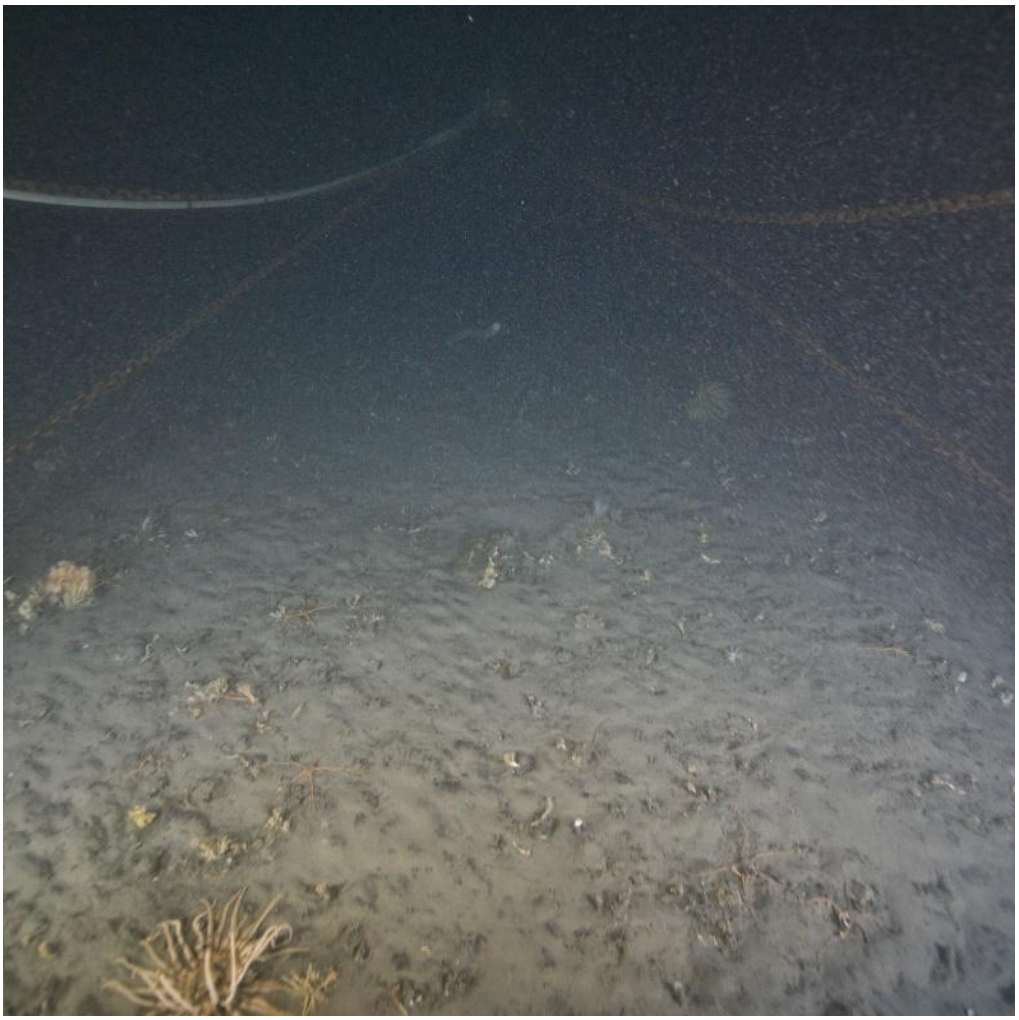


Figure 11: Example trawl from the recent HIMI voyage on RSV Nuyina (19th Jan 2026).

To quantify, monitor, and reduce the immediate impact of the RSTS on vulnerable benthic ecosystems, possible ways forward could be to:

1. Update the analysis of (Welsford et al. 2014) for the IUCN zones 1a and II using historical survey data where VME indicator species were collected—e.g. using the methods of Hill et al. (2017)—to inform alternative sampling locations that avoid more vulnerable benthic habitats.

2. During the survey, attach cameras to trawl gear to compare imagery of benthic habitats surveyed with the diversity and abundance of taxa collected in trawls. Associating trawl catch with visual observations of benthic habitats will enable; a) the validation of step 1 and contribute to ongoing refinement of suitable sampling locations; and b) retrospective assessment of the impact of the survey on benthic habitats within the Marine Reserve.

3. Assess the association of different benthic habitats with the population structure and abundance of toothfish, icefish and bycatch species, to assess if active avoidance of vulnerable benthic habitat will introduce sampling biases that need to be accounted for in assessments.

4.2 Development of alternative survey methods

As a longer-term strategy, the design of the RSTS could be adjusted to alter the way that monitoring is conducted within the marine reserve. Redesign of fishery independent surveys to account for management changes has been done in a number of places (Shertzer et al. 2025; DeFilippo et al. 2023; Anderson et al. 2024; Jones et al. 2023). For example, in 2007 the New Zealand Government introduced benthic protected areas (BPAs) which overlapped with the spatial footprint of a demersal survey for hoki (Stevens et al. 2023). In this case, the government provided an exemption to continue trawling in the BPAs under the condition that tows would be carried out along previous tow paths. In contrast, when the New Zealand Government introduced a marine mammal sanctuary which overlapped with a survey for Australasian snapper, no exemption was provided and instead there was a need to redesign the survey and to conduct a retrospective reanalysis of the survey time series (Jones et al. 2023). Hence, nuances of case studies must be carefully translated into viable options for redesign for the HIMI marine reserve and the RSTS.

One common element of advice from case studies is that, where possible, it is important to maintain the current survey design while rigorously testing alternative designs in parallel to enable clear comparison of methodologies (Anderson et al. 2024; Field et al. 2006, Kotwicki et al. 2026). **Error! Reference source not found.**In a paper on pathways towards modernising fisheries-independent surveys, Kotwicki et al. (2026) recommended that instead of complete replacements of extractive survey methods with new alternative approaches, traditional and new technologies should be combined to minimize the impact of extractive gears while assuring that all data needs are met. Some further principles for introducing alternative sampling methods include:

1. Sufficient overlap between the existing trawl and the alternative method to allow for comparison and calibration of the two methods.

2. An incremental incorporation of the alternative method, rather than a wholesale replacement of the existing trawl method, to ensure consistency in the time series (Field et al. 2006; Anderson et al. 2024; Pollack et al. 2025; Kotwicki et al. 2026).

Potential alternative, low-impact methods and how their observation types compare against the required data for stock assessments (at the minimum absolute abundance and catch length composition) are summarised in Table 4. None of these however can collect all types obtained from a trawl survey which are used in species assessments, such as age, sex and maturity of individuals.

Table 4: Alternative sampling methods and their usefulness for the different managed species.

Method	Toothfish	Icefish	Other Species	Comments
Acoustics	- Not usable (Toothfish are invisible in acoustic surveys as don't have a swim bladder)	- Method for abundance estimates yet to be fully developed - Additional trawl tows needed for fish length data	- Could be useful for some species but method development and additional trawl tows needed to verify species and fish length data	- Only few species are detected - Trawl tows needed for catch size composition - Further work needed on estimating abundance from acoustic signals (e.g. target strength) - Not currently a vessel readily available to conduct.
Visual methods (Camera tows)	- Difficult/ uncertain abundance estimates - Uncertain fish length data	- Difficult/ uncertain abundance estimates - Uncertain fish length data	- Difficult species ID - Difficult/ uncertain abundance estimates - Uncertain fish length data	- Generally poor visibility and low sampling volume - Maintaining camera track consistently near bottom can be difficult - Gear depth limitation - No capture of fish
BRUVs (baited remote underwater video)	- Only relative abundance at best (not useful for stock assessment) - Uncertain fish length data	- No abundance or fish length (not attracted to bait)	- Only some species may be attracted to BRUVs - Only relative abundance at best - Uncertain fish length data	- Works only on species that are attracted to BRUVs - No useful abundance estimates as attraction range is unknown
Longline survey	- Only relative abundance at best (not useful	- Does not catch icefish	- Only some species are caught by longlines	- Works only on species that are attracted to longlines

	for stock assessment) - Does not capture small fish		- Only relative abundance - Strong size selectivity	- No useful abundance estimates as attraction range is unknown
eDNA	- No abundance - No fish length data	- No abundance - No fish length data	- No abundance - No fish length data	- Unclear 'effort' (what is sampled?) - Genetic ID markers needed

5 Discussion

Excluding the IUCN zones 1a and II of the HIMI Marine Reserve from the RSTS sees a reduction in the overall coverage (by area) of 40%, with one stratum (Plateau West) being completely inside the expanded IUCN zones 1a and II. However, this equates to only a 22% reduction in effort (by number of hauls) due to the stratification in the sampling design of the survey.

Removal of data inside of the IUCN zones 1a and II primarily impact the major signals of CPUE of bycatch species. The signal for Toothfish (D. eleginoides) and Mackerel Icefish (C. gunnari) in strata that partially overlap the IUCN zones 1a and II looks to be robust to removing samples from within these zones, most likely because the strata were designed to be focus on these two species. However, Mackerel Icefish are consistently abundant in the Plateau West, which is completely within the Marine Reserve zones 1a and II. The largest change in signal occurs for bycatch species that fall under the HIMI management plan, particularly C. rhinoceratus and L. squamifrons.

The catch-weighted length composition information from the RSTS trawls for the two targeted species show similar results for partially overlapping strata when hauls inside of the IUCN zones 1a and II are included or removed. For Toothfish, the suspected impact of excluding Plateau West is unlikely to be significant because the population structure in this stratum seems to be consistent with that of the other strata on the shallow parts of the plateau (Plateau Southeast and Evitas).

Icefish are more mobile across the southern part of the shallow plateau, and their population structure is spatially variable, therefore the information from the length proportions in Plateau West appears to be more unique. While it appears to icefish is present in Plateau West and Plateau Southeast, they typically show slightly different ratios of cohorts between these two strata. However, the density in Plateau West is much lower than that in Plateau Southeast, and so the respective overall proportions are often variable.

While abundance indices and length-composition signals are important for assessments, the analysis in this report has not addressed the removal of RSTS samples from other analyses that are important for assessments, such as biological parameter estimation and age composition for Toothfish. The analysis has neither looked in detail at the flow-on effects to the assessments themselves. Maschette (2026) explores the impact on the Icefish assessment, while investigation of the effect on the

Toothfish assessment is recommended to take place through a management strategy evaluation (MSE) after current work on the stock assessment have been finalised.

We also explore options for altering the RSTS to better meet the IUCN values of the Marine Reserve within the IUCN zones 1a and II. Immediate work could start to quantify and mitigate the impact of the RSTS on VMEs through a redesign of the trawl sampling approach. Work could also be undertaken to potentially explore alternative data collection types. However, none of the alternative survey methods provide adequate information for the assessments of toothfish, icefish and the wider fish communities.

To maintain the long-term utility of the survey around HIMI for fishery management and ecosystem monitoring, we recommend that best practice is applied when exploring alternative survey methods while maintaining consistency in the data derived from the current RSTS design.

Recommendations:

- Rigorously design a transition project for any changes to the survey design or methodology inside IUCN zones 1a and II of the Marine Reserve.
- Establish a formal transition period where the current survey is run in parallel with alternative designs or methods (for example a five-year transition period).
- Detailed quantification of the impact of any changes to the survey design or methodology on the assessments of status and trends in toothfish, icefish, bycatch species and the wider fish community.
- Analysis of vulnerable benthic habitats inside of the IUCN zones 1a and II and alteration of the survey operations to avoid these areas if necessary.

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Appendix

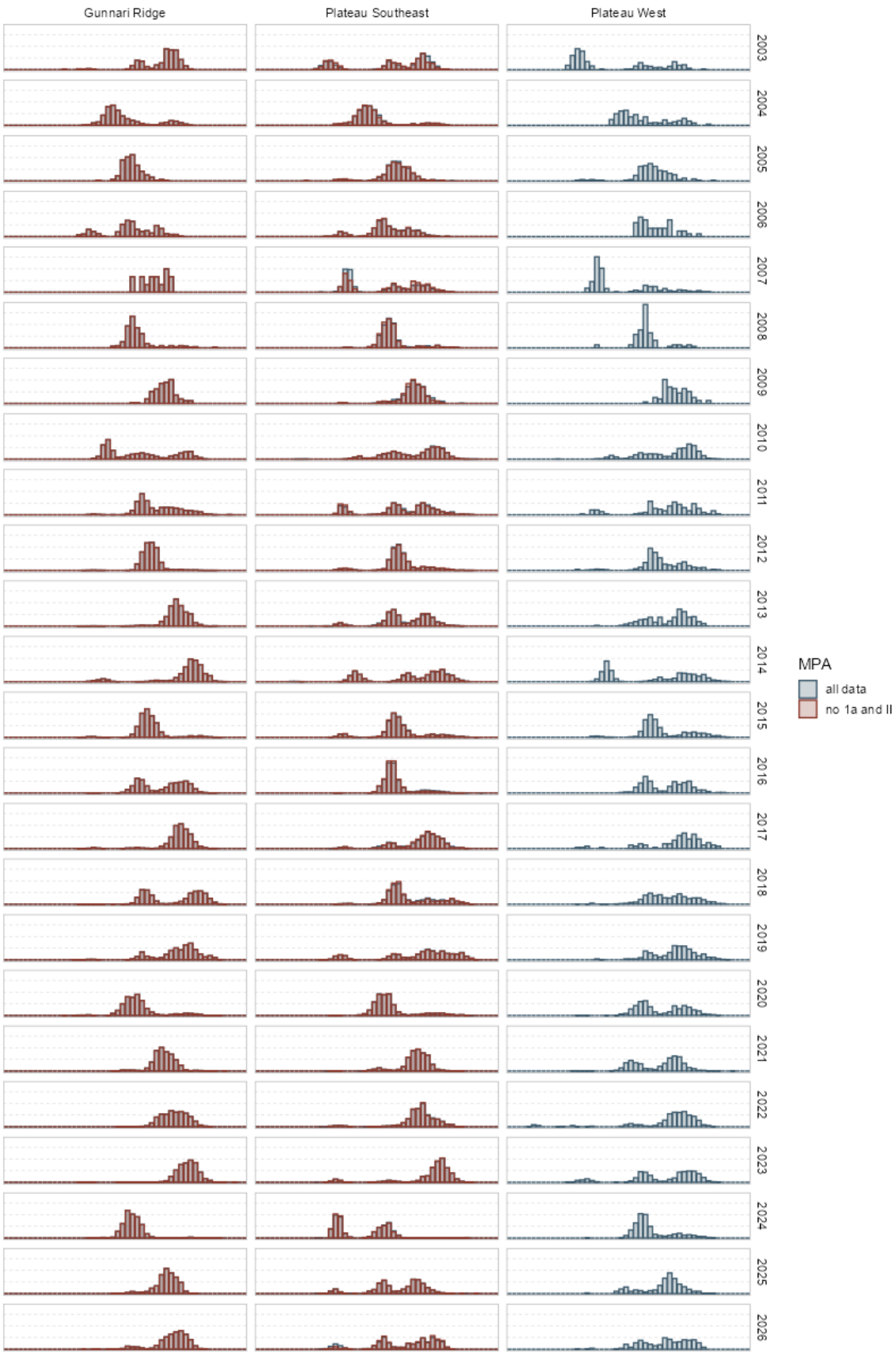


Figure A 1: The catch-weighted length-proportions of Mackerel Icefish.

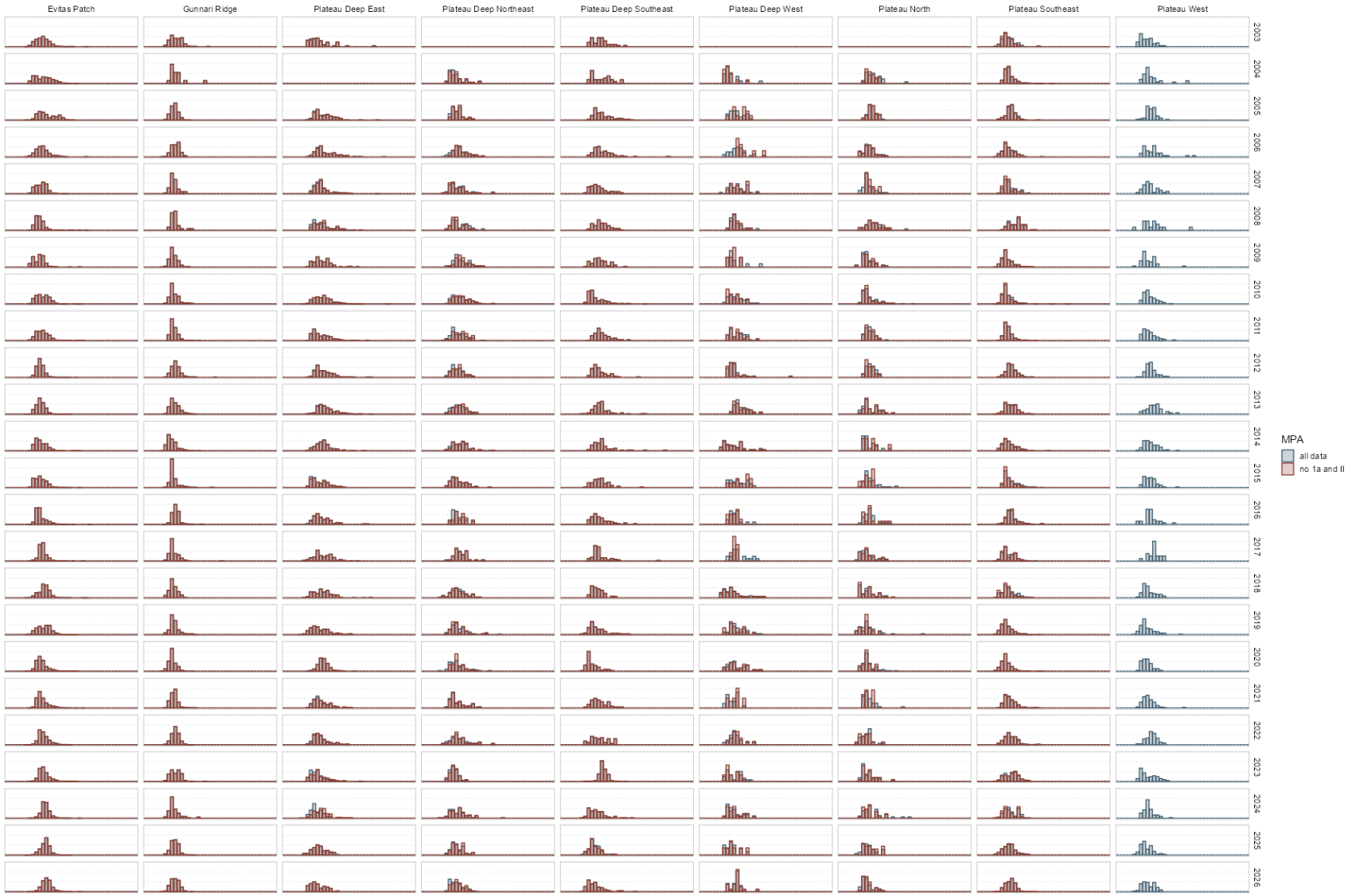


Figure A 2: The catch-weighted length-proportions of Patagonian Toothfish.

Reanalysis of historic mackerel icefish stock assessments with reduced Random Stratified Trawl Survey sampling at Heard Island and McDonald Islands.

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Recommendations

Reducing the sampling effort of the random stratified trawl survey (RSTS) for mackerel icefish leads to increased uncertainty in estimates of both population biomass and cohort structure. In a re-analysis of histrorical stock assessments, assuming no survey samling in the IUCN categorys IA and/or II of the HIMI Marine Reserve, would have resulted in reductions to catch limits, and in some instances led to severe challenges fitting stock assessments. As such, it is reccommended that the sampling in icefish strata not be reduced beyond current levels.

Additionally, this analysis highlights the need for increased sampling in future RSTS of Plateau West due to it contributing 49.52% of the survey area and currently being under sampled, potentially contributing to the large fluctuations to catch limits seen in this fishery.

Abstract

Following the request at SARAG 74 we present the outputs from the re-runs of the last 10 annual stock assessments for mackerel icefish (*Champsocephalus gunnari*) when removing the spatial area and samples of both the IUCN category IA alone, and the IUCN categorys IA and II together, and compare the results with original stock assessment estimates. All parameter estimates showed some level of change in the reruns with weight-at-length being the least impacted. Fits to length data showed inconsistent changes throughout the series of reruns with some cohorts increasing in density whilst others decreased. This led to large fluctuations in estimates of juvenile proportions in some years. Biomass estimates used in the assessment showed consistent decreases with reductions ranging from 16.69 – 66.74% when removing the IUCN IA and II areas. First year catch limits from these biomass estimates showed a commensurate reduction of 11.44 – 62.07% from those in the original stock assessment.

Introduction

Mackerel icefish are refered to as a 'boom and bust' species due to their large fluctuatations in population size (Maschette & Welsford, 2019). In addition to this, they are also highly mobile and shift throughout their known distribution range with little consistent aggregation. Because of these features CCAMLR manages mackerel icefish with a different set of decision rules from other species such as toothfish. CCAMLR uses a two-year deterministic stock assessment based on trawl surveys to determine a two-year catch limit, with future catch limits based on updated surveys. The stock assessment uses a conservative biomass estimate and projects in forward for two years under no-fishing, then projects the population for the same two years to determine the catch which would result in 75% escapement of the second year biomass in the no-fishing projection (Constable et al., 2005, Figure 1). These rules were set by CCAMLR following a series of workshops SC-CAMLR, 2001) to develop management procedures for mackerel icefish which in order to implement the rules:

'*research surveys need to be as representative as possible of the true status of the stock and whilst there are limitations to the bottom trawl method, it is important to continue these surveys as they provide a continuous time series.*'

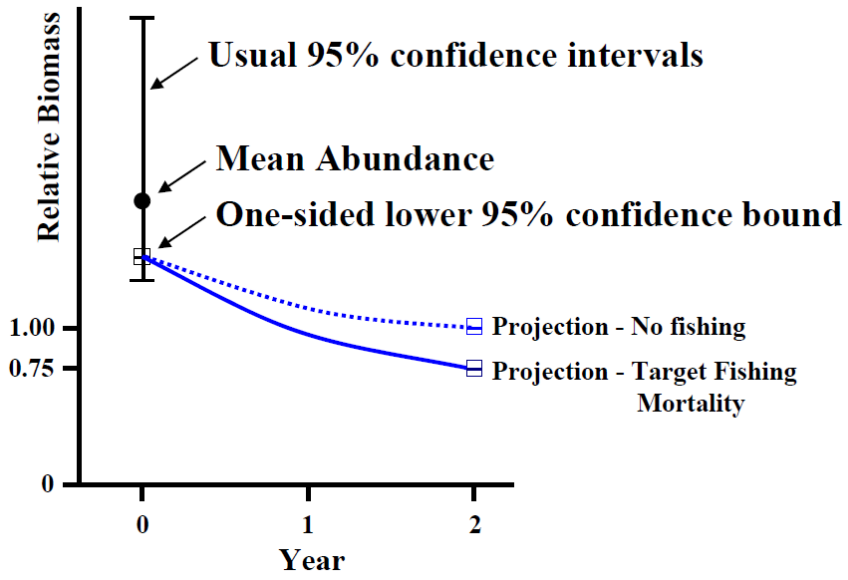


Figure 1: Decision rule for determining yield for mackerel icefish in year 1 and 2 after a survey (from Constable *et al.* 2005).

In each year since 1997, a random stratified trawl survey (RSTS) has been conducted in the Heard Island and McDonald Islands (HIMI) region to assess the abundance and biology of fish and invertebrate species. The survey provides information for input into the stock assessments for the two target species, *D. eleginoides* and *C. gunnari*. Surveys have been conducted as

consistently as possible each year to ensure a continuous data time series from the fisheries (Maschette et al., 2026).

A marine reserve was declared, and further expanded within the HIMI EEZ in 2002 and 2014 respectively. In the latter it was classified as an IUCN category IA strict nature reserve (henceforth IUCN IA), though under the 2014 HIMI management plan (Commonwealth of Australia, 2014) the RSTS was permitted through the research priority "Stratified random sampling in and around the Reserve of those fish species targeted in the HIMI fishery."

In 2024 a further expansion of the the HIMI marine reserve was declared with the addition of IUCN category II (henceforth IUCN II) and IV areas. Following the declaration of the expansion, it was advised that RSTS sampling in IUCN Ia and II marine reserve categorys may not be approved from 2027 onwards (SARAG, 2026).

Noting that the IUCN IA and II marine reserve categorys cover 60% of the RSTS strata used for mackerel icefish stock assessments (Figure 2), SARAG 74 requested that the last 10 annual stock assessments be re-run to estimate the effects of not sampling within the MPA. Here we present the outputs of the stock assessment when removing of the spatial area and samples of both the IUCN IA alone, and the IUCN IA and II areas, and compare with original stock assessment estimates.

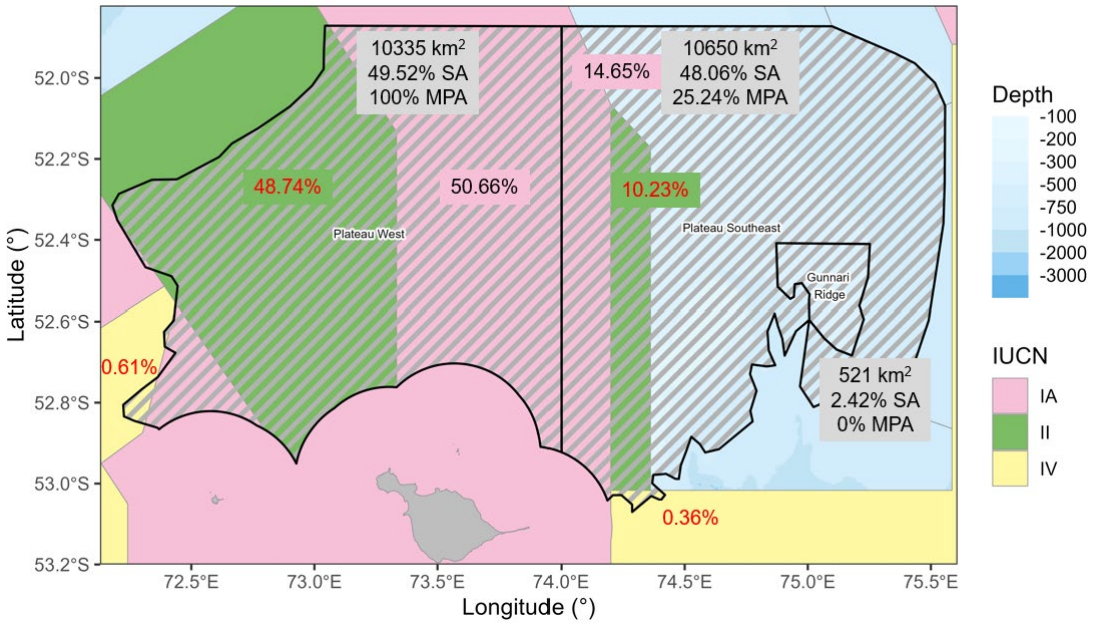


Figure 2: Overlap of the random stratified trawl survey strata used in the mackerel icefish stock assessment with the 2024 marine reserve.

Methods

Survey data range

The surveys from 2016-2025 were used in this analysis. The three strata where mackerel icefish are abundant (Gunnari Ridge, Plateau West and Plateau Southeast) were surveyed in daylight when icefish are close to the seafloor and most effectively sampled by demersal trawls (van Wijk *et al.* 2001). Survey hauls were allocated at random within each stratum, however a minimum spacing of 5 nautical miles between survey stations was specified to ensure hauls would not overlap. In each year survey stations were split into three scenarios: 1) original survey stations used in their respective stock assessments, 2) survey stations which were located outside of the IUCN 1A, and 3) survey stations which were located outside of the IUCN 1A and 2. Each of these were subsequently used for estimating the stock assessment input parameters in each year.

Assessment methods

The stock assessment structure followed those used in the recent years for assessing yield in mackerel icefish.

Weight-at-length relationship

The parameters of the weight-at-length relationship, *a* and *b* were re-estimated using the *nls*() function in R (R Development Core Team 2025) to fit the relationship:

$$W = aL^b$$

where *W* is the weight (kg) and *L* is the length (mm) of individual icefish taken during the 2025 survey.

Cohort structure

A mixture analysis was undertaken using the CMIX procedure (de la Mare 1994, de la Mare *et al.* 2002) to estimate the density of fish in each age class. The contribution of each age class to the overall biomass was estimated by scaling each age class by its mean weight at length. The survey data were pooled to a single survey data set. As in previous years the sampling effort across strata was un-equal and the data are re-scaled so that the mean of the re-scaled data is the same as the stratified mean of the raw data. For each haul in *k* strata, the density data are re-scaled by the composite sampling fraction following de la Mare & Williams (1996):

$$D_{i,j} = d_{i,j} \frac{A_i}{\sum_k A_k} \times \frac{\sum_k n_k}{n_i}$$

where $D_{i,j}$ is the re-scaled density for haul *i* in stratum *j*, $d_{i,j}$ is the original density estimate for that haul, and A_i and n_i are the area and the number of hauls in stratum *i* respectively.

Additionally, the relative importance of each haul to the respective cohorts fitted in each year were explored by allocating the catch weighted length frequencies to cohorts based on the probability of each length bin being in a given cohort.

Length-at-age

Maschette *et al*. (2024) evaluated growth parameters using survey data. Here we use their estimate for the period 2018-2024 as agreed by WG-FSA-IMAF-2024 (para. 3.7). The growth function estimated $L\infty$ of 559.1 mm, a growth rate (K) of 0.294 and T_0 of 0.066.

Maturity

For the assessment, all fish (aged 1 – 3 years) were assumed to be mature so that the status of the whole stock is monitored.

Natural mortality

Natural mortality was assumed to be 0.4 (de la Mare 1998).

Survey biomass and preliminary yield estimation

Using the method described in Constable *et al.* (2005, Appendix 1), a bootstrap algorithm was implemented in R to estimate the uncertainty in the total biomass (tonnes) of mackerel icefish over the survey area. The lower one-sided 95% confidence bound of the biomass estimate was then used as the estimate of the standing stock at the start of the projection period.

The Grym package in R (Wotherspoon & Maschette 2020) was used to estimate the fishing mortality and corresponding catch that satisfies the short-term decision rule, i.e. that will result in a 75% escapement relative to a two-year projection with zero fishing mortality (Figure 1).

Few fish in the mackerel icefish population in Division 58.5.2 survive beyond age 4, with a drop in abundance between 3+ and 4+ cohorts observed in consecutive surveys (Welsford 2011, Welsford 2015). Consequently, the assessment scenarios run here only includes the biomass estimated from the 0+ to 3+ cohorts.

Results

Survey data range

Removal of just the IUCN Ia area resulted in an annual removal of 3.5-32.7% of survey stations. Further removal of the IUCN II area increased this to 24.2-40.0% of survey stations being removed. The latter of which completely removes the Plateau West strata from the analysis (Table 1).

Table 1: Number of survey stations used per year under differening marine reserve removals. GR = Gunnari Ridge; PSE = Platea Southeast, PW = Plateau West.

	Original				Remove IUCN IA				Remove IUCN IA & II			
Year	GR	PSE	PW	Total	GR	PSE	PW	Total	GR	PSE	PW	Total
2016	22	30	10	62	22	30	6	58	22	25	0	47
2017	22	30	10	62	22	25	4	51	22	23	0	45
2018	18	30	10	58	18	21	6	45	18	18	0	36
2019	3	30	10	43	3	27	5	35	3	25	0	28
2020	18	30	10	58	18	27	4	49	18	25	0	43
2021	18	30	10	58	18	27	7	52	18	21	0	39
2022	18	30	10	58	18	25	6	49	18	22	0	40
2023	18	29	10	57	18	26	6	50	18	21	0	39
2024	18	28	10	56	17	24	5	46	17	21	0	38
2025	14	31	10	55	14	21	2	37	14	19	0	33

Weight-at-length relationship

Of all the parameters estimated for the stock assessment the weight-at-length relationship is possibly the least sensitive to changes in sampling. Removal of either the IUCN IA alone, or with the IUCN II area as well, whilst resulting in lower sample sizes and changes to the length range covered by those samples, resulted in minimal change to the parameter estimates for the weight-at-length relationship (Table 2).

Table 2: Weight-at-length relationship parameters with sample numbers, minimum and maximum lengths (mm) for mackerel icefish from the RSTS. O = original, IA = removal of samples in the IUCN IA (pink), II = removal of samples in the IUCN IA and II (green). Note there were no length weight relationship for 2018 due to scale issues on the vessel.

	Sample #			Min length			max length			a			b		
Year	O	IA	II	O	IA	II	O	IA	II	O	IA	II	O	IA	II
2016	1767	1469	1172	166	166	166	467	467	426	1.32E-09	1.21E-09	1.06E-09	3.257	3.273	3.295
2017	3409	3142	3075	143	155	155	436	436	436	9.16E-10	8.78E-10	8.63E-10	3.316	3.322	3.325
2019	3536	3209	2570	134	134	134	456	456	452	1.08E-09	1.01E-09	9.60E-10	3.286	3.295	3.302
2020	5851	4737	4543	143	143	143	453	453	443	1.98E-09	2.12E-09	2.11E-09	3.185	3.171	3.171
2021	7197	6283	5228	132	132	161	462	462	451	1.34E-09	1.36E-09	1.50E-09	3.251	3.248	3.230
2022	5517	4546	4044	49	49	157	429	429	429	8.22E-10	6.78E-10	7.02E-10	3.331	3.362	3.355
2023	6236	5662	4795	127	127	144	473	473	473	1.05E-09	9.48E-10	1.07E-09	3.286	3.304	3.281
2024	5215	4364	3696	123	151	151	445	445	445	3.41E-09	3.13E-09	3.02E-09	3.090	3.103	3.109
2025	4772	4270	4151	123	137	144	452	452	452	2.84E-09	3.09E-09	3.01E-09	3.123	3.107	3.112

Cohort structure

Using CMIX to fit length cohorts annually generally resulted in a reduction in density estimates of every respective cohort. The extent of this reduction varied both across years, individual cohorts and in relation to whether hauls in the IUCN IA alone, or also in IUCN II were removed (Figure 4). In some cases, such as 2024 individual cohort densities increased with the removal of hauls within the marine reserve. These shifts in cohort densities resulted in changes to the annual estimate of the proportion of 0 – 3+ year old icefish within the population in all years except 2017 (Figure 3).

Additionally, model and cohort fits to the reduced datasets were much poorer in all years. In two instances entire cohorts could not be fit and were lost from the estimate, and in four of the years the models had to be given strict parameter estimates to enable them to fit at all.

When considering the different sampling locations across the the survey strata to the relative importance for each age cohort (Figures 5 – 8) it can be seen that irrespective of which age class explored there are no consistent spatial areas which show more importance than the others from one year to another.

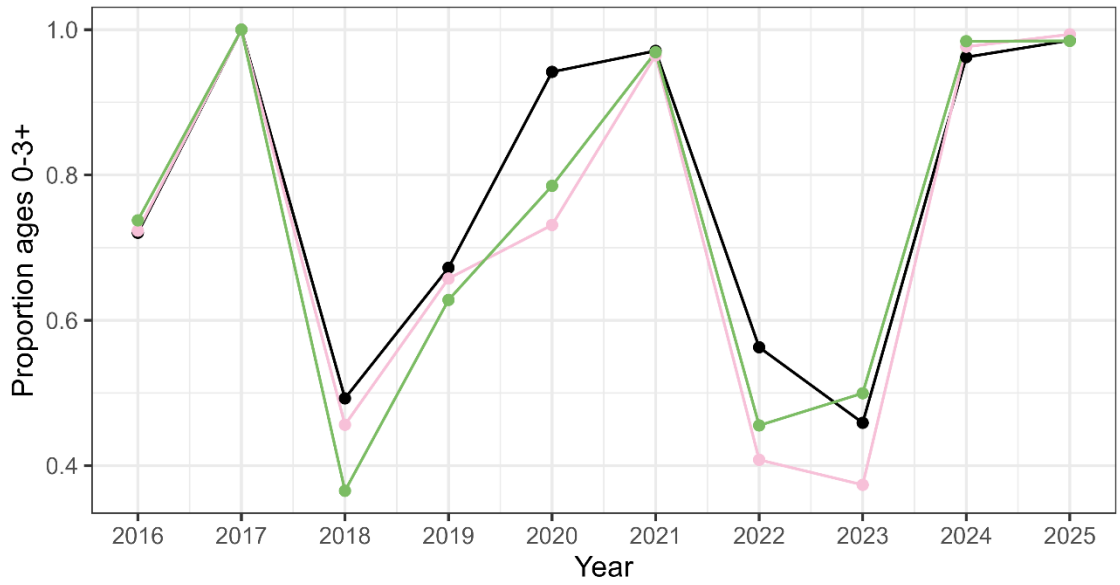


Figure 3: Comparison of the estimated proportion of age cohorts 0 – 3+ in the population of mackerel icefish under different spatial scales of data availability. Original model fits are shown in black, model fits with the removal of data in the IUCN IA are shown in pink, and green shows the removal of data in IUCN IA and II.

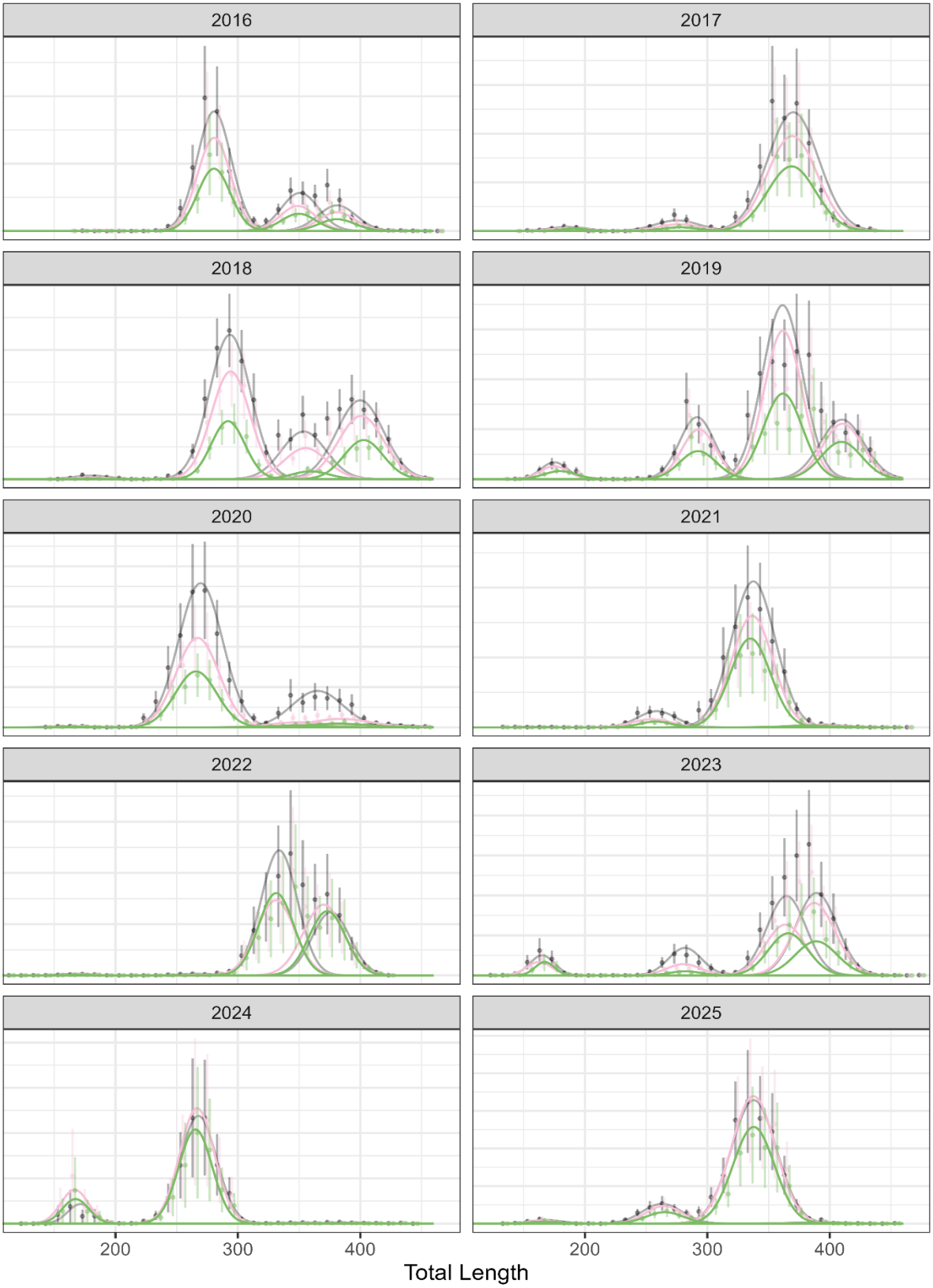


Figure 4: Example comparison of the estimated age cohorts of mackerel icefish under different spatial scales of data availability. Original model fits are shown in black, model fits with the removal of data in the IUCN IA are shown in pink, and green shows the removal of data in IUCN IA and II.

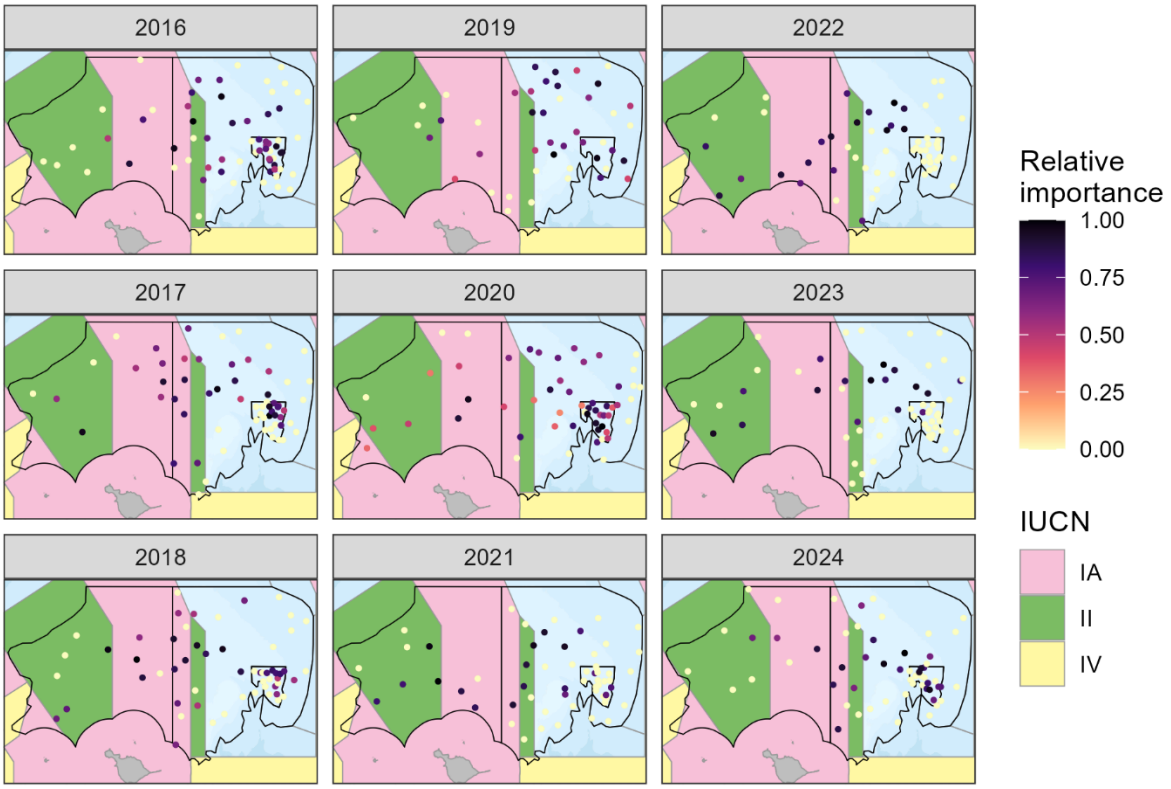


Figure 5: Relative importance of random stratified trawl survey stations by year for the 1+ age cohort of mackerel icefish.

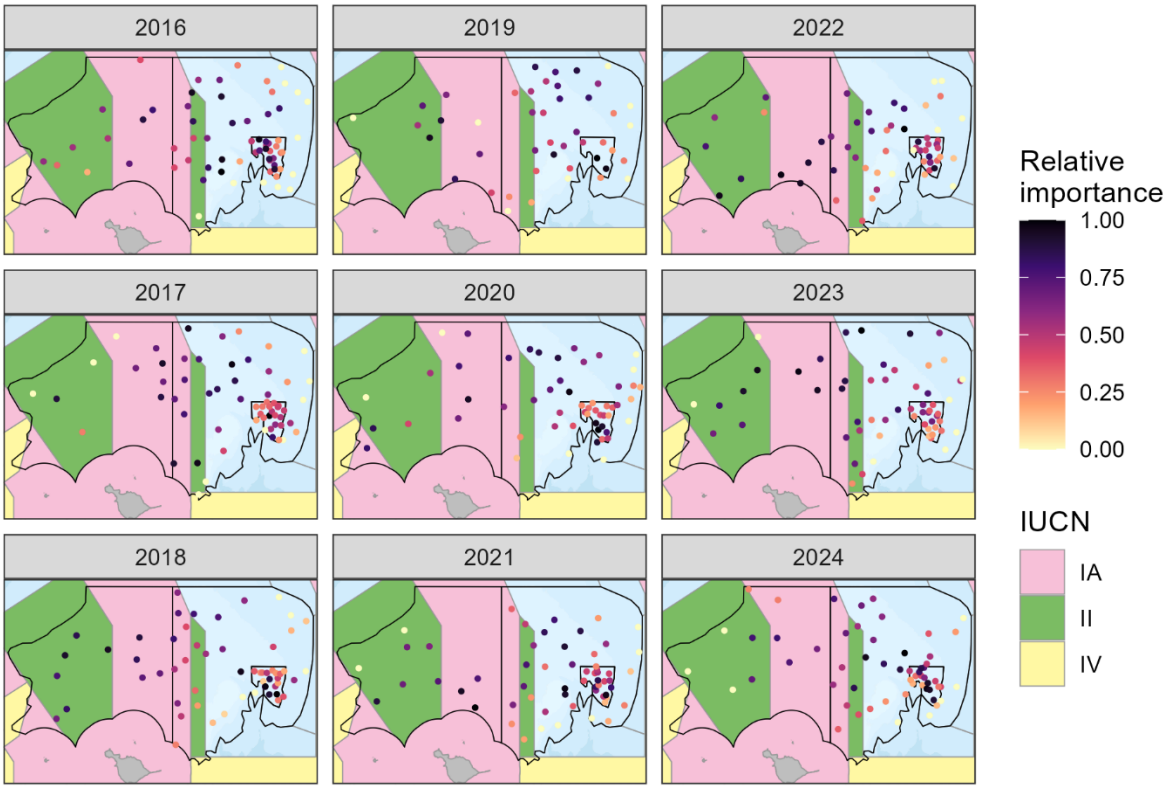


Figure 6: Relative importance of random stratified trawl survey stations by year for the 2+ age cohort of mackerel icefish.

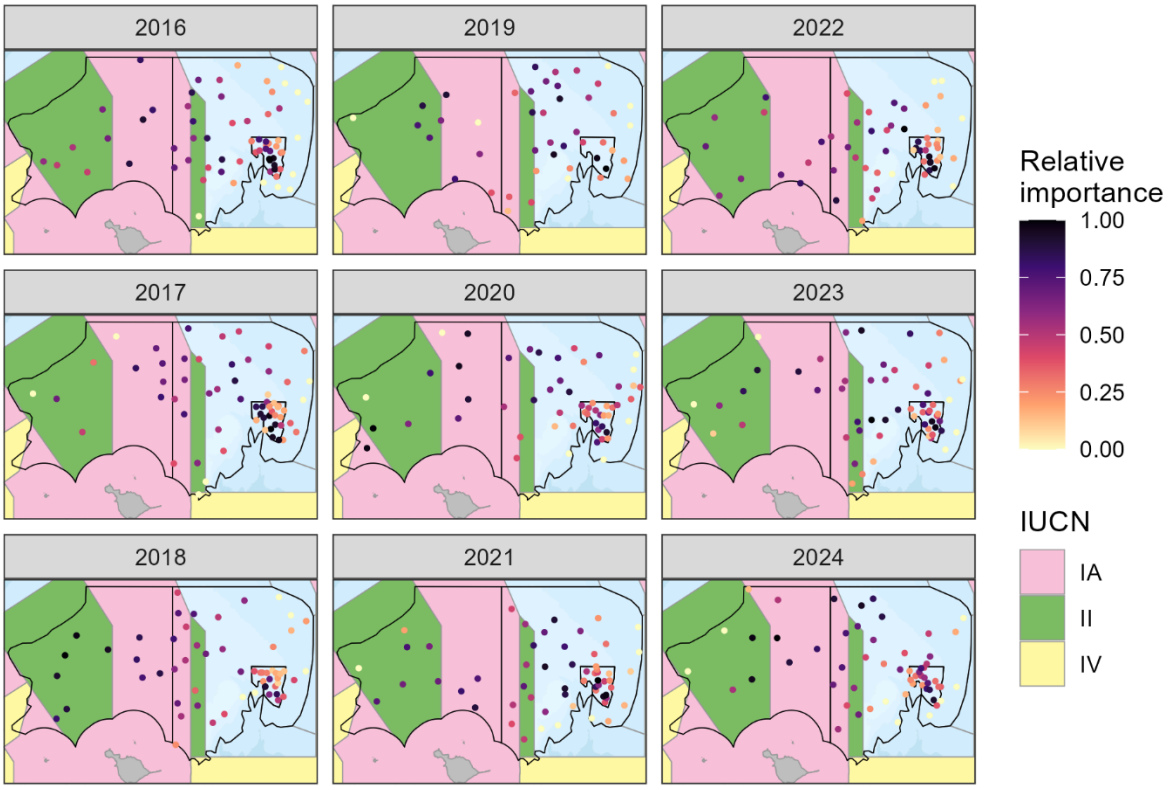


Figure 7: Relative importance of random stratified trawl survey stations by year for the 3+ age cohort of mackerel icefish.

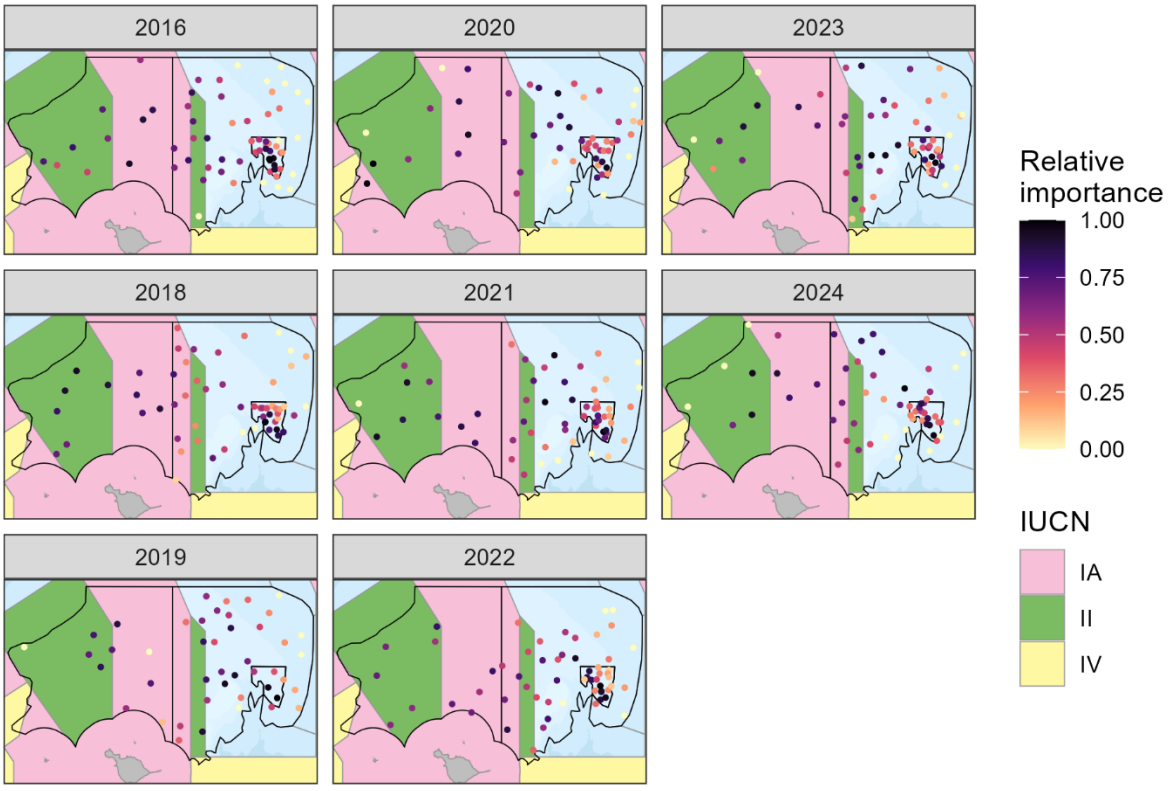


Figure 8: Relative importance of random stratified trawl survey stations by year for the 4+ age cohort of mackerel icefish.

Survey biomass

Removal of the IUCN IA or IUCN IA & IUCN II area and samples, results in a systemtic reducation of the lower one-sided 95% biomass estimates.

The IUCN IA section of the marine reserve covers 50.66% and 14.65% of the Plateau West and Plateau Southeast survey strata respectively. In the same strata IUCN II covers 48.74% and 10.23% of the Plateau West and Plateau Southeast survey strata respectively. The removal of both categories of the marine reserve results in 0.61% of Plateau West remaining, which has not been sampled in the examined time period.

Removal of the IUCN IA area alone results in reductions of survey biomass between 11.82 – 37.94%. Further removal of the IUCN II area results in reduction of survey biomass betweem 16.63 – 59.63% (Figure 9, Table 3).

Whilst the removal of sampling in these areas results in a downward bias on our estimates of population size, this change is further exacerbated by being combined with the changes to the estimated proportion of juveniles in the population which is used in the stock assessment. This results in the biomass estimate used in the stock assessments being 11.07 – 51.82% lower than the original estimates when just removing the IUCN IA area, and 16.69 – 66.74% lower when also removing the IUCN II area (Table 3).

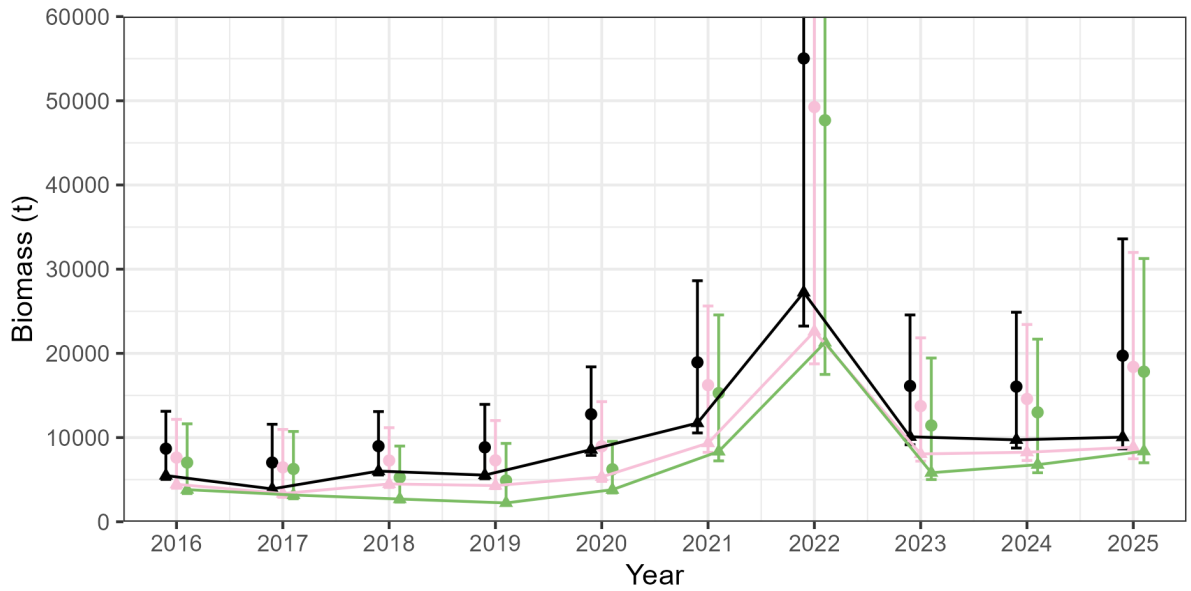


Figure 9: Comparison of the estimated bootstrapped biomass for mackerel icefish under different spatial scales. Original model fits are shown in black, model fits with the removal of data and area in the IUCN IA are shown in pink, and green shows the removal of data and area in IUCN IA and II.

Table 3: Comparison of the lower one-sided 95% bootstrap estimates of total biomass (all cohorts) and biomass estimates used for the assessment (0 – 3+ cohorts) of mackerel icefish under different spatial scales. Brackets contain the percentage change from the original estimate in the assessment.

	Total Biomasss (All cohorts)			Assessment Biomass (0 – 3+ cohorts)		
Year	**Original**	**IUCN IA**	**IUCN IA & II**	**Original**	**IUCN IA**	**IUCN IA & II**
2016	5490	4448 (-19%)	3815 (-30.5%)	3955	3217 (-18.7%)	2814 (-28.8%)
2017	3901	3351 (-14.1%)	3175 (-18.6%)	3901	3351 (-14.1%)	3175 (-18.6%)
2018	6018	4490 (-25.4%)	2699 (-55.2%)	2965	2049 (-30.9%)	986 (-66.7%)
2019	5539	4299 (-22.4%)	2236 (-59.6%)	3724	2826 (-24.1%)	1404 (-62.3%)
2020	8573	5321 (-37.9%)	3807 (-55.6%)	8075	3890 (-51.8%)	2989 (-63%)
2021	11722	9341 (-20.3%)	8508 (-27.4%)	11692	9010 (-22.9%)	8244 (-29.5%)
2022	27242	22608 (-17%)	21290 (-21.8%)	14880	9225 (-38%)	9694 (-34.8%)
2023	10092	8055 (-20.2%)	5825 (-42.3%)	4631	3009 (-35%)	2910 (-37.2%)
2024	9731	8254 (-15.2%)	6777 (-30.4%)	9363	8061 (-13.9%)	6669 (-28.8%)
2025	10049	8862 (-11.8%)	8378 (-16.6%)	9901	8804 (-11.1%)	8249 (-16.7%)

Preliminary yield estimation

As may be expected, the reductions in biomass used for the stock assessments result in consistently lower first year catch limits. Reductions to catch limits ranged betweeen 9.80 – 52.87% when removing the IUCN Ia area, and reductions betweeen 16.88 – 66.14% when further removing the IUCN II area (Figure 10 & 11, Table 4). The catch limits in year two had a similar trend with reductions betweeen 7.54 – 50.35% when removing the IUCN IA and reductions betweeen 11.44 – 62.07% when further removing the IUCN II.

The exception to this was 2016, where the year two catch limit increased by 1.74% when just the IUCN IA was removed. This was due to the change in proportions of each age cohort with CMIX placing a higher proportion of fish in the 1+ and 2+ cohorts which were previously in the 4+ and 5+ age classes and not included in the model. These fish when projected forward with growth result in a larger proportion of the biomass being available to the fishery.

Table 4: Comparison of the estimated catch limits for mackerel icefish in year 1 and year 2 under different spatial scales. Brackets contain the percentage change from the original estimate in the assessment.

	Year 1			Year 2		
Year	**Original**	**IUCN IA**	**IUCN IA & II**	**Original**	**IUCN IA**	**IUCN IA & II**
2016	561	506 (-9.8%)	441 (-21.4%)	402	409 (1.7%)	356 (-11.4%)
2017	526	450 (-14.4%)	426 (-19%)	395	339 (-14.2%)	320 (-19%)
2018	443	315 (-28.9%)	150 (-66.1%)	320	258 (-19.4%)	125 (-60.9%)
2019	527	397 (-24.7%)	198 (-62.4%)	406	308 (-24.1%)	154 (-62.1%)
2020	1276	638 (-50%)	487 (-61.8%)	1047	538 (-48.6%)	413 (-60.6%)
2021	1528	1207 (-21%)	1098 (-28.1%)	1172	896 (-23.6%)	812 (-30.7%)
2022	2616	1233 (-52.9%)	1292 (-50.6%)	1857	922 (-50.4%)	963 (-48.1%)
2023	714	426 (-40.3%)	404 (-43.4%)	599	342 (-42.9%)	320 (-46.6%)
2024	1824	1601 (-12.2%)	1326 (-27.3%)	1723	1593 (-7.5%)	1306 (-24.2%)
2025	1429	1268 (-11.3%)	1188 (-16.9%)	1126	996 (-11.5%)	933 (-17.1%)

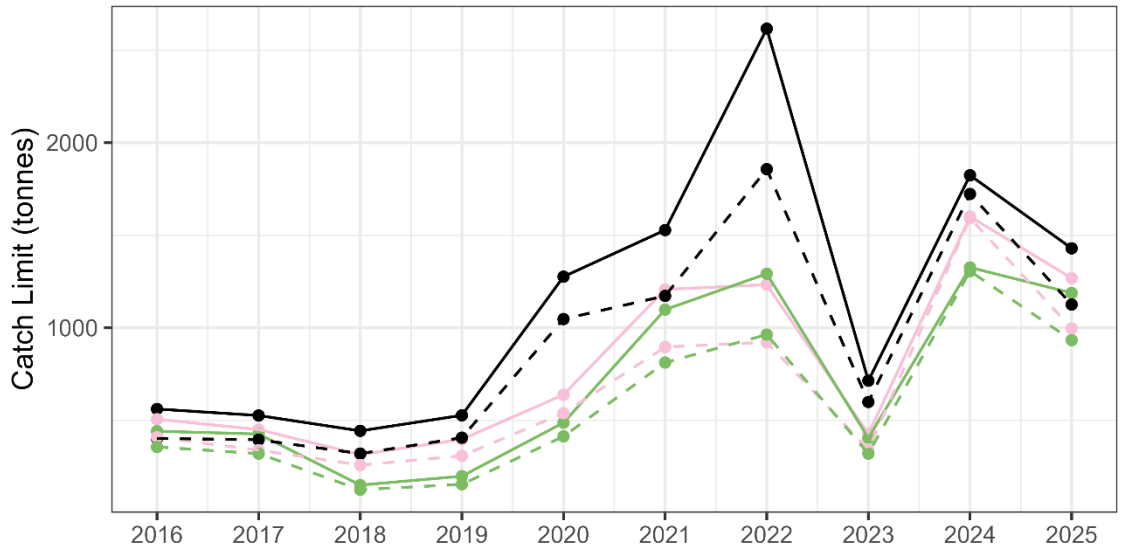


Figure 10: Comparison of the estimated year 1 (solid line), and year 2 (dashed line) catch limits for mackerel icefish under different spatial scales. Original model fits are shown in black, model fits with the removal of data and area in the IUCN IA are shown in pink, and green shows the removal of data and area in IUCN IA and II.

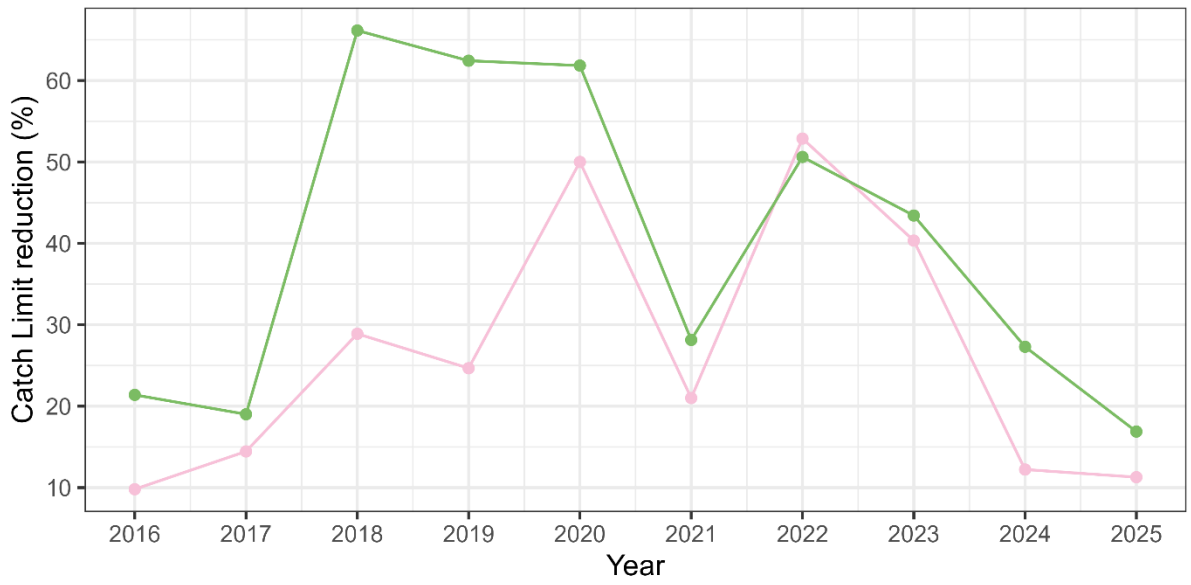


Figure 11: Comparison of the estimated year 1 catch limit reduction for mackerel icefish under different spatial scales. Removal of data and area in the IUCN IA are shown in pink, and green shows the removal of data and area in IUCN IA and II.

Discussion

The current advice in CCAMLR is that research surveys used for the stock assessment of mackeral icefish need to be as representative as possible of the true status of the stock (SC-CAMLR, 2001). As such, the only currently agreed method for determining the biomass and population parameters for mackerel icefish through the use of trawl surveys like the RSTS and the bottom trawl survey conducted around South Georgia. This paper shows that due to the nature of mackerel icefish population dynamics, not sampling within either the IUCN IA or the IUCN II has an impact on the ability to estimate the true status of this stock.

The results show changes to all parameter estimates to some degree when reducing the coverage of the RSTS on the icefish population. Whilst not tested here due to time constraints, the changes in the cohort estimates would also have flow on effects to the estimation of growth for this population. These changes would in turn would have an effect on catch limit advice. The reduction in sample size also had severe impacts on the ability to fit some of the models, particularly CMIX.

This work also provides the first review of the importance of different spatial areas for individual cohorts across years. In doing so, it particularly highlights that Plateau West has been undersampled across the years. This is not a new finding, and it has been noted in the past, the number of sample stations in this strata were a negotiation based on the total number of stations across the whole survey and the estimate that Plateau West was likely to be the most

homogenous survey strata for fish density. Based of the exploration of cohort distribution between years we would propose that Plateau West is not the most homogeneous strata and that the years in which the biomass is particularly low may be a result of the icefish being predominantly in this strata but not being sampled by the small number of stations. We recommend that this be tested through an increased number of stations in Plateau West if future RSTS occur.

With regards to potential alternative methods for providing data which could be used within the stock assessment (see also Leadbetter et al. 2026) there are essentially two key data types that alternative methods would need to be able to obtain, 1) an index of biomass, and 2) an unbiased length density distribution.

CCAMLR has discussed this in recent years and whilst acoustic biomass estimates may be feasible there is currently no agreement within CCAMLR on their use for mackerel icefish due to the difficulty in estimating a target strength for the species as well as discerning them from co-occurring species such as unicorn icefish. Similarly, there is no an obvious method available to provide a length density distribution for this species as zooplanktivores are not attacted to instruments such as baited cameras.

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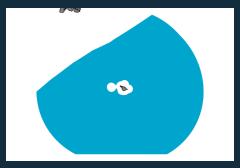
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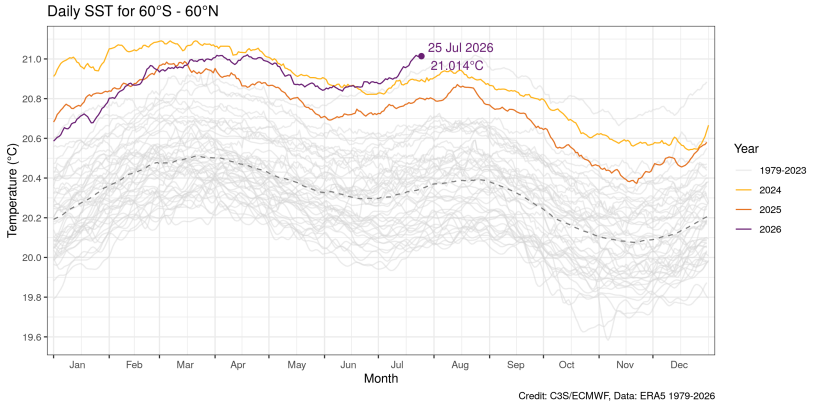
Heard Island and McDonald Islands Fishery



July 28, 2026

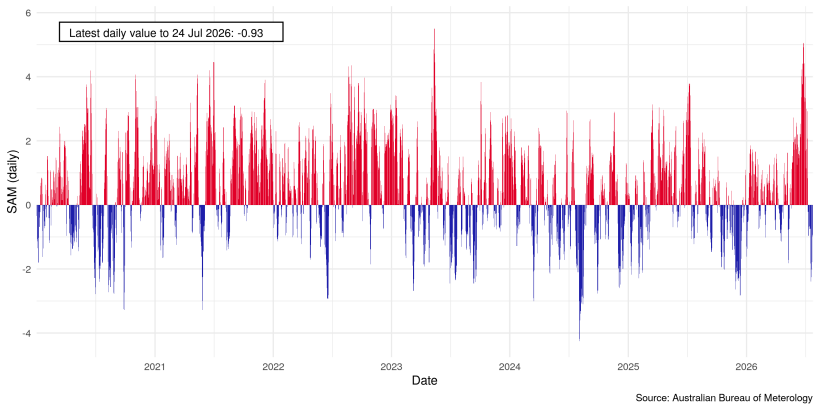
Historical Period

Climate Drivers: Sea Surface Temperature (SST)



Global Sea Surface Temperatures (SST) are at record highs in 2026 (*Copernicus*)[1].

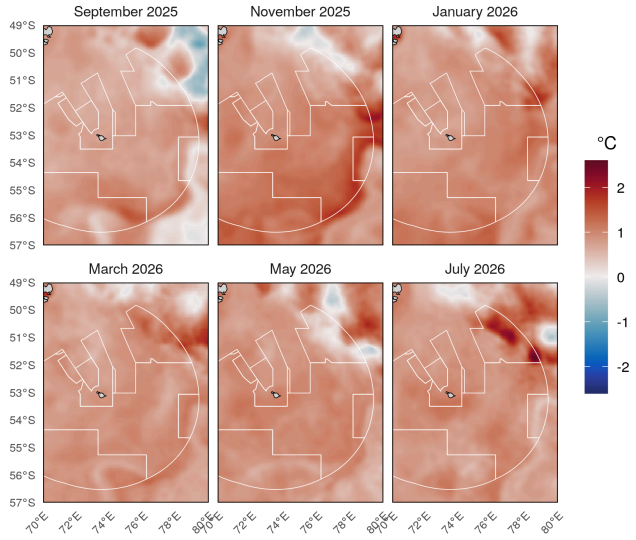
Climate Drivers: Southern Annular Mode (SAM)



Southern Annular Mode (SAM) indicates the N-S movement of westerly winds in the mid-high latitudes. Positive SAM events (westerlies move poleward) have become more common over time[2]. (*BOM SAM*).

Positive SAM events may influence toothfish catch indirectly by altering Southern Ocean circulation and the delivery of warm Upper Circumpolar Deep Water to the HIMI fishing grounds. Historical analysis indicates higher catch rates during positive SAM events[3].

Regional Dynamics: SST Anomaly

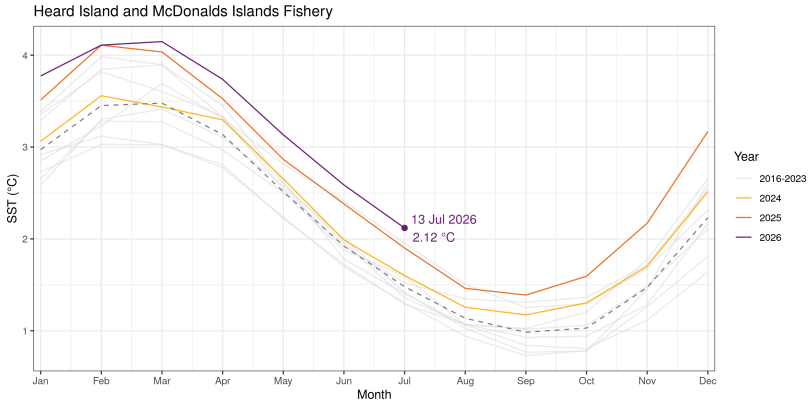


Source: CMEMS, Climatology: 1981-2022

Bi-monthly maps of SST anomalies. Anomalies are relative to 1993-2016. White lines are the Australian EEZ and marine park boundaries.

- The HIMI region has had anomalously warm surface waters over the past year[4].
- SST can influence the presence of toothfish[3].

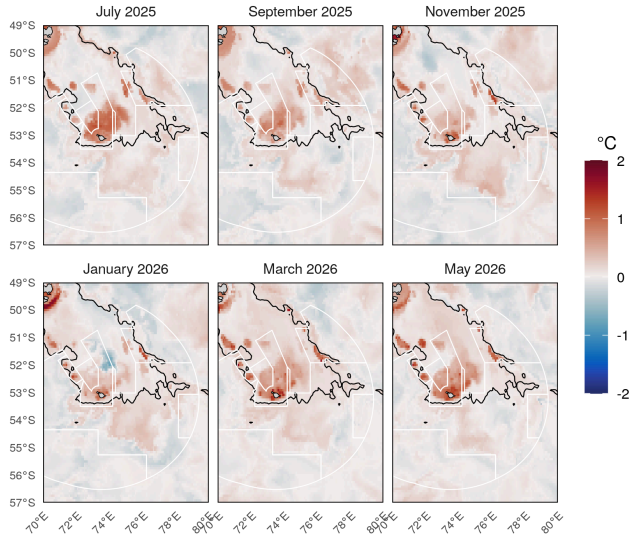
Regional Dynamics: SST monthly timeseries



Timeseries of monthly averaged SST for example years 2016-2026[4].

- Surface temperatures in 2026 have been the warmest in 10 years.

Regional Dynamics: Modelled Bottom Temperature Anomaly

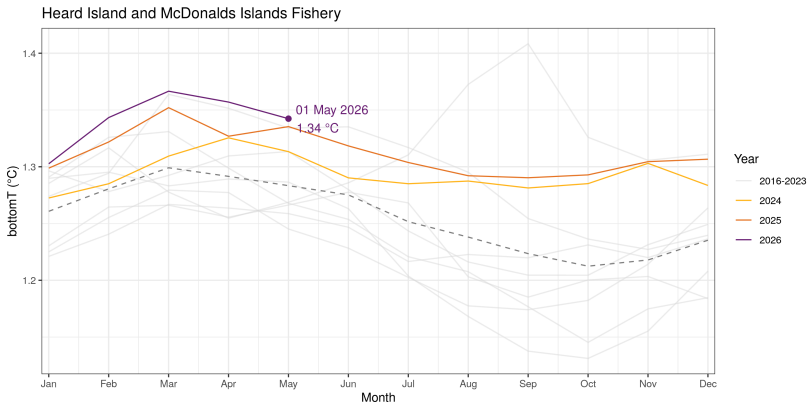


Source: CMEMS, Climatology: 1993-2016

Bi-monthly maps of bottom temperature anomalies, with the 1000 m contour shown in black. Anomalies are relative to 1993-2016. White lines are the Australian EEZ and marine park boundaries.

- The HIMI region has seen anomalously warm waters across most of the plateau over the past year[4].
- Patches of anomalously cool water can be seen on the plateau north of Heard Island.
- Low (high) temperatures can decrease (increase) toothfish catchability at a lag of ~6 months[5].

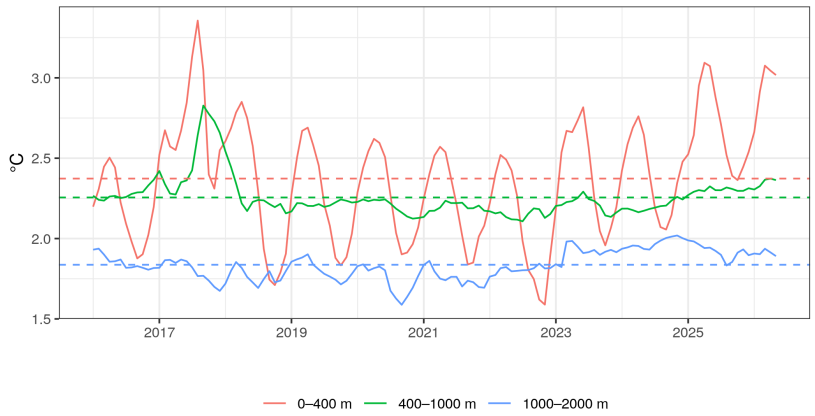
Regional Dynamics: Bottom temperature monthly timeseries



Timeseries of monthly averaged bottom temperature for example years 2016-2026[4].

- Bottom temperatures in 2026 have been the warmest in 10 years.

Regional Dynamics: Bottom Temperature Time-series



Area-averaged monthly bottom temperature of three depth bins since 2016[3]. Dashed lines are the average across years.

- Temperatures have been above average in each depth bin since 2025.
- At deeper depths (1000-2000 m), bottom temperatures have been above average since 2023.
- 2℃ is the lower preferred temperature of Patagonian toothfish at HIMI[5].

Observations

2026 observations

- Industry reported some of the highest catch rates in years.
- A high abundance of small juvenile toothfish was observed across depths and fishing grounds.
- Operations were heavily influenced by seabird limits, skate move-on rules, strong currents, and persistent poor weather.

2025 observations

- Fishing has been good, with fish found in all locations. Lots of small fish noted.
- Less sea lice than normal.
- Boats reporting the worst winter weather in a long time.
- Catches were high at start of season, but dropped off over Jun-Jul.

2024 observations

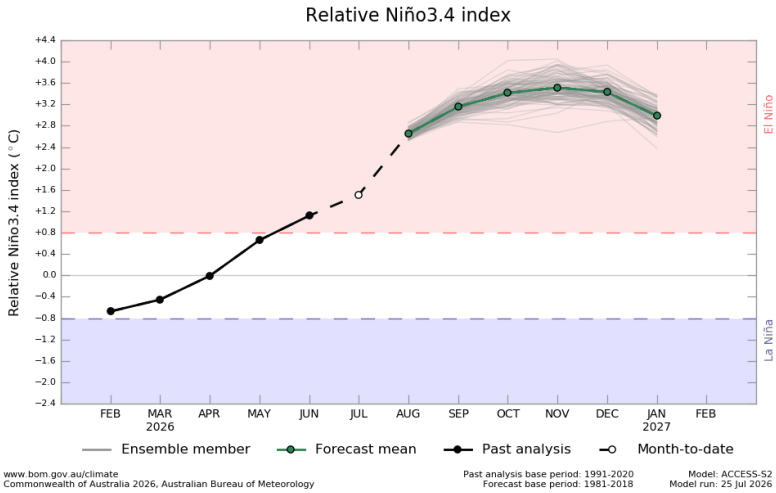
- Trips and catch rates have been standard.
- Catch sizes have been average, ranging 5-7 kg depending on the area.
- No Orcas seen; Minkes sighted; Sperm whale depredation occurred.

2023 observations

- Catches have been unremarkable, but in line with the past few years.
- Two size classes of toothfish in catches.
- Small increases in fish size compared to last year.
- Increased interference from sea lice (depredation or eating bait).
- Orcas observed and the 90-mile move-on rule worked effectively.
- Sea ice observed to clear faster this year. No obvious signed of the impact of low sea ice extent.

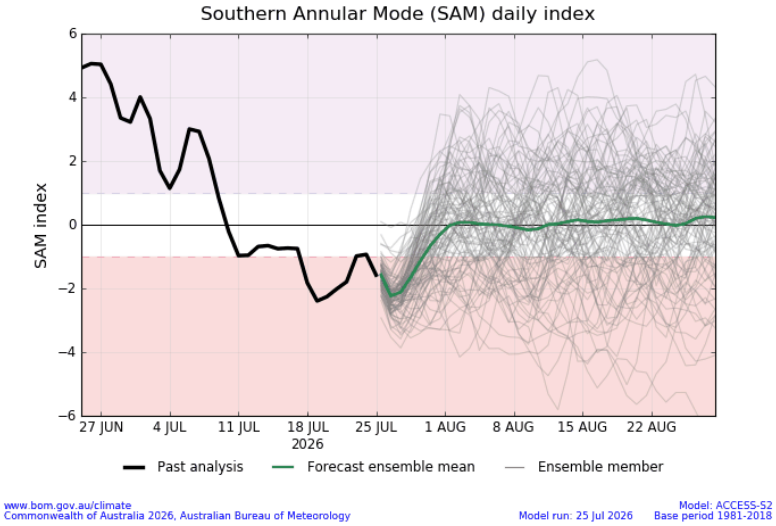
Future Outlook

Climate Drivers: Nino3.4



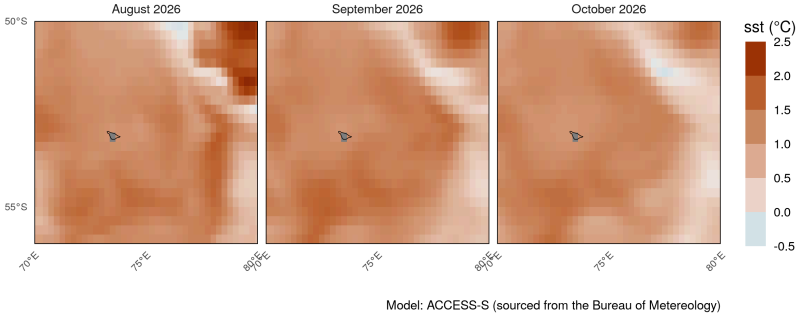
El Niño is underway, forecast to strengthen, and could be one of the strongest events on record. During El Niño, the Southern Annular Mode tends to shift to negative phases, bringing westerly winds further north (*BOM*)[6]. The direct impacts on this fishery are unclear, but El Niño conditions can elevate ocean temperatures on top of long-term warming trends.

Climate Drivers: Southern Annular Mode



SAM events tend to last 1-2 weeks, and forecasts are updated regularly. SAM has been negative and is forecast to return to neutral conditions in the next fortnight (*BOM SAM*)[7].

Regional Dynamics: SST Anomaly



Forecasts of SST anomalies for the next three months indicate anomalously warm conditions across the region (*BOM*)[8]. Forecasts are updated regularly.

Sources:

(1) https://pulse.climate.copernicus.eu/.

(2) http://www.bom.gov.au/climate/sam/

(3) Williams et al., (2025). https://doi.org/10.1111/gcb.70549.

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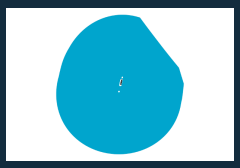
(5) https://www.frdc.com.au/project/2019-169

(6) http://www.bom.gov.au/climate/ocean/outlooks/?index=nino34

(7) http://www.bom.gov.au/climate/sam/

(8) https://access-s.clide.cloud/

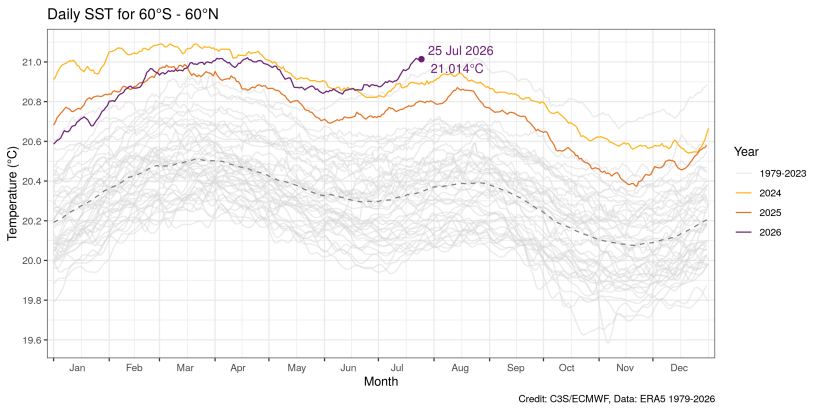
Macquarie Island Toothfish Fishery



July 29, 2026

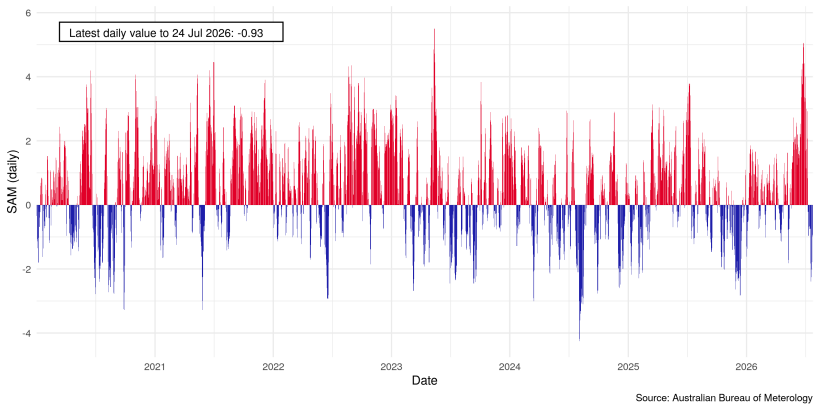
Historical Period

Climate Drivers: Sea Surface Temperature (SST)



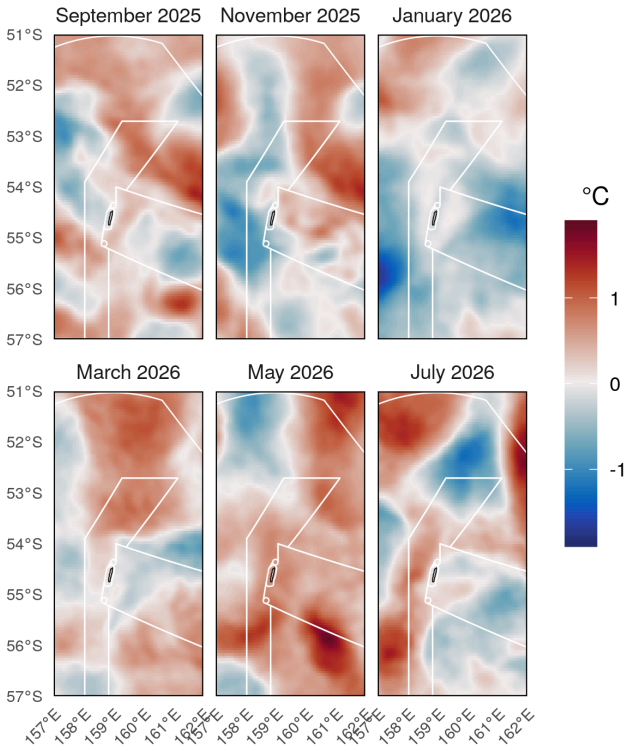
Global Sea Surface Temperatures (SST) are at record highs in 2026 (*Copernicus*)[1].

Climate Drivers: Southern Annular Mode (SAM)



Southern Annular Mode (SAM) indicates the N-S movement of westerly winds in the mid-high latitudes. Positive SAM events (westerlies move poleward) have become more common over time, resulting in stronger winds[2] (*BOM SAM*).

Regional Dynamics: SST Anomaly

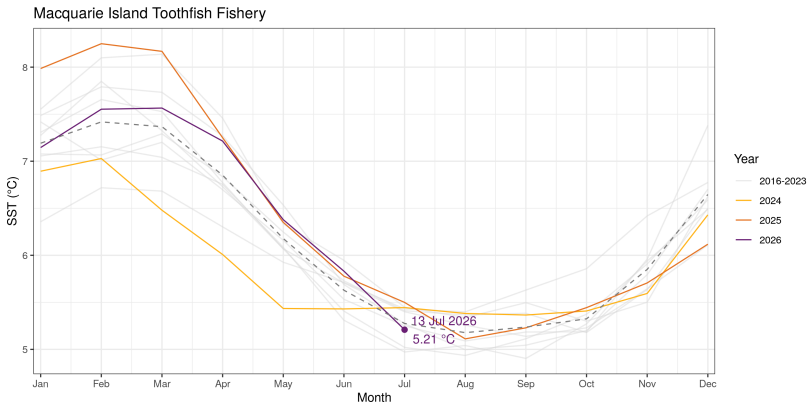


Source: CMEMS, Climatology: 1981-2022

Bi-monthly maps of SST anomalies[3]. Anomalies are relative to 1993-2016. White lines are the Australian EEZ and marine park boundaries.

- Surface waters are dynamic, with temperatures alternating between being cooler and warmer than average between months.
- SST can influence the presence of toothfish at HIMI but this relationship is unkown at Macquarie Island[4].

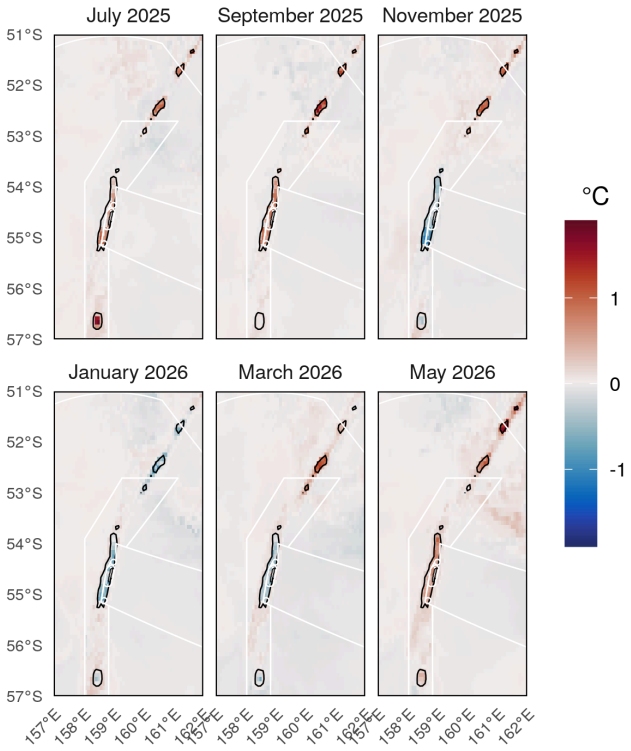
Regional Dynamics: SST monthly timeseries



Timeseries of monthly averaged SST for example years 2016-2026[3].

- Average surface temperatures in 2026 have been within the range of the last 10 years.

Regional Dynamics: Modelled Bottom Temperature Anomaly

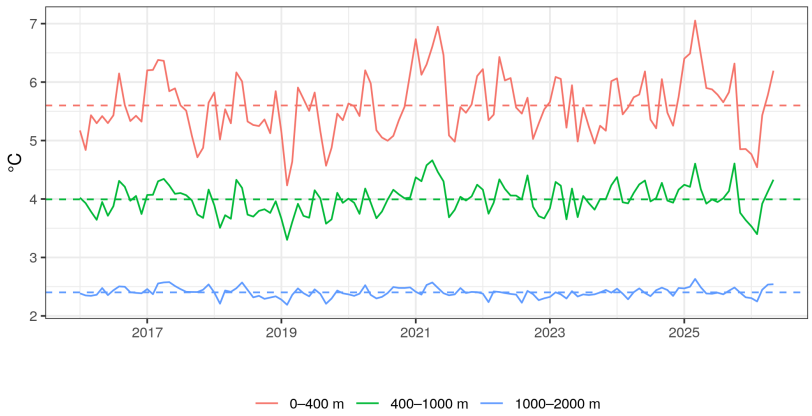


Source: CMEMS, Climatology: 1993-2016

Bi-monthly maps of bottom temperature anomalies, with the 1000 m contour shown in black[3]. Anomalies are relative to 1993-2016. White lines are the Australian EEZ and marine park boundaries.

- Shallow (<1000 m) northern areas have remained warmer than average for most of the year
- Bottom temperatures near Macquarie island were cooler than average during Nov-March.
- Low (high) temperatures can decrease (increase) toothfish catchability at a lag of ~6 months at HIMI, but this relationship is less clear at Macquarie Island[5].

Regional Dynamics: Bottom Temperature Time-series



Area-averaged monthly bottom temperature of three depth bins since 2016[3]. Dashed lines are the average across years.

- Across all depths, temperatures fell below average at the end of 2025 through early 2026. This trend is largely driven by shallow areas around Macquarie Island.
- Temperatures at all depths have been steadily rising in 2026, and are currently within range of historical observations.
- 2°C is the lower preferred temperature of Patagonian toothfish[5].

Observations

2026 observations

- SST at the start of the season was unusually warm but returned to normal by mid-June.
- More consistent bad weather and very strong currents. Currents south of Bishop pulled largest floats under water, which has never happened before.
- Fishing in the north had consistent catches, while catches in the south were lower and consisted of large numbers of small fish.

2025 observations

- Slow start to the season but catches improved.
- Good catches in areas that hadn't been fished previously.
- One occurrence of sperm whale depredation.
- Boats reporting the worst winter weather in a long time.

2024 observations

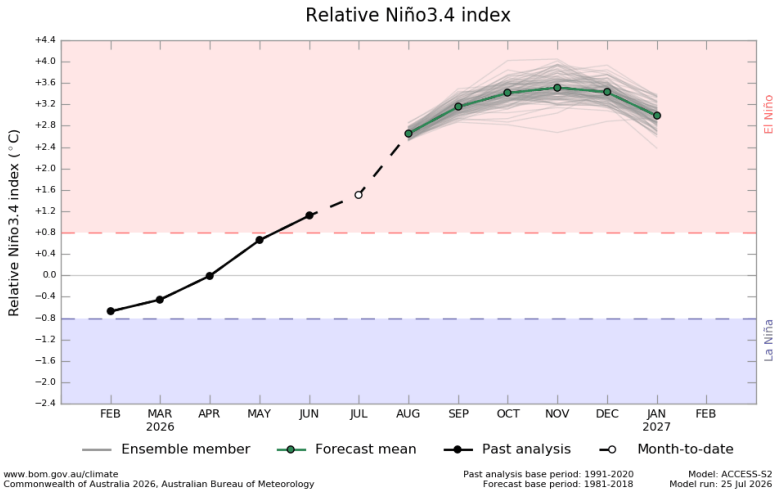
- None recorded.

2023 observations

- Initial fishing efforts finding good sized fish.
- No obvious signs of the impact of low sea ice extent.
- The interaction and location of currents in this region are of interest, and a better indicator of ecosystem and fishing conditions compared to sea ice extent.

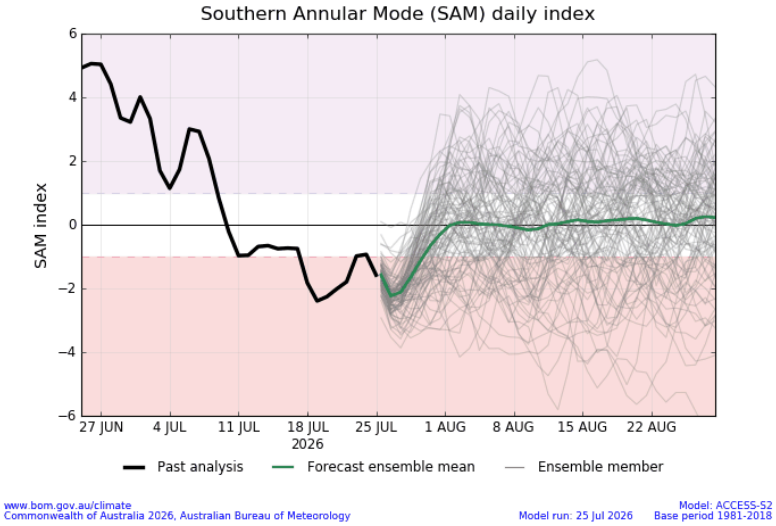
Future Outlook

Climate Drivers: Nino3.4



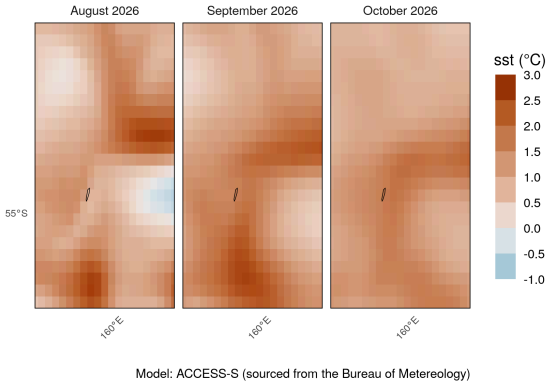
El Niño is underway, forecast to strengthen, and could be one of the strongest events on record. During El Niño, the Southern Annular Mode tends to shift to negative phases, bringing westerly winds further north (*BOM*)[6]. The direct impacts on this fishery are unclear, but El Niño conditions can elevate ocean temperatures on top of long-term warming trends.

Climate Drivers: Southern Annular Mode



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Regional Dynamics: SST Anomaly



Model: ACCESS-S (sourced from the Bureau of Metereology)

Forecasts of SST anomalies for the next three months indicate anomalously warm conditions across the region (*BOM*)[8]. Forecasts are updated regularly.

Sources:

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(3) Copernicus Marine Service.

(4) Williams et al., (2025). https://doi.org/10.1111/gcb.70549.

(5) https://www.frdc.com.au/project/2019-169

(6) http://www.bom.gov.au/climate/ocean/outlooks/?index=nino34

(7) http://www.bom.gov.au/climate/sam/

(8) https://access-s.clide.cloud/

Results from the 2026 random stratified trawl survey in the waters surrounding Heard Island in Division 58.5.2

Dale Maschette[1,2], Tim Lamb[1], Cara Masere[1], Philippe Ziegler[1].

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[2] Fisheries and Aquaculture Centre, Institute for Marine and Antarctic Studies (IMAS), University of Tasmania, 20 Castray Esplanade, Battery Point, Tasmania 7001, Australia

Abstract

During March 2026, the annual random stratified trawl survey (RSTS) around Heard Island and McDonald Islands (HIMI) was conducted in CCAMLR Division 58.5.2, with the completion of 165 stations. The survey was conducted on the *FV Cape Arkona*. Sampling protocols such as the design and the duration of the hauls were similar to recent surveys, but with a new set of randomly selected haul stations. The catch of Patagonian toothfish (*Dissostichus eleginoides*) was 63.9 t. The catch of mackerel icefish (*Champsocephalus gunnari*) was 5 t. Biomass estimates for most of the managed by-catch species were similar to the survey averages in recent years. Length and weight measurements were taken for 13,990 fish.

Introduction

The fisheries for Patagonian toothfish (*Dissostichus eleginoides*) and mackerel icefish (*Champsocephalus gunnari*) have been operating since 1997 in the Australian Fishing Zone around the Australian territory of Heard Island and McDonald Islands (HIMI) in Division 58.5.2. The fisheries started as trawl fisheries, and added longline gears in 2003 for *D. eleginoides*. Changes in the fishery for *D. eleginoides* have seen an increase in the number of longline vessels and from 2015 a phasing out of trawling.
In each year since 1997, a random stratified trawl survey (RSTS) has been conducted to assess the abundance and biology of fish and invertebrate species. The survey provides information for input into the stock assessments for the two target species, *D. eleginoides* and *C. gunnari*. Surveys have been conducted as consistently as possible each year to ensure a continuous data time series from the fisheries. In addition, RSTS data is used within bycatch assessment models.

The random stratified trawl surveys have two principal long-term aims, namely 1) to assess the abundance of juvenile and adult *D. eleginoides* on the shallow and deep parts of the

Heard Island Plateau (300 to 1000m); and 2) to assess the abundance of *C. gunnari* on the Heard Island Plateau.

For the annual survey, the area of the plateau down to 1000 m was divided into ten strata, each covering an area of similar depth and/or abundance of target species. Although the number and boundaries of strata have been adjusted over the years, they have been consistent since 2002 (Welsford *et al.* 2006). Prior to this, surveys were focused on sampling icefish habitat (1997 and 1998) and toothfish habitat (1999), and are included in the relevant assessments. From 2000, the surveys were designed to sample both toothfish and icefish populations in waters to a depth of 1000 m, although in 2000 and 2003 some of the strata in deeper waters were not sampled. Since a review of the survey design in 2003 (Candy *et al.* 2004), a minimum of 10 stations have been sampled in each of nine strata. The tenth stratum, Shell Bank, is closed to fishing but has been occasionally included in the survey, the two most recent surveys being 2005 and 2014. The sampling regime has been stable, with the same number of hauls in each stratum between 2006 and 2014. From 2015 onwards, an additional 5 hauls were included in the Ground B stratum. This report presents the outcomes of the survey for 2026.

Methods

Survey design

The target species for six strata in the survey area was *D. eleginoides*, while both *D. eleginoides* and *C. gunnari* were targeted together in the remaining three strata (Table 1). The survey strata boundaries and the number of stations chosen for sampling in eight strata has remained the same since the 2006 survey (Nowara et al. 2006). The sampling strategy for the ninth stratum, Ground B, was changed in 2015 to make it more consistent with that of the rest of the survey. Prior to the 2015 survey the ground was divided into 29 squares and a subset of 20 were sampled with one haul in each. From 2015, the ground was stratified into two areas with randomly allocated stations, 15 in the first area and 10 in the second. Thus, there were 5 more stations added to the total hauls in this stratum. As in previous surveys, unique random starting locations and headings for each trawl station were selected, with variable station numbers per strata (Table 1).
A set of starting position co-ordinates and headings for each station in each stratum was provided to the fishing vessel conducting the survey, including first choice and reserve positions. If it was not possible to trawl at one of the first choice locations due to unsuitable bottom conditions, the first suitable station on the reserve list for that stratum was chosen instead. If weather conditions made it difficult to follow the prescribed heading, the tow was made in the reverse direction, terminating approximately at the nominated starting point.

Table 1: Allocation of stations to strata and time of day for sampling of principal species for the survey.

Stratum	Name	Number of stations	Principal species	Time of day for sampling
1	Plateau Southeast	30	Toothfish, Icefish	Daytime only
2	Gunnari Ridge	18	Toothfish, Icefish	Daytime only
3	Plateau West	10	Toothfish, Icefish	Daytime only
4	Plateau North	15	Toothfish	Any time of day
5	Plateau Deep Northeast	15	Toothfish	Any time of day
6	Plateau Deep East	30	Toothfish	Any time of day
7	Plateau Deep Southeast	10	Toothfish	Any time of day
8	Plateau Deep West	10	Toothfish	Any time of day
9	Ground B	25	Toothfish	Any time of day

Vessel and gear specifications

The annual survey was conducted aboard the *FV Cape Arkona* (Table 2). The same Champion trawl net was used as in previous years (Table 3) which included a small mesh (50 mm) codend liner, designed to retain small organisms.

Table 2: Vessel specifications for the Cape Arkona. Source: CCAMLR

Vessel specifications	
Year built	2018
Length	66.9 m
Beam	15.0 m
Engine power	3075 kW
Gross tonnage	2954 t
Carrying capacity	600 t
Fish hold capacity	1270 m3

Table 3: Champion trawl net specifications.

Net specifications	
Headrope length	38.5 m
Groundrope length	45 m (18.1 m rig)
Bobbin diameter	55 cm
Horizontal opening	23.5 m
Vertical opening	3.8 m
Belly mesh size	152 mm
No. meshes in belly	480
Throat mesh size	120 mm
Codend mesh size	90 mm (50 mm liner)
Codend mesh orientation	diamond
Trawl board type	Mobydick
Trawl board weight	3000 kg
Trawl board to wing length	150 m

Trawling procedure

Each survey trawl was of approximately 30 minutes duration on the bottom at a towing speed of 3 knots. For strata 1-3, which targeted *C. gunnari* as well as *D. eleginoides*, tows were conducted only between sunrise and sunset when icefish are concentrated near the bottom (van Wijk et al. 2001). Strata designed to target *D. eleginoides* only (strata 4-9, Table 1) were sampled throughout the day.
The survey design required all tows within a particular stratum to be completed within as short a time frame as possible. In two of the icefish strata Gunnari Ridge and Plateau Southeast sampling was required to take place without large delays in between, in case there was movement of icefish between these strata. All shots were conducted as far as possible within the specifications for towing speed and gear configuration. Under the circumstances where a shot had to be aborted, it was counted as valid as long as 15 minutes of fishing time was completed. Otherwise, the shot was repeated at the same or a reserve location, depending on the reason for abandoning the shot. Tow distance was calculated as the shortest distance between start and finish positions of the trawl established by GPS. A standard effective net opening of 19 m was applied to the tow distance to calculate swept area. Estimates of headline height of 7 m and wingspread of 19 m during normal fishing operations were provided by the skipper.

Catch and biological sampling

The catch was recorded separately for each haul. Start and end time, geographical location and depth at the start and end of each haul were recorded in the database. The catch was first sorted into species/taxon groups, then weighed and sampled for biological measurements. For catches of less than 400 kg of each target fish species (*C. gunnari* and *D. eleginoides*) as well as for grey rockcod (*Lepidonotothen squamifrons*) and unicorn icefish (*Channichthys rhinoceratus*), the entire catch was weighed. If the catch was greater than 400 kg, the skipper's estimate and the weight from factory production were recorded.
Length measurements were taken from a random sub-sample of fish (numbers dependent on the species and availability) on an electronic measuring board and biological measurements from a smaller sample. For *C. gunnari*, *D. eleginoides*, *L. squamifrons* and *C. rhinoceratus*, up to 200 individuals of each species were measured for each haul. For *Bathyraja spp.*, up to 50 individual length measurements were taken. Numbers and weights of any other species of by-catch were recorded and similar measurements were taken for benthos where practical.
For each haul, biological measurements were taken from a random sample of up to 50 of each of the four main species of fish and from skates. Measurements recorded were individual weight, standard length and total length (TL), sex, and gonad stage. Otoliths were collected from *D. eleginoides* and some of the fish by-catch species which had biological measurements taken.

Tagging

Dissostichus eleginoides were tagged with two T-bar tags (Hallprint). As biological sampling was the first priority, fish were tagged only if time permitted.

Biomass estimates

Total biomass estimates of the targeted and main by-catch fish and skate species in the survey area were calculated by summing each stratum biomass, based on the mean densities calculated from all hauls in a stratum. A stratified non-parametric bootstrap was used to estimate uncertainty (95% confidence intervals) from resampling the haul data.
Biomass of Macrourus for 2021 was re-estimated after detecting an error in the relevant database holdings.

RESULTS AND DISCUSSION

Survey coverage

A total of 165 valid stations were completed for the survey between the 1st of March and 27th of March (Table 4).

Table 4: Dates and number of planned and completed hauls for each stratum in the survey.

Stratum	Start Date	End Date	Area (km2)	No hauls allocated	No hauls completed	No valid hauls
Plateau Southeast	14-Mar	20-Mar	10,404	30	30	30
Gunnari Ridge	19-Mar	21-Mar	521	18	18	18
Plateau West	12-Mar	15-Mar	10,440	10	11	10
Plateau North	06-Mar	11-Mar	15,170	15	15	15
Plateau Deep Northeast	05-Mar	08-Mar	15,090	15	15	15
Plateau Deep East	01-Mar	05-Mar	13,120	30	30	30
Plateau Deep Southeast	26-Mar	27-Mar	5,340	10	10	10
Plateau Deep West	10-Mar	12-Mar	13,370	10	10	10
Ground B	21-Mar	25-Mar	481	25	26	25
All Strata	01-Mar	27-Mar	83,936	163	165	163

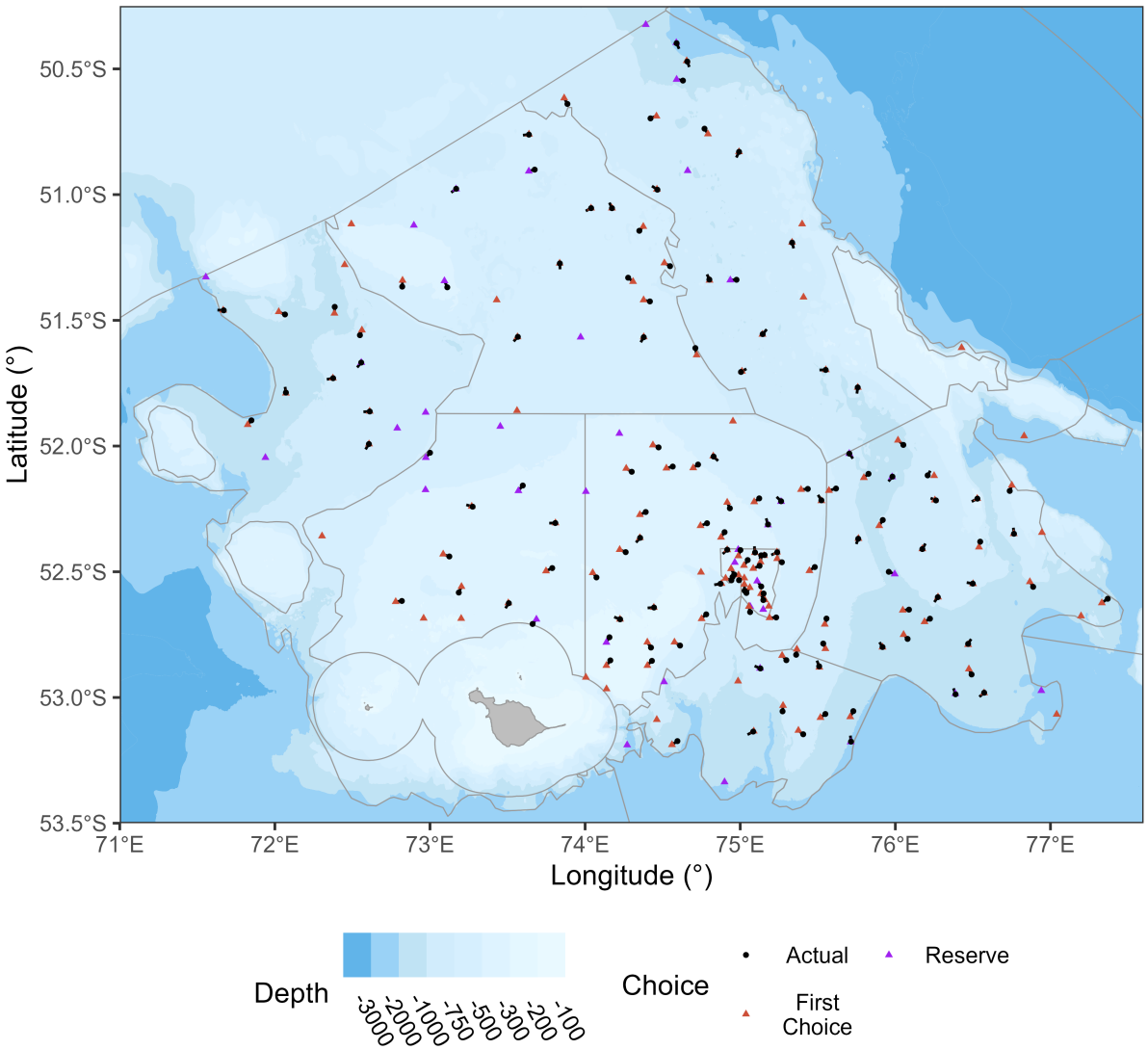


Figure 2: The distribution of sampling hauls within strata for the survey. Hauls on the main trawling ground (Ground B) are not shown.

Catch

The most abundant fish caught during the survey was *D. eleginoides*, with 63.9 t primarily caught on Ground B. A total of 5 t of *C. gunnari*, were caught, primarily from Gunnari Ridge (Table 5). The catches of managed by-catch species were dominated by *C. rhinoceratus*, *L. squamifrons*, *B. eatonii*, and *Macrourus caml* (Table 5). The most abundant invertebrate group in the catch were cephalopods, but anemones, sponges, and seastars, were also well represented in the catch. The catch of *C. rhinoceratus*, *L. squamifrons*, *Macrourus spp.* and *Bathyraja spp.* were lower than the respective survey averages of the last five years.

Table 5: Catches of main taxa (kg) in the 2021 to 2026 surveys.

Taxon	2021	2022	2023	2024	2025	2026
Target species						
D. eleginoides	77,936	36,192	66,801	86,322	69,902	63,857
C. gunnari	35,665	71,027	16,014	25,630	23,844	4,970
Managed by-catch species						
C. rhinoceratus	8,313	5,435	7,012	5,843	5,195	1,945
L. squamifrons	3,370	3,042	2,000	4,436	356	441
Macrourus spp.	961	659	649	661	466	516
Bathyraja spp.	1,871	1,954	1,505	1,656	1,924	1,072
Other Fish						
Other bony fish	526	419	474	737	680	526
Other elasmobranchs	72	46	97	241	33	208
Invertebrates						
Crustaceans	25	28	20	35	29	27
Molluscs	5	2	71	2	3	1
Cephalopods	69	58	73	77	38	50
Jellyfish	16					
Other invertebrates	4,939	2,250	5,427	3,479	2,763	2,382

Biomass estimates

Mean biomass estimates from the surveys for the last 15 years for *C. gunnari* have ranged from approximately 1,400 to 53,000 t, with 2026 being almost 4,800 t (Figure 2). At just over 31,300 tonnes, the mean biomass estimate for *D. eleginoides* in 2026 was slightly higher than in the previous year.
Among the managed bycatch species, the biomass estimates for *C. rhinoceratus* showed a decrease in biomass whilst *Macrourus* spp. showed a slight increase (Figure 3). Biomass estimates of *L. squamifrons* were similar to 2025. The estimated biomass for the *Bathyraja* species were lower than last year (Figure 4).

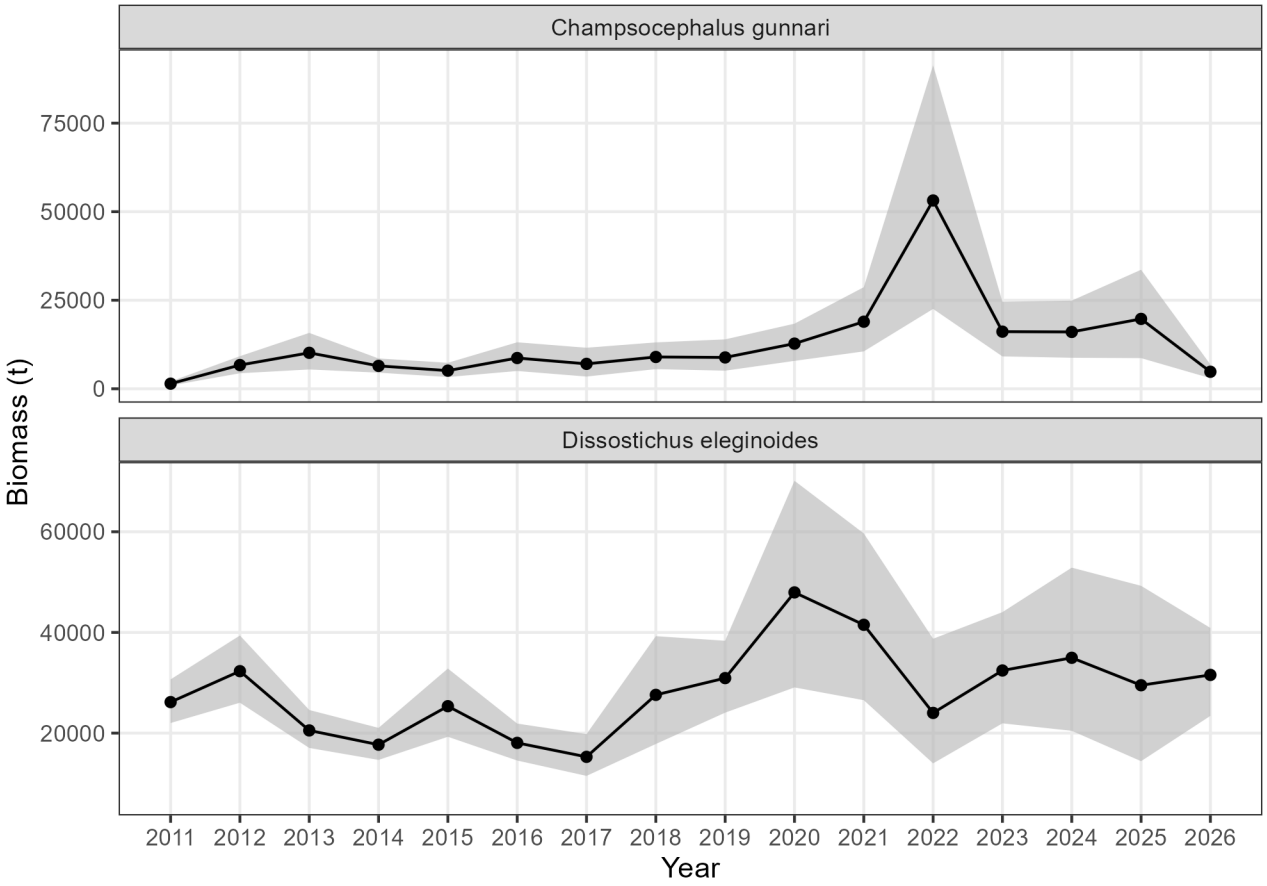


Figure 2: Biomass estimates (tonnes, mean and 95% CIs) for target fish species for the last 15 surveys.

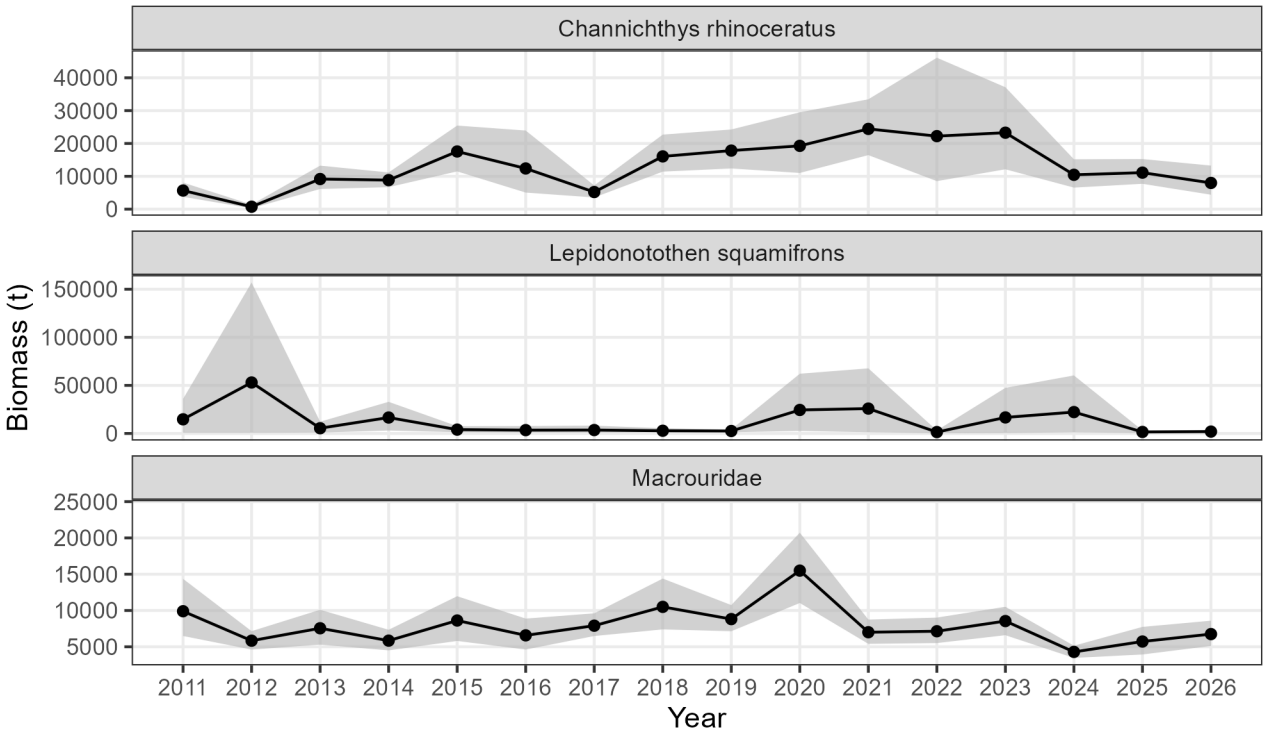


Figure 3: Biomass estimates (tonnes, mean and 95% CIs) for managed fish by-catch species for the last 15 surveys.

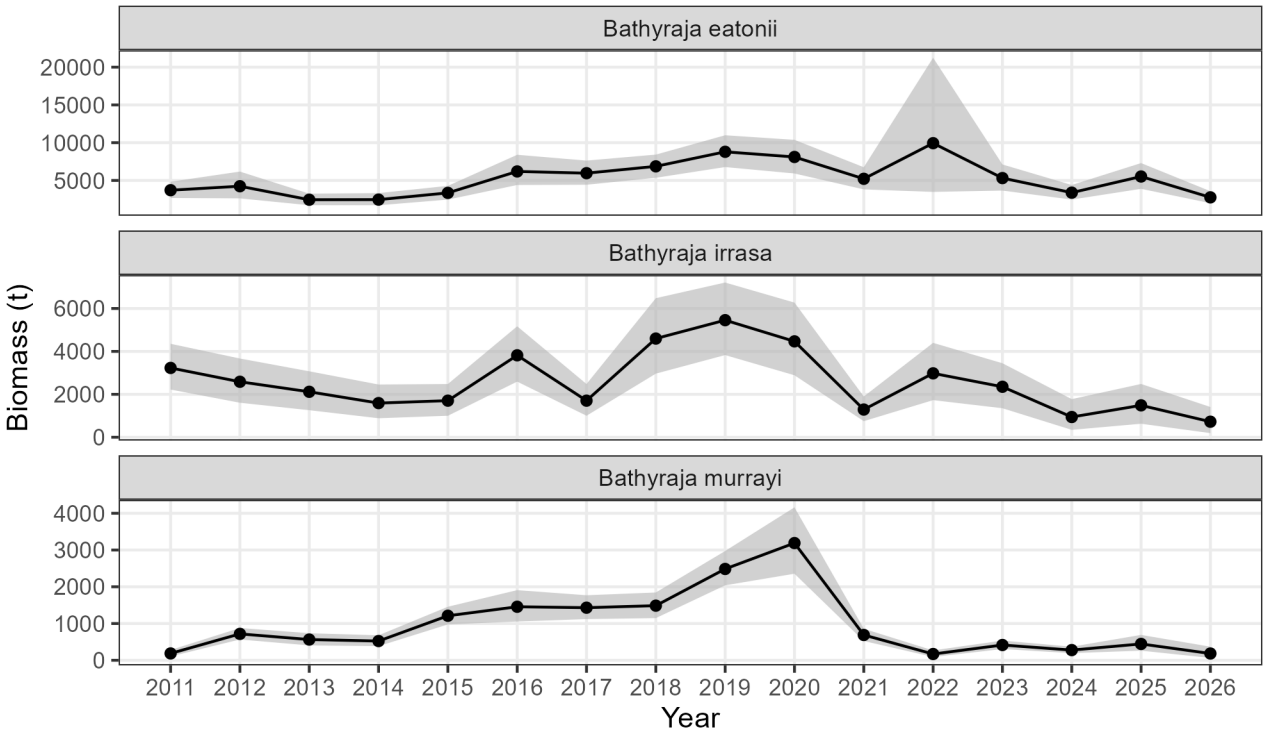


Figure 4: Biomass estimates (tonnes, mean and 95% CIs) for skate species for the last 15 surveys.

Biological data

A total of 13,990 fish were measured during the 2026 survey (Table 6). Otoliths were taken from 3 species, namely *Dissostichus eleginoides*, *Lepidonotothen squamifrons*, and *Macrourus caml*. A small number of *Bathyraja maccaini* were identified this year. This seems unusual, and further work is planned to confirm these identifications.

Table 6: Number of length measurements and otoliths taken by species in the survey.

Species	Lengths	Otoliths
Fish		
Dissostichus eleginoides	4,811	1,128
Champsocephalus gunnari	2,892	0
Channichthys rhinoceratus	2,270	0
Macrourus caml	1,780	33
Lepidonotothen squamifrons	1,077	264
Gobionotothen acuta	308	0
Antimora rostrata	178	0
Muraenolepis sp.	165	0
Lindbergichthys mizops	84	0
Macrourus holotrachys	60	0
Zanclorhynchus spinifer	35	0
Paradiplospinus gracilis	20	0
Macrourus whitsoni	16	0
Macrourus carinatus	12	0
Mancopsetta maculata	10	0
Cynomacrurus piriei	9	0
Notothenia rossii	6	0
Rajiformes	6	0
Notolepis coatsi	5	0
Bathydraco antarcticus	5	0
Amblyraja georgiana	3	0
Nansenia antarctica	1	0
Skates		
Bathyraja eatonii	158	0

Table 6: Number of length measurements and otoliths taken by species in the survey.

Species	Lengths	Otoliths
Bathyraja murrayi	50	0
Bathyraja irrasa	15	0
Bathyraja maccaini	13	0
Bathyraja sp.	1	0
Total	13,990	1,425

The sex of 10,132 fish was recorded (Table 7, for species where >10 were seen in the survey) and gonad maturity examined for most of these (Table 8). Gonad maturity of bony fish was assessed on a scale of 1-6 and skates 1-3, with mature gonads represented in both fish and skates by stage 3. Most fish were found to be immature. The majority of female and male *D. eleginoides* were found to be at stage 1 and 2. Most *C. gunnari*, *C. rhinoceratus*, *L. squamifrons* and *M. caml* were found at stages 1 to 3, however all were seen showing later stages. *Bathyraja spp.*, were found in all 3 stages, with the majority being immature.

Table 7: Number of each sex identified for species where >10 were seen in the survey. F = female, M = male, J = Juvenile, U = unable to be determined

Species	F	M	J/U	Total
Fish				
Dissostichus eleginoides	2,286	2,291		4,577
Macrourus caml	918	574	19	1,511
Champsocephalus gunnari	987	505		1,492
Channichthys rhinoceratus	970	389	7	1,366
Lepidonotothen squamifrons	345	268	22	635
Muraenolepis sp.	91	7		98
Gobionotothen acuta	91	5		96
Antimora rostrata	71	1		72
Macrourus holotrachys	15	6		21
Skates				
Bathyraja eatonii	68	90		158
Bathyraja murrayi	23	20	1	44
Bathyraja irrasa	8	6		14
Bathyraja maccaini	5	8		13
Total	5,878	4,170	49	10,097

Table 8: Maturity stage (by sex) found in species where >20 individuals were examined for gonad maturity in the survey. Stage 3 represent mature gonads (blue numbers) in scales for both fish and skates.

	Females							Males						
		Stage							Stage					
Species	N	1	2	3	4	5	6	N	1	2	3	4	5	6
Fish[1]														
Dissostichus eleginoides	2,286	1,936	347					2,291	1,517	770	1			
Macrourus caml	918	430	271	186	31			574	253	110	172	36	3	
Champsocephalus gunnari	987	146	544	286	11			505	232	215	56	2		
Channichthys rhinoceratus	970	79	387	232	263	9		389	63	169	137	20		
Lepidonotothen squamifrons	345	133	155	36	10			268	162	69	18			
Muraenolepis sp.	91	15	27	47	2			7	3	4				
Gobionotothen acuta	91	11	65	15				5	1	4				
Antimora rostrata	71	52	19					1	1					
Macrourus holotrachys	15	6	9					6	6					
Skates[2]														
Bathyraja eatonii	68	5	3	1				90	18	24	47			
Bathyraja murrayi	23	9						20	14	3	3			

1: Maturity scale for fish: 1 Immature, 2 Maturing or resting, 3 Developing, 4 Gravid (females) or Ripe (males), 5 Spent, 6 Resting

2: Maturity scale for skates: 1 Immature, 2 Maturing, 3 Mature

Tagging

A total of 131 *D. eleginoides* were tagged during the survey in 2026, distributed across survey strata.

ACKNOWLEDGEMENTS

We are grateful to Austral Fisheries and Australian Longline for providing research support necessary to undertake this survey at sea, to the observers, Monique Kahya (AFMA) and Marius Kapp (CapMarine).

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A preliminary assessment for mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on results from the 2026 random stratified trawl survey.

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Recommendations

We recommend the catch limits in Conservation Measure 42-02 be set at 130 t in the 2026/27 season and 112 t in the 2027/28 season.

Abstract

The annual random stratified trawl survey was undertaken in Division 58.5.2 in the vicinity of Heard Island and McDonald Islands during March 2026. Based on data from this survey, this paper provides a preliminary assessment for mackerel icefish (*Champsocephalus gunnari*) population structure, abundance and yield in Division 58.5.2 using standard CCAMLR methods (CMIX and Grym).

The 2026 survey indicated relatively small abundances of 1 to 3-year old icefish. The 4+ cohort accounted for 69.7% of the population biomass, but is not used in the projections to estimate catch limits. Based on the Grym implementation, catches of 130 t in the 2026/27 season and 112 t in the 2027/28 season satisfy the CCAMLR decision rules.

Introduction

The fishery for mackerel icefish (*Champsocephalus gunnari)* around Heard Island and McDonald Islands in Division 58.5.2 began in 1997 (CCAMLR 2020). A random stratified trawl survey (RSTS) has been undertaken each year on the shallow plateau (<1000 m) in Division 58.5.2 to collect data on the distribution, abundance and population structure of Patagonian toothfish, mackerel icefish and other species.

Prior to 2011, the population of mackerel icefish in Division 58.5.2 generally exhibited one or two cohorts which dominated in abundance and biomass, and these were separated in age by one or two years (Welsford 2010, Welsford 2015, Williams *et al.* 2001). Since the maximum age of mackerel icefish in this region is thought to be around five years, strong cohorts have resulted in large variation of population abundance and the amount of production available to the fishery (SC-CAMLR 2010). However, between 2011 and 2016 at least four and often five cohorts were apparent in the population simultaneously, with no single cohort being overwhelmingly dominant (Maschette & Welsford 2019). Since 2016 there have been at least four cohorts present with normally the 2+ and 3+ being cohorts being the largest (Maschette & Welsford 2019, Appendix A Figure A.3).

This study provides an analysis of data collected in the 2026 survey to estimate the current abundance and cohort structure in the mackerel icefish population in Division 58.5.2 and its implications for yields in the fishery for the 2026/27 and 2027/28 seasons.

Methods

2026 survey

The design of the survey conducted in 2026 used the same principles as previous surveys in Division 58.5.2 (Maschette *et al.* 2026). The three strata where mackerel icefish are abundant (Gunnari Ridge, Plateau West and Plateau Southeast) were surveyed in daylight when icefish are close to the seafloor and most effectively sampled by demersal trawls (van Wijk *et al.* 2001). Survey hauls were allocated at random within each stratum, however a minimum spacing of 5 nautical miles between survey stations was specified to ensure hauls would not overlap. Icefish density estimates per haul ranged from 0 – 15.8 tons per km^2. Survey diagnostic information as outlined in Maschette *et al.* (2018) and endorsed by WG-SAM-18 (para. 3.11) are presented in Appendix A.

Assessment methods

The assessment method followed those agreed by SC-CAMLR (SC-CAMLR-XVI, para 5.70) for assessing yield in mackerel icefish, as published by de la Mare *et al.* (1998), and is identical to that used to estimate yields for mackerel icefish in Division 58.5.2 in previous years. Recent work undertaken as part of the krill management strategy (SC-CAMLR-38 Table 1, para 3.34) re-implementing the Generalized Yield Model (GYM) software in an open source software has resulted in the R package 'Grym' (Wotherspoon & Maschette 2020). Briefly, the Grym implements the same projections as the GYM software but uses an explicit solution with the composite trapezoidal quadrature rule rather than an adaptive Runge Kutta method, resulting in a more accurate projection (Maschette *et al.* 2020).

Assessment diagnostic information as outlined in Maschette *et al.* (2018) and endorsed by WG-SAM-18 (para. 3.11) are presented in Appendix B.

Cohort structure

A mixture analysis was undertaken using the CMIX procedure (de la Mare 1994, de la Mare *et al.* 2002) to estimate the density of fish in each age class. The contribution of each age class to the overall biomass was estimated by scaling each age class by its mean weight at length. The survey data were pooled to a single survey data set. As in previous years the sampling effort across strata was un-equal and the data are re-scaled so that the mean of the re-scaled data is the same as the stratified mean of the raw data. For each haul in k strata, the density data are re-scaled by the composite sampling fraction following de la Mare & Williams (1996):

$$D_{i,j} = d_{i,j} \frac{A_i}{\sum_k A_k} \times \frac{\sum_k n_k}{n_i}$$

where $D_{i,j}$ is the re-scaled density for haul i in stratum j, $d_{i,j}$ is the original density estimate for that haul, and A_i and n_i are the area and the number of hauls in stratum i respectively.

Weight-at-length relationship

The parameters of the weight-at-length relationship, a and b were re-estimated using the *nls*() function in R (R Development Core Team 2025) to fit the relationship:

$$W=aL^b$$

where W is the weight (kg) and L is the length (mm) of individual icefish taken during the 2025 survey.

Length-at-age

Maschette *et al*. (2024) evaluated von Bertalanffy growth parameters using survey data. Here we use their estimate for the period 2018-2024 as agreed by WG-FSA-IMAF-2024 (para. 3.7). The growth function estimated $L\infty$ of 559.1 mm, growth rate K of 0.294 and t_0 of 0.066.

Maturity

For the assessment, all fish (aged 1 – 3 years) were assumed to be mature so that the status of the whole stock is taken into account when estimating yield.

Natural mortality

Natural mortality was assumed to be 0.4 (de la Mare 1998).

Survey biomass and preliminary yield estimation

Using the method described in Constable *et al.* (2005, Appendix 1), a bootstrap algorithm was implemented in R to estimate the uncertainty in the total biomass (tonnes) of mackerel icefish over the survey area (Appendix B). The lower one-sided 95% confidence bound of the biomass estimate was then used as the estimate of the standing stock at the start of the projection period.

In combination with the biological parameters and other input settings shown in Appendix B (Table 3), the Grym package in R (Wotherspoon & Maschette 2020) was used to estimate the fishing mortality and corresponding catch that satisfies the short-term decision rule, i.e. that will result in a 75% escapement relative to a two-year projection with zero fishing mortality (Figure 1).

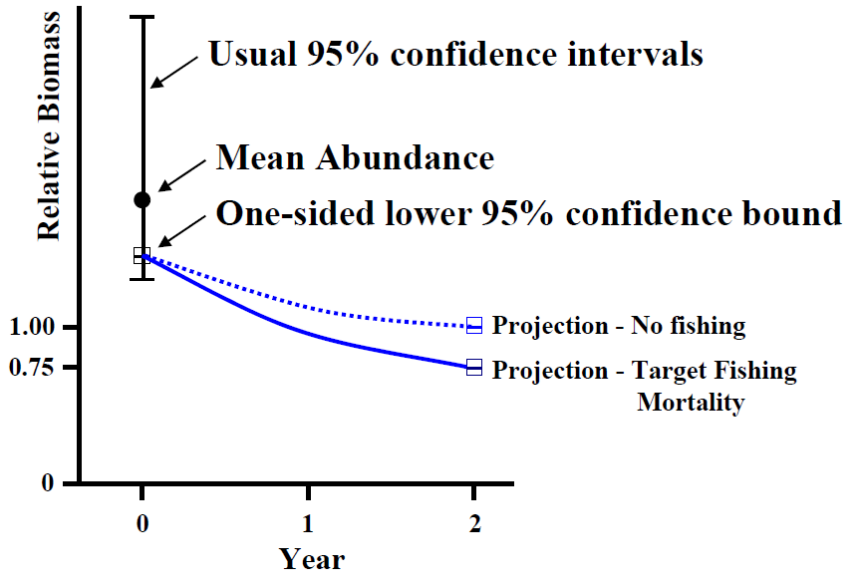


Figure 1. Decision rule for determining yield for mackerel icefish in year 1 and 2 after a survey (from Constable *et al.* 2005).

Few fish in the mackerel icefish population in Division 58.5.2 survive beyond age 4, and typically a drop in abundance between 3+ and 4+ cohorts is observed in consecutive surveys (Welsford 2011, Welsford 2015). Consequently, the assessment scenarios run here only includes the biomass estimated from the 0+ to 3+ cohorts.

Results

Cohort structure

The best CMIX fit to the survey length density data was achieved when the population was assumed to consist of four components, i.e. year classes 1+ through 4+ (Tables 1 and Appendix B). A substantial 4+ cohort dominated the 2026 survey (Figure 2). Overall fish density was estimated to be lower than last year (Table 2).

Table 1. Results of CMIX analysis of mackerel icefish from the 2026 random stratified trawl survey in Division 58.5.2.

	Mixture Components			
	1 (1+)	2 (2+)	3 (3+)	4 (4+)
Mean length (mm)	167	267	335	368
SD (mm)	12.4	14.9	16.6	17.4
Intercept of CV	8.3			
Slope of CV	0.02			
Total density (n.km^{-2})	29	185	273	612
SD (n.km^{-2})	14	37	1467	252
Sum of observed densities	1098			
Sum of expected densities	1099			

Table 2. Comparison of mean density of mackerel icefish (n.km^{-2}), and the CMIX estimate of overall and cohort density in the surveys conducted in 2024, 2025 and 2026 in Division 58.5.2. Note that the age of each year cohort increments by one year after the nominal birthdate of 1 December. For example, the 2+ cohort observed in 2025 is the same as 3+ cohort observed in 2026.

Year	Month	Overall Density		Cohort Density			
		Expected	Observed	1+	2+	3+	4+
2024	March	23155	23221	2331	20339	226	260
2025	March	4121	4156	73	494	3517	37
2026	March	1098	1099	29	185	273	612

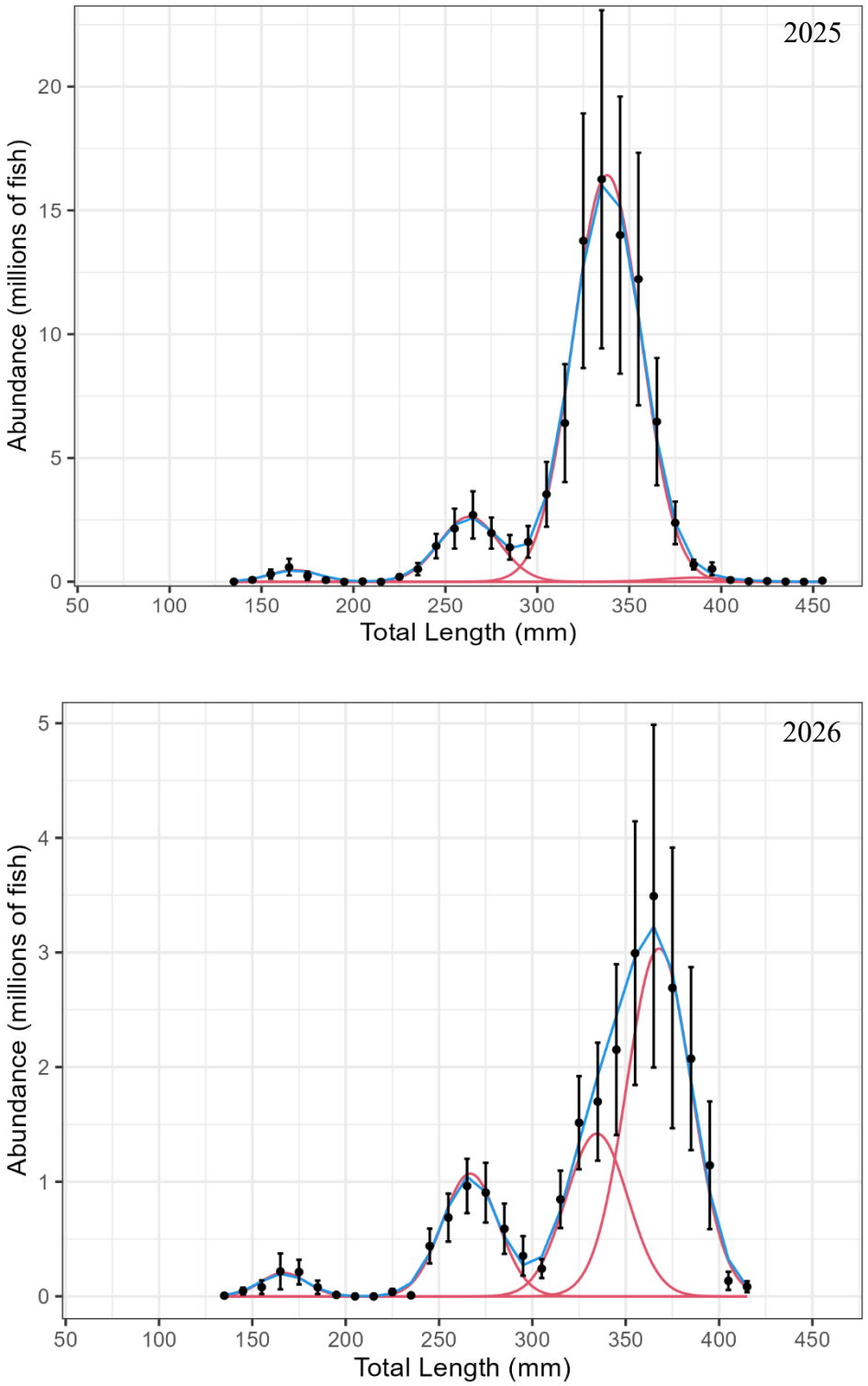


Figure 2. Observed and estimated length densities using CMIX for mackerel icefish in the surveys from March 2025 (upper panel) and March 2026 (lower panel). Shown are observed mean abundances at length (black circles, ± SE), fitted total abundances at length (blue lines), and fitted abundances at length for the different components (red lines).

Weight-at-length relationship

The weight-at-length relationship was re-estimated based on 2 748 icefish measured during the survey. The re-estimated weight-at-length relationship closely followed that of last year (Table 3, Figure 3).

Table 3. Estimates of the weight-at-length parameters of mackerel icefish fitted to data from each survey conducted in 2025 and 2026 in Division 58.5.2.

Model	Parameter	
	a	*b*
2025	2.842E-09	3.123
2026	1.002E-09	3.302

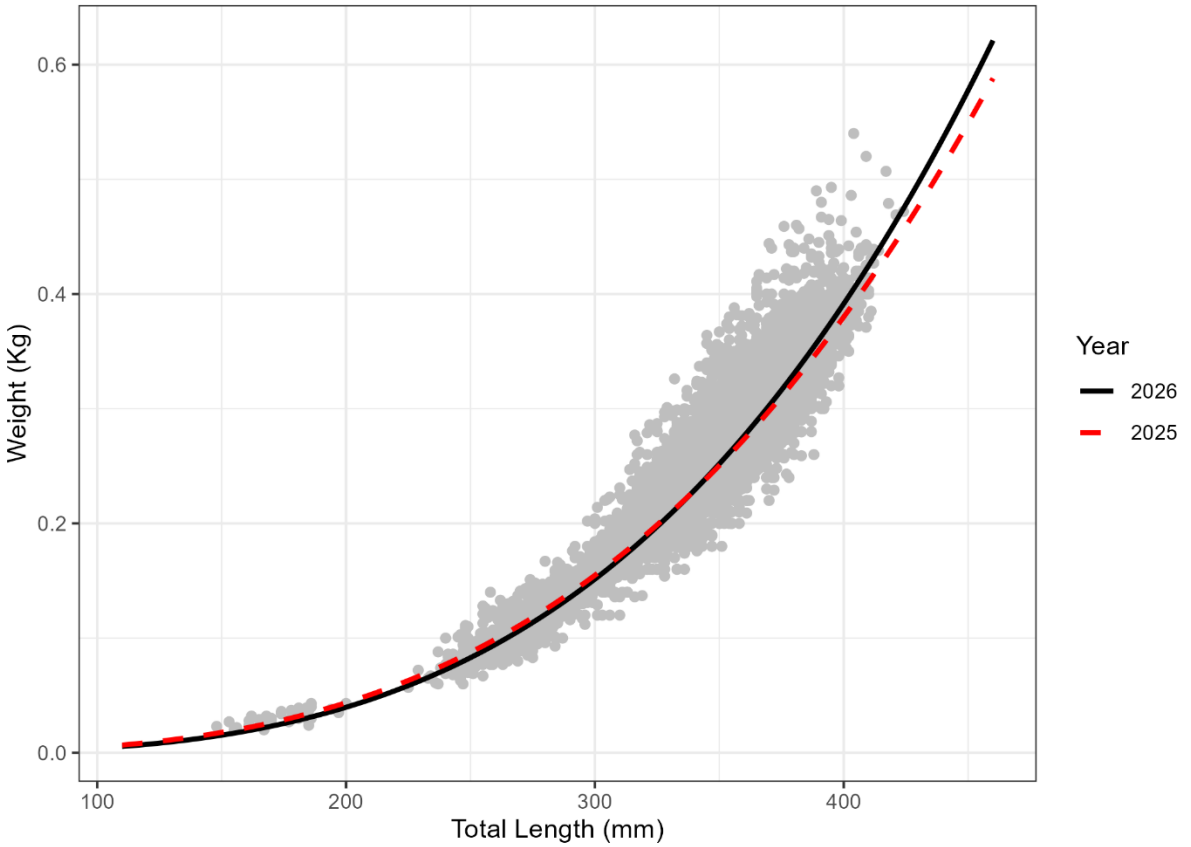


Figure 3. Weight-at-length data for mackerel icefish sampled during the 2026 random stratified trawl survey in Division 58.5.2 (grey dots) with fitted non-linear least squares regression (solid black line) and fitted regression to the 2026 survey. The 2025 survey fit is shown as a dashed red line.

Using the estimated weight-at-length relationship for 2026, the contribution of each age class to the overall biomass present during the survey was estimated, indicating that fish up to 3+ only constituted around 30.33% of the biomass present across the three icefish strata (Table 4).

Table 4. Proportion of mackerel icefish biomass at age in the 2026 random stratified trawl survey in Division 58.5.2.

Age class	Mean length (mm)	Density ($n.km^{-2}$)	Mean weight (kg)	Proportion of biomass (%)
1+	167	29	0.022	0.25
2+	267	185	0.103	7.30
3+	335	273	0.218	22.78
4+	368	612	0.297	69.67

Survey biomass and preliminary yield estimation

The biomass estimates with bootstrapped uncertainty for each icefish survey stratum and overall are shown in Table 5. The 2026 survey showed a much lower mean biomass, and lower one-sided 95% confidence interval biomass compared to 2025 (Appendix 1, Figure B.2).

Table 5. Abundance (tonnes) of mackerel icefish in Division 58.5.2 estimated by bootstrapping hauls from the 2026 random stratified trawl survey. SE = standard error; Lower CI & Upper CI = lower and upper confidence intervals respectively; LOS 95% CI = lower one-sided 95% confidence interval.

Stratum	Mean	SE	Lower CI	Upper CI	LOS 95% CI
Gunnari Ridge	2 808	799	1 364	4 381	1 577
Plateau SE	945	317	422	1 629	483
Plateau W	1 044	247	605	1 517	670
Pooled	4 797	994	2 998	6 845	3 254

The stock projection used the proportion of overall biomass made up by the 1+, 2+ and 3+ cohorts (30.33%, Table 4). This means that 987 t of the overall 3 254 t lower 95% CI (Table 5) was used in the Grym projection. A total of 419 t of icefish was caught after the survey was conducted, of which 210 t consisted of the 1+, 2+ and 3+ cohorts of the catch and was used in the forward projections. The Grym projection indicated that catches of 130 t in the 2025/26 season and 112 t in the 2026/27 season satisfy the CCAMLR decision rules (Table 6).

Table 6. Target fishing mortality rate and annual yields of mackerel icefish in Division 58.5.2, estimated to ensure 75% escapement over a 2-year projection period for the 1+, 2+ and 3+ cohorts using the Grym package, based on the parameters shown in Table B.2.

Initial biomass estimate (t)	**Target fishing mortality rate (yr^{-1})**	**Catch after survey**	**Yield (tonnes)**	
			2026/27	**2027/28**
987	0.1467	210	130	112

Discussion

Robustness of harvest strategy

Mackerel icefish are known to be a highly plastic species with differing population parameters across its geographic range (Kock 2005). Recent stock assessments indicate that population parameters vary through time within the same population (Maschette & Welsford 2019), which can pose a challenge for stock assessments (SC-CAMLR 2001). However, the current harvest strategy appears sufficiently conservative to avoid harvesting that would be inconsistent with the CCAMLRs objectives (Appendix Figure B.4). Estimating biological parameters regularly (such as Maschette *et al*. 2024) for this assessment also ensures that long-term environmental changes, such as those which are predicted to occur due to global climate change and may impact population characteristics, are accounted for.

Management Advice

The 2026 survey showed a large 4+ cohort in the mackerel icefish population in Division 58.5.2. This was to be expected given that the same cohort was present in the 2025 assessment as a strong 3+ cohort. As in previous years, this assessment assumes that the 4+ cohort is unlikely to be available to the fishery in the coming years, and therefore only uses the 1+ to 3+ cohorts in the forward projections. The 2026 survey also showed a large reduction in overall biomass, and such a large fluctuation in biomass is not uncommon in mackerel icefish (Maschette & Welsford, 2019).

Following the previous advice of CCAMLR, given the plasticity of this species and the differences seen in growth between time periods presented in Maschette *et al*. (2024), we estimated the catch limits using the most recent period of estimated growth (2018-2024).

The projections of the Grym indicated that catches of 130 t in the 2026/27 season and 112 t in the 2027/28 season satisfy the CCAMLR decision rules. We recommend that catch limits be set for these seasons based on this assessment, and a revised assessment be conducted based on survey data collected in 2027 since cohorts younger than age 3+ are not well selected by the survey gear.

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Appendix C changes in stock assessment parameters

Table C1: Table summarising evidence for changes in stock assessment and population parameters or processes that could be due to the effects of environmental variability or climate change in the mackerel icefish fishery in Division 58.5.2.

Parameter or process	Population	Stock assessment
Recruitment: Mean recruitment, Recruitment variability (σ_R and autocorrelation)	Icefish surveys show high interannual variability in year class strength. The drivers for interannual changes in recruitment have not been fully explored. Maschette & Welsford (2019) provided and initial hypothesis for the apparent shift in recruitment which occurred between 2008-2011.	Stock assessments for icefish assume no future recruitment in the two-year projection period. The stock assessments are based on the most recent estimate of recruitment from an annual trawl survey and therefore account for interannual variability in recruitment.
Biomass	As a result of highly fluctuating recruitment the population has show highly variable biomass through time showing up to three-fold increases or decreases from one year to another (See appendix B2).	The lower one-sided 95th confidence interval from a bootstrapped biomass estimate from the most recent trawl survey is used as the initial biomass in the stock assessment. This is done to account for the large interannual variability in observed in biomass estimates.
Length at maturity	Length at maturity has been investigated as part of Maschette *et al*., (2024) and has shown fluctuation in the size of maturity through time for both males and females with a generally increasing size of 50% maturity since 2008.	There is no maturity component in the stock assessment.
Stock-recruit relationship	The relationship between spawning stock and recruitment has not been thoroughly investigated.	Due to the stock assessment having no recruitment component there is no stock-recruitment relationship in the stock assessment.
Natural mortality	Natural mortality is uncertain. De la Mare (1998) estimated M to be around 0.30 for age 2 and above, and 0.64 for age 3 and above based on a Heincke estimate for survivorship from age a to all older ages but acknowledge that these estimates were highly uncertain due to recruitment and sampling variability.	Within the stock assessment M is fixed at 0.4.

Growth rates	Growth rates appear to have changed through time, with an increasing asymptotic average length (L∞) and a decreasing growth rate coefficient (K) (Maschette *et al*., 2024).	Within the time series of assessments growth has been estimated four times, as part of the 1997, 2010, 2017 stock assessments and in Maschette *et al.*, (2024)
Length-weight relationship	Annual Length-Weight relationships have shown some fluctuation through time although this is likely due to the presence or absence of size classes in the population (Maschette *et al.*, 2024).	In the stock assessment, estimates from the most recent trawl survey are used.
Sex ratio changes	No evidence of changes in sex ratio in the survey data through time (Maschette *et al.,* 2024).	The stock assessment is an unsexed model.
Spatial distribution	No evidence in the change of spatial distribution through time has been observed (Maschette *et al.,* 2024).	The stock assessment has no spatial components in the model.
Stock structure	Within Division 58.5.2 there have historically been three populations hypothesised. One on Shell Bank to the east of the plateau, one on Pike Bank to the north-west of the plateau and one on the southern part of the plateau centred on Gunnari Ridge. The Pike bank population was heavily over fished prior to the establishment of the Australian and French EEZs and shows little signs of recovery. The fishery is limited to the population on the southern part of the plateau. Gunnari Ridge consistently shows the largest aggregations of adult icefish with Plateau Southeast and Platea West showing a patchier distribution with all age classes present.	
Locations of spawning and site fidelity	Gunnari Ridge is the primary area for spawning mackerel icefish. Icefish seem to move in and out of this area throughout the year.	

Review of HIMI managed bycatch species' assessments

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1 Summary

Management of Patagonian toothfish (*Dissostichus eleginoides*) and mackerel icefish (*Champsocephalus gunnari*) within the waters of Heard Island and McDonald Islands (HIMI) includes the calculation of sustainable total allowable catch for these two commercially targeted species; as well as the estimation of bycatch limits for species that may be bycaught during fishery operations including, but not limited to, grey rockcod (*Lepidonotothen squamifrons*), unicorn icefish (*Channichthys rhinoceratus*), skates and rays (*Bathyraja* sp.), and grenadiers (*Macrourus* sp.; macrourids). In this paper we provide an overview of assessments that have been undertaken for bycatch managed species in HIMI, highlight species-specific information where applicable, and provide an indicative workplan outlining the anticipated delivery of the next round of assessments for each of the bycatch managed species.

2 Current bycatch limits and move-on provisions at HIMI

Annual bycatch limits for bycatch managed species including grey rockcod, unicorn icefish, skates and rays, and grenadiers are set by AFMA (AFMA, 2026). The current bycatch limits for the HIMI fishery are listed in Table 1. In addition to maximum allowable bycatch over a given season, operators are also subject to move-on provisions with respect to a local concentration of bycatch for a given species. Typically, these move-on rules require that when the given trigger limit is taken in one haul, then the vessel must move and not fish (with the same gear) within 5 nautical miles of that location for five days. The time series of catch by gear type of these bycatch managed species is also presented (Figure 1 and 2). The bycatch limits listed represent domestic limits yet also are part of the relevant CCAMLR conservation measure CM 33-02 (2025). Bycatch limits are based on CCAMLR decisions, the most recent assessments (where sufficiently robust conclusions have been presented), or, if not available, comparative species information and/or assessments that are able to provide adequate confidence and precaution in estimated values (Table 2).

Table 1. Current bycatch limits and move-on rules for bycatch managed species within the Heard Island and McDonald Islands fishery.

Species common name	Scientific name/s	2025-26 total allowable catch (tonnes)	Operational trigger limits and move-on provisions[1]
Grey rockcod	*Lepidonotothen squamifrons*	80	2 tonnes or more
Unicorn icefish	*Channichthys rhinoceratus*	1663	5 tonnes or more
Skates and rays	*Bathyraja irrasa, Bathyraja eatonii, Bathyraja murrayi*	120	2 tonnes or more
Macrourids (shallow)	*Macrourus caml* and *M. whitsoni*	409	3 tonnes or more (*Macrourus* sp. combined)
Macrourids (deep)	*Macrourus holotrachys* and *M. carinatus*	360	3 tonnes or more (*Macrourus* sp. combined)
Other deepwater species	Such as *somniuss* spp.	50	2 tonnes or more (*Somniuss* pp.)
Any other bycatch species			1 tonne or more

As can be seen from Table 2, assessments that have been undertaken on bycatch limits within HIMI are underpinned by the Generalised Yield Model (GYM) (Constable and De La Mare, 1996). The GYM is an age-structured population simulation approach that can test ranges of life-history parameter values (such as natural mortality, fecundity, age at maturity, recruitment variability) and is able to incorporate uncertainty in these parameters by drawing from specified probability distributions across many simulation trials. The model was developed in the context of CCAMLR work on krill and other Southern Ocean resources, where the emphasis was on precautionary management given substantial scientific uncertainty about stock status and productivity.

[1] If a vessel hits these thresholds, a "move-on" obligation is triggered requiring them to shift fishing locations.

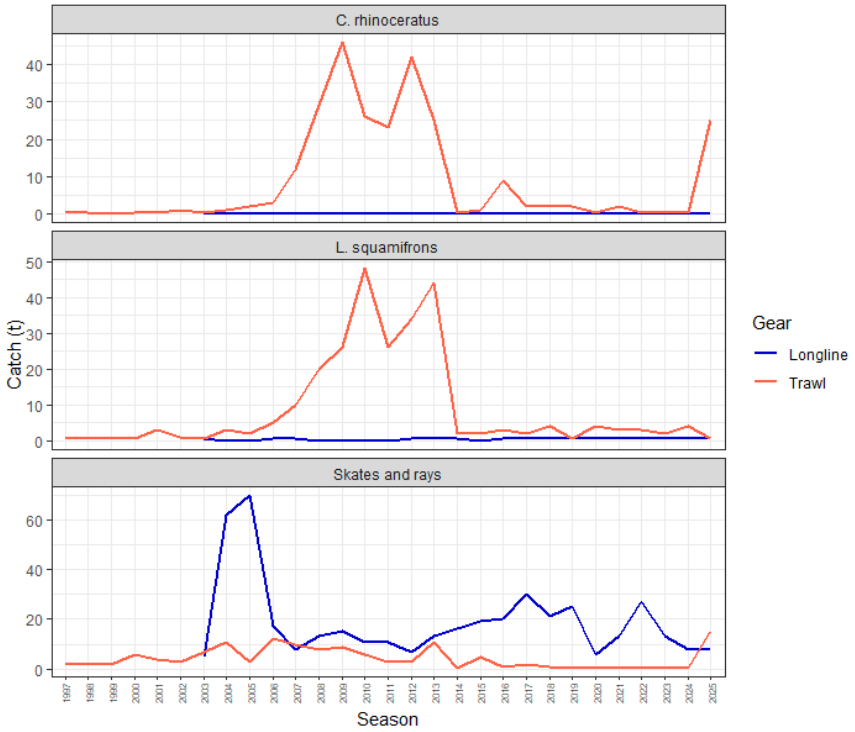


Figure 1. Reported catch (in tonnes) of Unicorn icefish (*C. rhinoceratus*), grey rockcod (*L. squamifrons*) and Skates and rays (*Bathyraja* sp.) within HIMI. Catch is separated by gear type and includes data collected from 1997 to 2025. Data source: CCAMLR Fishery Report 2025 (https://fishdocs.ccamlr.org/FishRep_HIMI_TOP_2025.html).

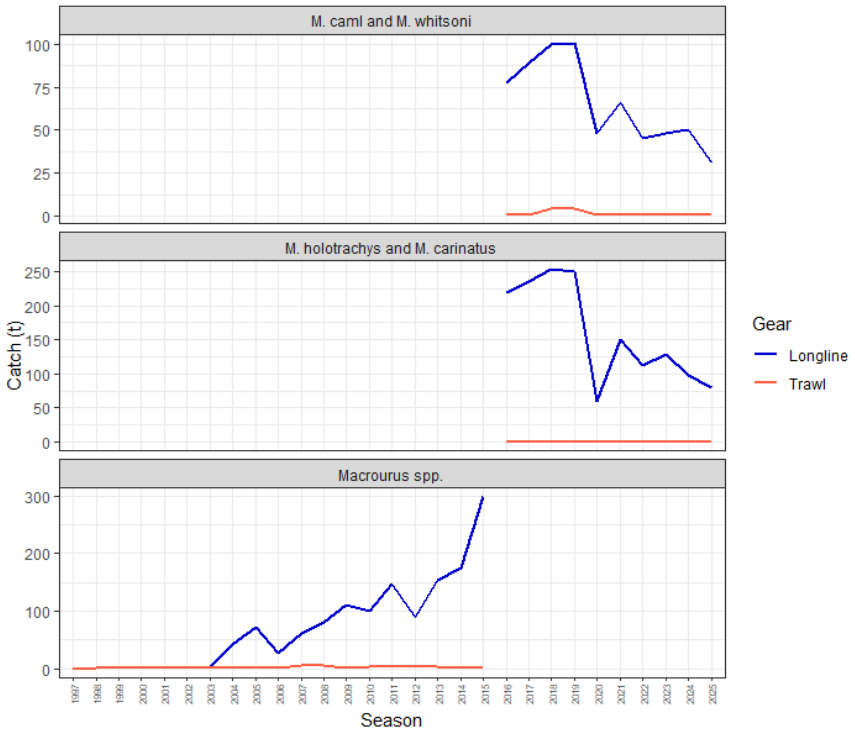


Figure 2. Reported catch (in tonnes) of Unicorn icefish (*C. rhinoceratus*), grey rockcod (*L. squamifrons*) and Skates and rays (*Bathyraja* sp.) within HIMI. Catch is separated by gear type and includes data collected from 1997 to 2025. Data source: CCAMLR Fishery Report 2025 (https://fishdocs.ccamlr.org/FishRep_HIMI_TOP_2025.html).

Table 2. Overview of the assessments that have been used to investigate bycatch catch limits for bycatch managed species at HIMI. Data used is associated with the first listed reference.

Species	Model used	Data used	Comments	References
Grey rockcod	GYM	Commercial bycatch from 1997/98; biomass estimates from surveys in HIMI from 1990 to 1993.	Estimated range of yield values were 7-911t (Constable et al. 1998). These values were adjusted through CCAMLR.	Constable et al. 1998
Unicorn icefish	GYM (with some variations)	Commercial longline data from 2003 – 2014; RSTS data from 2015.	Updated assessment provided a large increase in the bycatch limit for this species.	Maschette and Dell, 2015; Constable et al. 1998
Skates	GYM	Commercial bycatch from 1997/98; biomass estimates from surveys in HIMI from 1990 to 1993.	The initial assessment by Constable et al. 1998 combined all three *Bathyraja* species when calculating a bycatch limit. More recent work by Cleeland et al. (2022) has explored species-specific assessments.	Constable et al. 1998; Cleeland et al. 2022.
Macrourids (shallow)	GYM	Commercial longline data from 2003 – 2014; RSTS data from 2015.	Assessment conducted for *M. caml* yet the resulting bycatch limit was proposed to apply collectively to both *M. caml* and *M. whitsoni*	Dell et al. 2015
Macrourids (deep)	GYM	Biological data from surveys in 1990, 1992 and 1993 in HIMI, both HIMI and BANZARE Bank in 1999, and commercial data from Macquarie Island	Biological data (from proximal areas) was primarily from *M. carinatus*. Density estimates (used for biomass) were calculated from BANZARE Bank.	van Wijk et al. 2003

3 Species-specific information

3.1 Grey rockcod

The bycatch limit for grey rock cod has been set at 80t from 1998 to the present.

The bycatch limit for grey rockcod was investigated by running a GYM assessment model that used survey data collected between 1990-1993 and commercial data from the 1997/98 season. A range of sustainable catch from 7– 911t was estimated (Constable et al. 1998).

An examination of spatial and temporal patterns of grey rockcod based on both commercial and research catches (i.e., the RSTS) used catch and effort data from 1997 to May 2012 (Nowara et al. 2012). Areas of higher concentration were found on the tops of banks (such as Shell Bank and Pike Bank) and in deeper waters south of Shell Bank. The largest concentration of *L. squamifrons* was noted to have been reported within the HIMI Marine Reserve. A more recent investigation into the age, maturity and growth dynamics of grey rockcod made use of RSTS data collected between 1990-2014 and commercial data from 1997-2014. Updated estimates of biological parameters were obtained from these analyses along with the identification of areas of higher densities (Maschette et al. 2015).

3.2 Unicorn icefish

The initial bycatch limit for unicorn icefish (between 1990 – 2015) was set at 150t in line with standard CCAMLR caps for bycatch species per season. This value was raised to 1663t in 2016 following an updated assessment.

A GYM assessment focused on *C. rhinoceratus* was conducted by Maschette and Dell (2015). The assessment relied on biological data collected during the RSTS. A total of 359 otoliths were used for age estimation, and 8459 fish were used to derive a length-weight relationship along with length cohorts. Maturity was estimated also. Biomass estimates were derived from the three RSTS strata which unicorn icefish primarily inhabit (Gunnari Ridge, Plateau southeast, and Plateau West). Both short- and long-term GYM yield estimates were derived with the latter (and updated biological parameters) suggesting that 1663t was an acceptable bycatch limit. This value is a significant increase from the previous assessment which calculated a range of 62-87t (Constable et al. 1998) and the initial bycatch limit set by CCAMLR.

Future assessments would likely benefit from a longer time period over which to estimate biological parameters, re-estimation of selectivity functions, as well as the consideration of a broader suite of model specifications to produce yield predictions under a range of biological settings for this species.

The assessment complemented previous studies which modelled catch-per-unit effort data from the RSTS and commercial data using GAMs to predict areas of higher density (Nowara et al. 2012). In

general trawl nets have higher rates of bycatch although this species was recorded across most of the shallow plateau area. Furthermore, higher concentrations of unicorn icefish were found to the north of Heard Island in waters shallower than 300m.

3.3 Skates

The bycatch limit for Bathyraja species has been set at 120t from 1997 to the present.

The first GYM assessment run to derive a long-term yield for this species grouping (i.e., all *Bathyraja* species) was based on biomass estimates from surveys in the region from 1990 to 1993 and a limited amount of biological data from the local area (Constable et al. 1998). The samples available for this analysis were primarily trawl caught species (i.e., *B. eatoni* followed by *B. murrayi*). Estimates of growth rates used in the assessment were from a comparative species (to *B. eatoni*), *Raja clavata*. Weight-length relationships were listed as being calculated from available samples which assumedly was the combined numbers of different species caught in the 1990-1993 surveys which were dominated by *B. eatoni*. Similarly, bycatch reports were primarily of *B. eatoni* which comprised 90% of trawl catches in 1997/98. Estimates of spawning season, maturity and recruitment were inferred from qualitative reports and literature. The range of precautionary catch limits for *Bahthyraja* spp. was estimated to be between 50 to 210t.

Cleeland et al. (2022) presented an updated assessment for skates which provided separate GYM assessments for *Bathyraja irrasa*, *Bathyraja eatoni* and *Bathyraja murrayi* . These assessments used catch and effort data from the RSTS (1997 – 2021) and considered reported bycatch from commercial trawl and longline operations over this same period. This report was a strong step forward in the provision of updated, species-specific assessments. Furthermore, the inclusion of ranges of parameters (in a stepwise manner) presented a more robust framework than had been reported previously. However, a few issues were noted by the authors. The calculation of bycatch history in the longline fishery combines vessel counts and the scaled observer partial counts. Furthermore, where there was a limited sample size, and proportions (of *Bathyraja* species) caught were extrapolated from gridded historical data. Both of these calculated values would be aided by additional investigation and sensitivities. In addition, the classification (and relative fate) of skate condition was highlighted as being of critical importance in assumptions related to post-release survival and estimation of bycatch through time. Finally, the estimation of biomass for *B. irrasa* was noted as a likely underestimate given the relatively small overlap between RSTS coverage and geographic distribution of this species. This mismatch has immediate knock-on effects for use within the GYM approach.

Some recent research has explored some of these issues in more detail, notably post-release survival rates and behavioural indicators of stress and relative condition of *B. irrasa* (Appert et al. 2025). In addition, findings from other researchers working on similar issues may provide details that could be incorporated into this work.

3.4 Grenadiers

The initial catch limit for Macrourid species (combined) was 50t in the 2002/2003 season. This value was raised to 465t in 2002/2004 before being decreased to 360t from 2004-2015. A GYM assessment formed the basis for catch limits applying to taxonomic pairings from 2016 to present; the combined catch limit for M. caml and M. whitsoni was set at 409t, and the combined catch limit for M. holotrachys and M. carinatus was set at 360t per season.

Van Wijk et al (1999; 2003) conducted an assessment of rough-scale grenadier (*Macrourus carinatus)* with biological data from HIMI (1990, 1992, 1993 and 1999) as well as BANZARE Bank (1999), commercial samples from Macquarie Island, and a biomass estimate based on density estimates from BANZARE Bank. The GYM calculated a yield of 360t for this species which was then applied to all Macrourus.

An assessment of *M. caml* was conducted by Dell et al. (2015). This assessment was able to incorporate data collected within HIMI waters as opposed to the previous assessment which relied on comparative data from proximal locations (Van Wijk et al 2003), however in some cases the same assumptions needed to be made due to limited data (for e.g., natural mortality). The assessment relied on additional data collected during the 2015 RSTS. Specifically, 346 otoliths were collected for ageing, and 2993 fish were measured for both length and weight. Maturity was assessed for 2662 fish. In turn, this biological data was used to estimate growth, length-weight relationships and maturity ogives. Commercial longline data from 2003 to 2014 was also used to estimate annual reported bycatch for *M. caml*. Based on the biological parameters used within the model, as well as the data available, the assessment suggested that the long-term sustainable yield of this species was 409 tonnes. Dell et al. (2015) also suggested a catch limit of 150t for the deeper water taxonomic Macrourus species if a new catch limit for the shallow water species was to be endorsed.

The value presented in Dell et al. (2015) was adopted as the current bycatch limit for the combined grouping of *M. caml* and *M. whitsoni* (shallow grenadiers), while the original catch limit for all Macrourus species of 360t was applied to the two deep-water species (*M. holotrachus* and *M. carinatus*).

Future assessments would likely benefit from a longer time period over which to estimate biological parameters, re-estimation of selectivity functions, as well as the consideration of a broader suite of model specifications to provide a yield predictions under a range of biological settings for this species. Exploration of each of the grenadier species on an individual basis would also seem worth progressing.

In addition to the GYM assessment, Dell et al. (2015) modelled catch per unit effort (CPUE) using generalised additive models to assist in predicting the most likely locations of high grenadier bycatch (at the taxonomic group level).

As stated above, there are four species of grenadiers (macrourids) that have been reported in HIMI waters. Observers report to taxonomic group, taxonomic pairing, or individual species. However, updates to historical observer records of grenadier species identification may be possible in future assessments. More than 800 otoliths collected at HIMI between 2015 – 2021 from the four different

macrourid species were used to examine whether otolith shape and outline analysis could be used as multivariate descriptors to categorise species (Connor et al. 2025). This research found very high accuracy rates for predicting between the two different depth groupings, as well as relatively high predictive rates within species groupings. Additional review of the potential of otolith morphological studies for macrourids would be useful to further underpin the application of this approach to historical data records. Lastly, as part of this study, an examination of additional biological parameters from aged fish was also conducted.

3.5 Additional approaches and analyses

As stated above, the use of GYM as a means of assessing single species is standard practice within CCAMLR when there are insufficient data or resources to run a fully integrated stock assessment. We recognise the value in presenting the GYM approach in the next iteration of assessments for bycatch managed species however we also note that there may be an opportunity to explore other statistical methodologies that are tailored to data-limited species. Such considerations rely heavily on a suitable match between available data and the given requirements of the associated assessment.

Furthermore, given the importance of biomass estimates in assessments, it is also worth exploring alternative estimation methods to design-based bootstrap estimates used so far. For example, Leadbetter et al. (2025) (and see Leadbetter et al. *this meeting*) used Bayesian hierarchical modelling to provide both a more precise (in comparison to the currently used RSTS biomass estimates, Maschette et al. *this meeting*) estimate of biomass and abundance, as well as length composition estimates. Other potentially valuable approaches to estimate biomass include spatio-temporal species distribution models (Louzada et al. 2025).

Inclusion of bycatch managed species within multi-species models could also be explored further given potential species' dependencies. A recent paper relying on RSTS data from 2003 to 2016 examined community composition and patterns of species diversity for 35 demersal fish species in HIMI (including all species listed above) using joint species hierarchical models (Williams et al. 2025). This work found increases in both geographic distribution of presence as well as relative count in some areas for all bycatch managed species at HIMI.

In addition, qualitative approaches to detecting and responding to relative risk including ecological risk assessments (Dell et al. 2016) as is presently in development (*see* AFMA, 2026), validation of move-on provisions, and predictions in species abundance and distribution in relation to projected climate change impacts would each provide additional guidance for sustainable fisheries management. Finally, ongoing monitoring and investigation, where warranted, of other bycatch species including seabirds, marine mammals, and sharks is also flagged.

4 Workplan going forward for bycatch managed species at HIMI

It is important that updated assessments for managed bycatch species be progressed. Such work will not only enable the use of more recent and comprehensive datasets, but also allow the consideration of new scientific research which may have important bearing on the structure and plausible ranges of biological parameters included within assessments. GYM assessments will be the priority of these assessments, however exploration of alternative approaches that provide additional analyses or are better aligned with available data for a given species or species group may also be pursued (Table 3).

Following recent efforts and focused research on skates (Cleeland et al. 2022; Appert et al. 2025), species-specific assessments for this taxon is the highest immediate priority. For all other species or species groups, a thorough evaluation and inventory of data holdings (both recorded from observers and vessels, as well as physical samples which may have been collected) will be undertaken over the next six months. This task will provide confirmation of the most suitable assessment model for each group yet also identify any data gaps that may be filled within 12 months and be effectively incorporated into a given assessment. However, given the length of time since the last assessments were undertaken, any new data collection will not come at the expense of the timing of the delivery of updated assessments unless agreed by SARAG.

Table 3. Anticipated delivery of progress and delivery against updated assessments for grey rockcod, unicorn icefish, skates and grenadiers.

Species	Jan-June 2027	Jul-Dec 2027	Jan-June 2028	Jul-Dec 2028
Grey rockcod	Data overview		Assessment exploration	Updated assessment
Unicorn icefish	Data overview	Assessment exploration	Updated assessment	
Skates	Updated assessment			
Grenadiers (shallow)	Data overview	Assessment exploration	Updated assessment	
Grenadiers (deep)	Data overview		Assessment exploration	Updated assessment

In addition, it is worth noting that assessment work only covers one facet of the research objectives applicable to monitoring requirements under the HIMI Fisheries Assessment Plan. These objectives are:

1) assessing distribution and abundance of target species, Patagonian toothfish (*Dissostichus eleginoides*) and mackerel icefish (*Champsocephalus gunnari*);

2) estimating stock dynamics of target species, including population parameters;

3) assessing distribution and abundance of major bycatch species including grenadiers, grey rock cod, unicorn icefish, skates and rays; and

4) assessing the effects of fishing on bycatch species and habitats.

Hence, more extended work on the basic biology, distribution and ecological effects for bycatch managed species would be useful to incorporate within research efforts and analyses going forward.

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An update on MP development for Macquarie Island Patagonian toothfish

SARAG Meeting 75

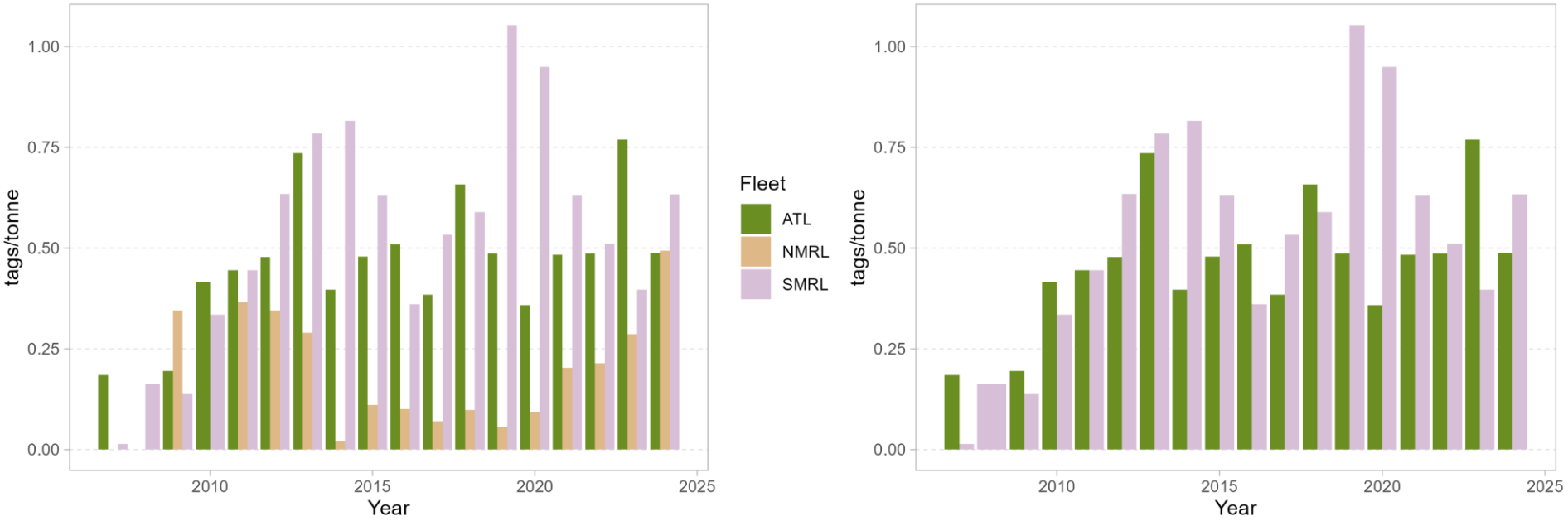
Pia Bessell-Browne & Rich Hillary | 20th Aug 2026



Is Aurora Trough a separate area

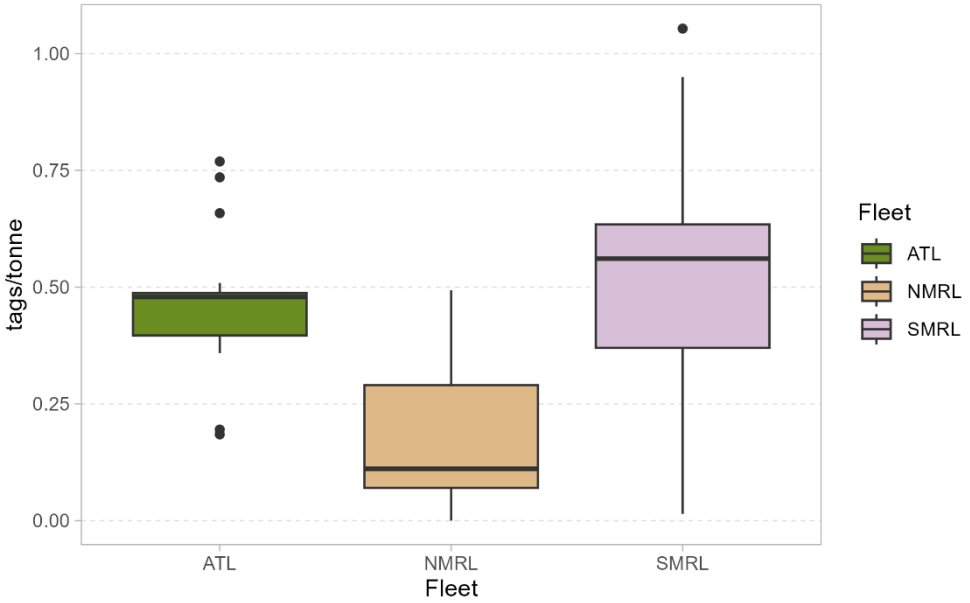
- SARAG74 suggested that we should consider a 3rd area in the OM separating the Aurora Trough from South Macquarie Ridge
- Before implementing we looked to see if there is evidence in the data to support this
- In the assessment differences in areas are driven by differences in tag recapture rates

Is Aurora Trough a separate area



Is Aurora Trough a separate area

- While there is annual variability in relationships overall trends show clear differences between NMRL & southern fleets (SMRL & ATL)



Is Aurora Trough a separate area

- Summary tag data suggests much higher movement rates between AT & SMRL than observed with the north
- This again suggest that spatial separation of AT & SMRL will not have a material effect on assessment & OM understanding

RelFleet	ATT	NVT	ATL	NMRL	SMRL
ATT	1461	1	171	2	41
NVT	10	166	1	7	6
ATL	0	0	1153	4	165
NMRL	0	0	6	104	37
SMRL	1	0	212	18	942

Is the N-S split in the right place

- There is probably a gradual change in dynamics rather than one specific line in reality
- Tag summaries presented above show clear differences between N & S through time
- This suggests that there is no evidence that the split is in the wrong place
- Can produce some extra data summaries to confirm but tag data suggests no concerns

MP development

- Following any OM adjustments need to move forward testing HCR options
- Focus on spatial, tag-based estimators

MP/HCR options

- Separate catch limits in the north and south
- Combined catch limit
  - Tuned to prevent south dropping below the LRP
  - Depends on input catch splits between N & S
- Higher TRP?
- Any other requests?

MP features

- 50% TRP, 20% LRP
- 20 years to TRP
- 10% change rule
  - Aim as a guide rather than to enforce
- Range of assessment frequency
  - 2-5 years
- Under and overcatch provisions

- Robustness tests
  - Recruitment trends
  - Growth changes
  - Length-weight relationship

Summary

- Moving forward with OM development and HCR refinement
- Aim to get runs and results back to this group at the next meeting
- Will confirm full robustness set at this stage

Catch splits

Fishing season	Longline AT	Longline NMR	Longline SMR	% north	% south
2019/20	227.9	143.5	79.7	32	68
2020/21	292.8	192.9	51.6	36	64
2021/22	252.1	34.6	171.4	8	92
2022/23	262.9	37.2	139.2	8	92
2023/24	186.0	66.4	204.1	15	85
2024/25	221.5	32.4	211.5	7	93



Australian Government

Australian Fisheries Management Authority

Sub-Antarctic Fisheries Annual Research Statement - DRAFT

2027/28

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Fishery Annual Research Statement 2027/28

AFMA funding in 2026/27 (AFMA Research Committee (ARC))

Title	Objectives and component tasks	Evaluation		
		Total cost (approx. only)	Priority/rank	Feasibility
CURRENT RESEARCH UNDERWAY WITH ONGOING COMMITMENTS				
Stock assessment and MSE of the Macquarie Island toothfish fishery: 2027-2031	1. To provide an updated stock assessment to the SARAG in the next scheduled assessment year (2027). 2. To provide the SARAG with updated TAC recommendations, via application of the management procedure. 3. To continue monitoring the stock through the mark-recapture program.	$494,000 (4 year project)	Essential	High

FRDC and AAD funding in 2026/27 (Industry Partnership Agreement (IPA))

Title	Objectives and component tasks	Evaluation		
		Total cost (approx. only)	Priority/rank	Feasibility
Current funded projects				
Investigating sources of variability in the Heard Island and McDonald Islands Patagonian Toothfish fishery (Project 2020-097)	Commercial in confidence	**$840,000**	Essential	High

Science to support Australia's Southern Ocean Fisheries 2024-2027 (Project 2023-173)	Commercial in confidence	**$2,612,000**	Essential	High
New identified research 2027-28				
Identifying alternative fishery independent sampling approaches for the HIMI Fishery and other associated research	Research to transition the HIMI Fishery from the RSTS to an alternative fishery independent sampling approach to inform Patagonian toothfish, icefish and bycatch species assessments. This includes testing of alternative approaches.	TBA	Essential	High

Additional Industry funded research in 2026/27

Title	Objectives and component tasks	Evaluation		
		Total cost (approx. only)	Priority/rank	Feasibility
Current funded projects				
HIMI Random Longline Survey	Undertake surveys to estimate the longline fishable abundance and biomass of Patagonian toothfish within HIMI	High (vessel time provided in-kind)	High	High
New identified research				

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Evaluation key:

Cost	Priority categories	Feasibility categories
High: >$200,000	Essential	High
Medium: $100,000 - $200,000	High	Medium
Low: <$100,000	Medium	Low
	Low	

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Table 1. SARAG priorities and progress as of May 2026.

Priority	Description	Notes
HIMI toothfish stock assessment	Develop a spatially explicit, sex-based stock assessment model.	This remains the highest immediate priority. CSIRO has been engaged by AAD to perform this work. Whilst a new model has been developed refinement of the model over the next few years will be necessary.
Future design on the RSTS	The new MPA management plan may impact the available survey area for the RSTS.	This is a high priority noting the importance of data collected from RSTS for both the toothfish and icefish assessment in the HIMI Fishery. Analysis is required to quantify the likely impacts and guide potential redesign of the survey.
Review decision rule for HIMI	Review of decision rule for setting TACs for toothfish in the HIMI Fishery.	This was initially identified as an action item at SARAG 69. SARAG 70 noted that the progress of this action item is to some extent dependent on other work that is currently underway such as the MSE project for MITF and the exploration of different decision rules at CCAMLR. AAD has funded CSIRO to undertake an MSE of the CCAMLR decision rule following the development of the new stock assessment.
Review harvest strategy for MITF	Review of decision rule for setting TACs for Toothfish in the MITF.	CSIRO is currently undertaking an MSE on alternate harvest strategies. Project is expected to be completed in 2027.
Bycatch Strategy, 2026	A revised bycatch strategy for the HIMI and MITF was agreed in 2026. The strategy includes a range of actions for implementation.	Several stock assessments updates are identified under the strategy. A specific workplan for delivering these updates is required.
HIMI Data Collection Approaches	AAD to work with CSIRO, industry and AFMA to develop a SARAG paper outlining the broad scientific and resource costs and benefits associated with the implementation of different surveys and research proposals.	This was initially identified as an action item at SARAG 66 and has progressively expanded in scope. Its main objective is to review the costs and benefits of the: • Random Stratified Trawl Survey (RSTS review, including variations to the periodicity) • continued refinement of the longline research hauls (LRH) and development of a time series of fishery independent longline hauls that can be considered for potential inclusion in the TMB toothfish stock assessment; and • Close Kin Mark Recapture The voluntary RLS was developed and has been underway since the 2023/24 fishing season, a new spatially explicit stock assessment model has been developed, and an MSE project has been contracted. The MSE project is likely to provide good guidance on the costs and benefits of varying the data inputs for the fishery.
Observer Data	Observer data to be analysed for gaps in observation (time of day) and develop paper on species specific diurnal patterns and risk.	This was initially identified as an action item at SARAG 70. SARAG noted that the additional analysis required to further evaluate the risk of daylight setting to seabirds in MITF has not been undertaken due to lack of resourcing, further noting AFMA's advice that if such work remains a priority a scope needs to be developed for a discrete project. Such work may also include the scientific analysis of observer seabird data to support SARAG's ongoing risk-assessment of the season extension trial.
Live release of small toothfish (HIMI and MITF)	Industry has requested flexibility to release small toothfish (under 1kg)	This was initially identified as an action item at SARAG 71. AAD and CSIRO have undertaken to analyse historical data for HIMIF and MITF, respectively to better understand the proportion of catch that <1kg toothfish make up and inform any changes required to sampling protocol. This work has been delayed due to competing priorities.