Species Listing Eligibility and Conservation Actions for *Centroberyx affinis* (Redfish): Catch Data from the South East Australian Marine Ecosystem Survey (SEA-MES) Voyages 1-4.

The Southeast Australian Marine Ecosystem Survey (SEA-MES) is revisiting previous bio-physical and ecosystem surveys of the Australian SE continental shelf using the CSIRO research vessel (RV) *Investigator* to document changes in the ecosystem over 30 years. It is attempting to untangle the effect of different human activities on the ecosystem, including climate change and fisheries.

SEA-MES consists of four voyages using *RV Investigator*, Australia's multi-purpose blue-water marine research vessel. Voyages 1-4 have been conducted in May 2023, July 2024, November 2024 and June 2025. Through a range of biological sampling techniques, it has captured an understanding of the ecosystem and foodweb structures from primary production of phytoplankton and benthic algae, through to secondary production of zooplankton, and the diets of fishes from stomach content analysis. It has also undertaken water column sampling to measure the physical and chemical properties of the ocean, towed a video system over the ocean bed to describe the benthic habitat, tested new ways of measuring and monitoring the ecosystem using DNA from tissue and free-floating in the marine environment,and counted seabirds using AI techniques.

Background

SEA-MES data collection has employed a range of techniques. The primary method of collection for fish and demersal fauna is demersal trawl using a semi-V-wing demersal trawl. The gear and equipment used by SEA-MES is replicated from the Southeast Fisheries Ecosystem Survey (SEFES) survey of Bax and Williams (2000) in the 1990s. Trawl operations were limited to daylight hours for voyages 1-3, and then paired locations were sampled day and night in SEA-MES 4.

Preliminary SEA-MES Results

Preliminary results from voyages 1-4 indicate catches of Redfish of 2.28 kg/ h in the SEA-MES sample locations where the species was found.

Species	Avg SEFES CPUE (kg/h)	Shots with species	Avg SEA-MES 1 CPUE (kg/h)	Shots with species	Avg SEA-MES 2 CPUE (kg/h)	Shots with species	Avg SEA-MES 3 CPUE (kg/h)	Shots with species	Avg SEA-MES 4 CPUE (kg/h)	Shots with species	Avg SEA-MES CPUE (kg/h) ± SD
Centroberyx affinis	127.29	103	0.39	9	1.41	9	2.61	9	3.47	17	2.28 ± 4.23

Abundance measurements (CPUE) over four SEA-MES voyages (Figure 1) were less than 20 kg/h. SEA-MES 4 measured the highest abundances of the recent voyages, which was confirmed on video camera (https://research.csiro.au/sea-mes/deep-towed-camera-view-of-redfish/). These abundances are less than 10% of the historical values from the SEFES voyages during the 1990's (Figure 2). SEA-MES samples also included the presence of the species in the Bass Strait, outside of the samples area of the SEFES survey.

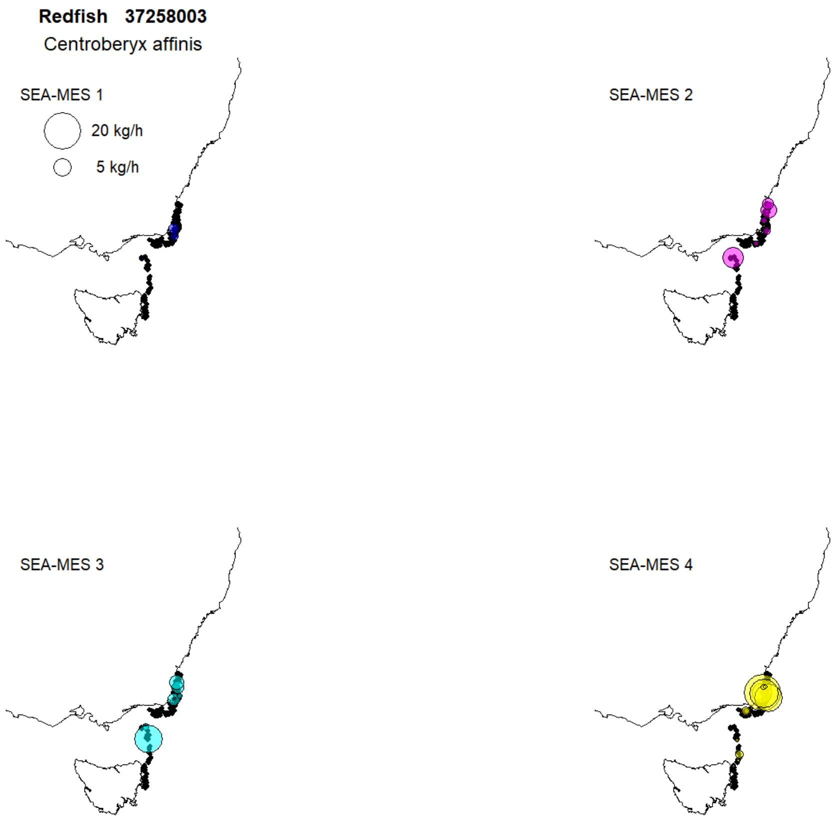

Figure 1. Catch-per-unit-effort (CPUE as kg/h) of Redfish by SEA-MES voyage. CPUE is shown as graduated coloured circle, zero catches as black dots.

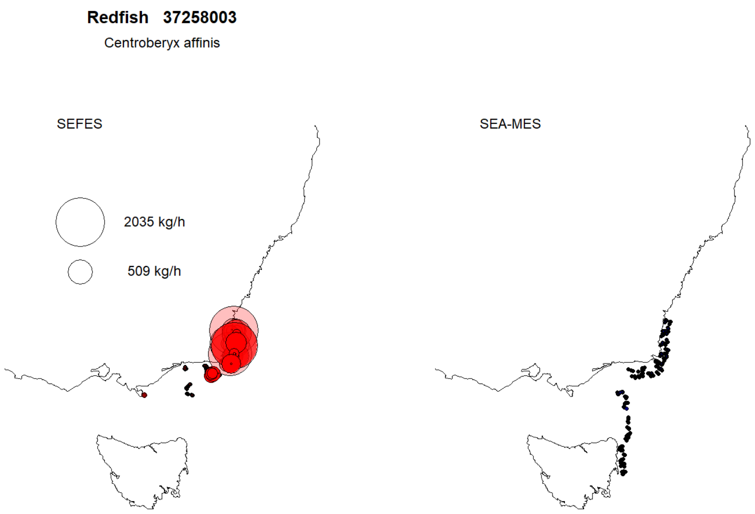

Figure 2. Catch-per-unit-effort (CPUE as kg/h) of Redfish by survey. Left: SEFES survey (Bax and Williams 2000) and right: SEA-MES voyages. CPUE is shown as graduated coloured circle, zero catches as black dots.

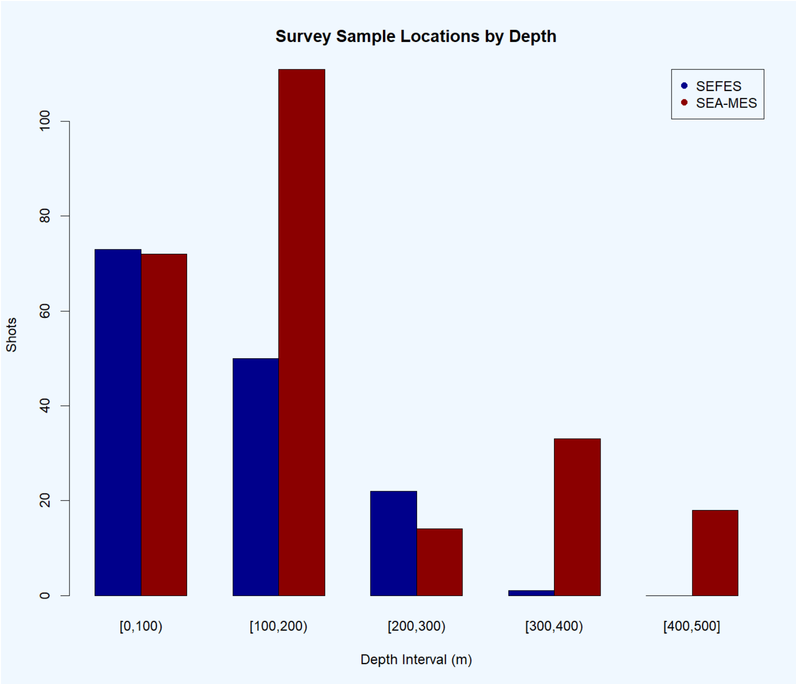

Figure 3. SEFES and SEA-MES sampling effort by depth range.

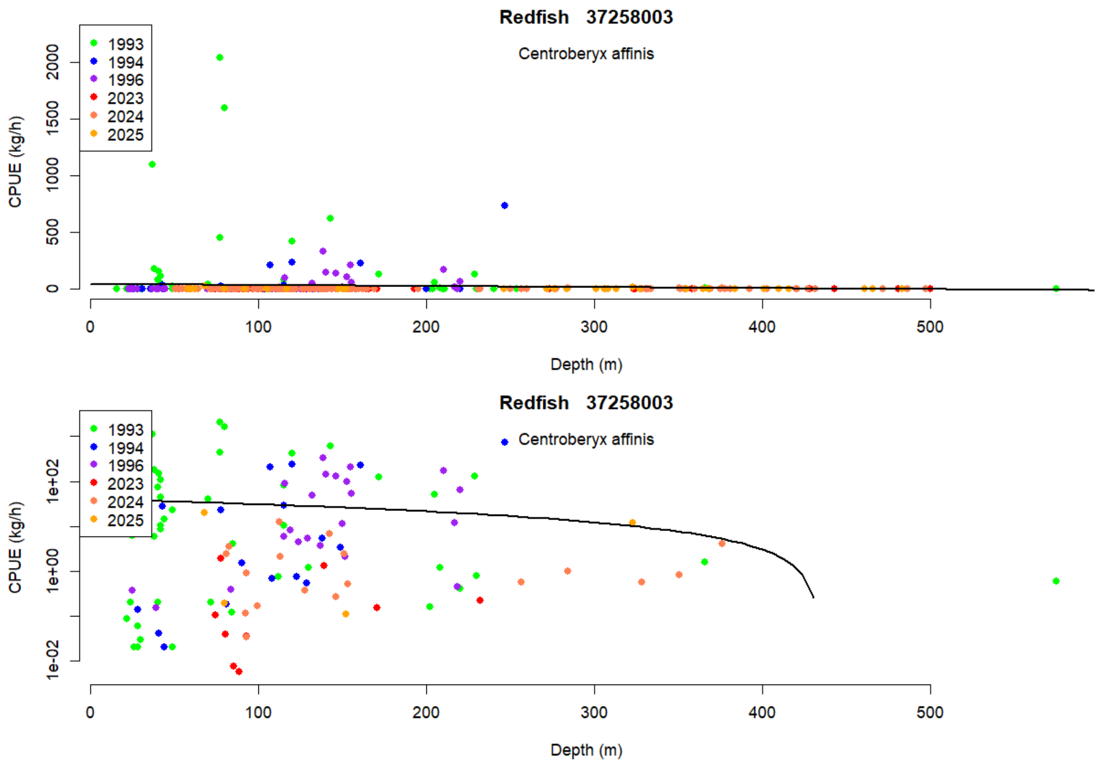

Figure 4. Redfish CPUE (kg/h) by sample depth and year (Cool colours 1993-1996: SEFES voyages; Warm colours 2023-2025: SEA-MES voyages). Top panel: arithmetic scale, that include 0 kg/h shots. Bottom panel: logarithmic scale, 0 kg/h shots omitted.

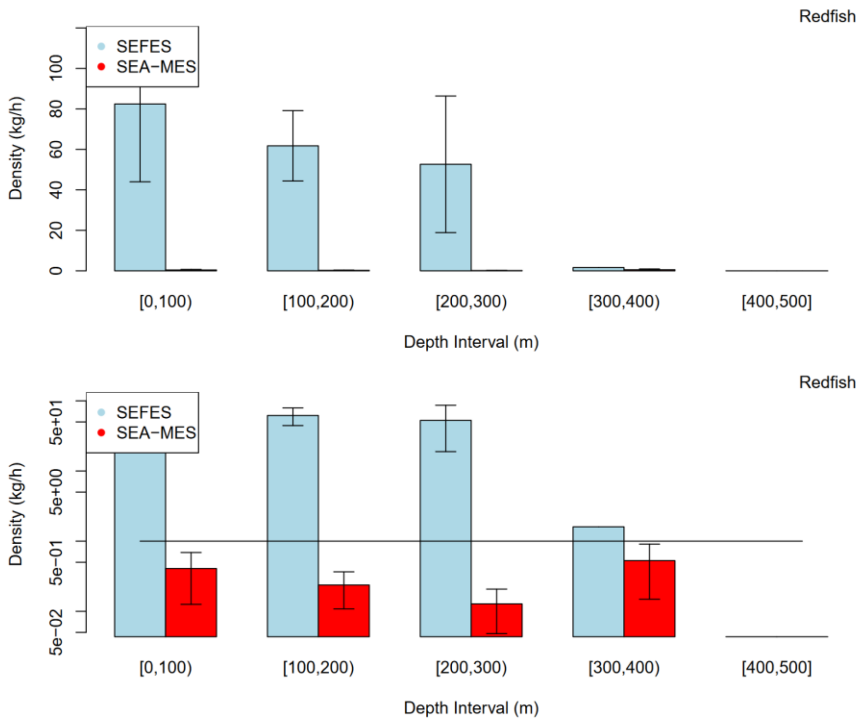

Figure 5. Average (± SE) CPUE (kg/h) of Redfish by depth range for SEFES and SEA-MES voyages. Top panel: arithmetic scale. Bottom panel: logarithmic scale. (Horizontal line represents 1.0 kg/h)

SEFES (Bax and Williams 2000) and SEA-MES sampling effort by depth range were comparable for depths <300 m (Figure 3). During SEA-MES, the species was found typically on the continental shelf at less than 250m (Figure 4), but consistently at levels far below the baseline survey (i.e. SEFES) of the 1990's (Figure 5).

Changes in fish communities over 30 years

Overall, the sampled demersal fish community composition differs between surveys over the 30-year period in the north (Figure 6). The fish community is more similar to the SEA-MES sites in the south (Figure 6) suggesting the ecosystem structure has shifted. The reasons are still unclear but could potentially be due to a range of factors the project is attempting to investigate, including oceanographic factors.

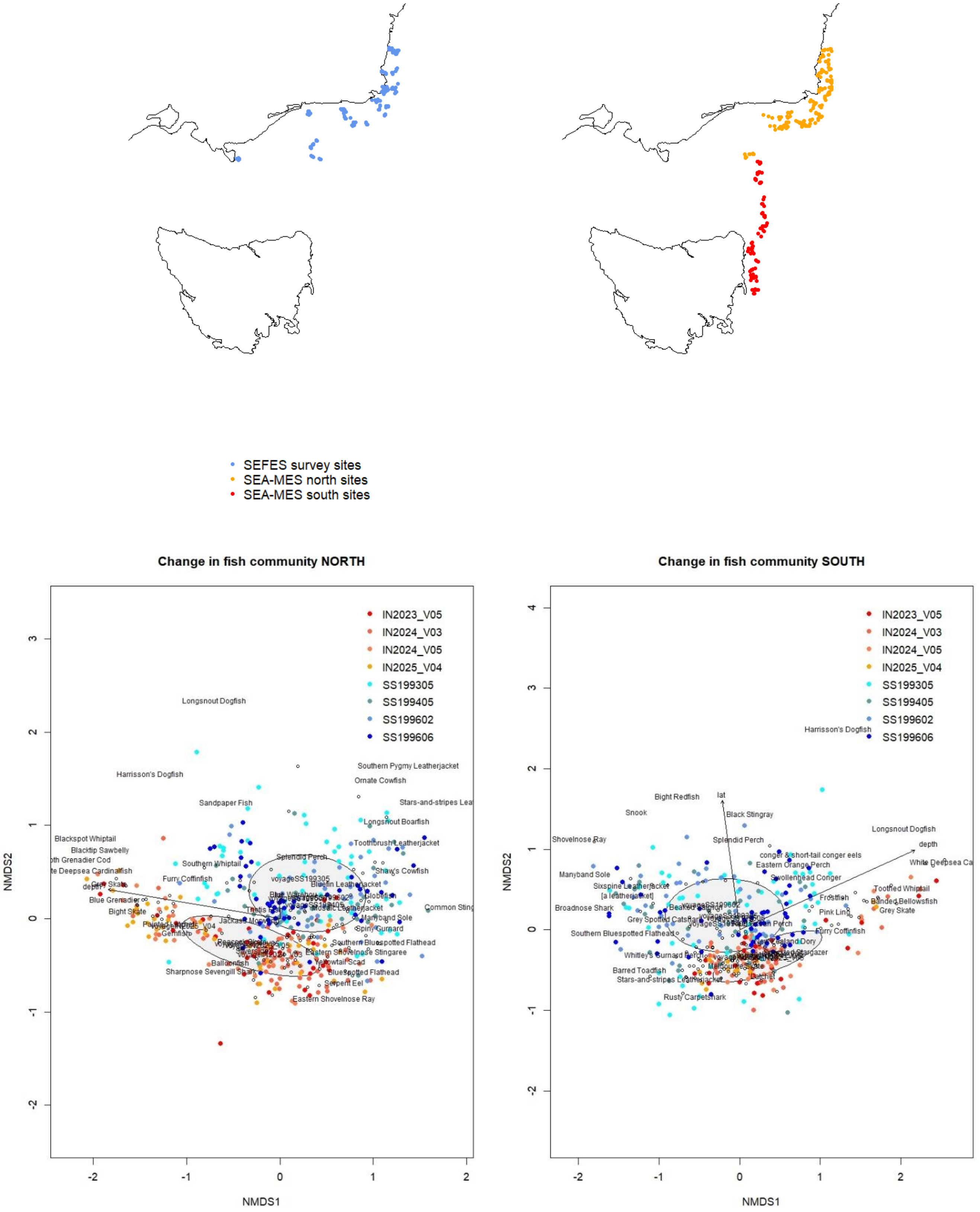

Figure 6. Top panel left: SEFES survey sites (blue); right: SEA-MES survey sites - NORTH same latitude at SEFES sites (orange); SEA-MES sites SOUTH of SEFES sites (red). Bottom panel: Ordination using non-metric multi-dimensional scaling. Left: species composition of SEFES sites compared to SEA-MES sites NORTH; right: species composition of SEFES sites compared to SEA-MES sites SOUTH. Environmental factors (depth) are shown as vectors. Ellipses are 95% confidence representation of survey voyages.

Changes in oceanographic conditions

An analysis of ocean conditions from the Bluelink ReANalysis (BRAN2020; Chamberlain et al. 2021) experiment, which uses a 10-km resolution (eddy-resolving) ocean model to simulate oceans conditions from 1993 to 2023 shows that eddy-mixing was higher during 2023 as measured by annual variability in sea surface height (Figure 7). In particular, a stationary a warm core eddy is easily seen in July 1993 (Figure 8). By contrast, July 2023 (Figure 8) has overall higher sea surface height right down the east coast of Tasmania, as a result of eddies moving through the region throughout the month (Figure 9). Sea surface temperature (Figure 10) was also higher during July 2023 compared to July 1993. Bottom temperatures, which are likely to be less variable, have also seen increases (Figure 11). These results are accessible at https://research.csiro.au/sea-mes/how-have-ocean-conditions-changes/. The specific effect of them on the ecosystem are still uncertain.

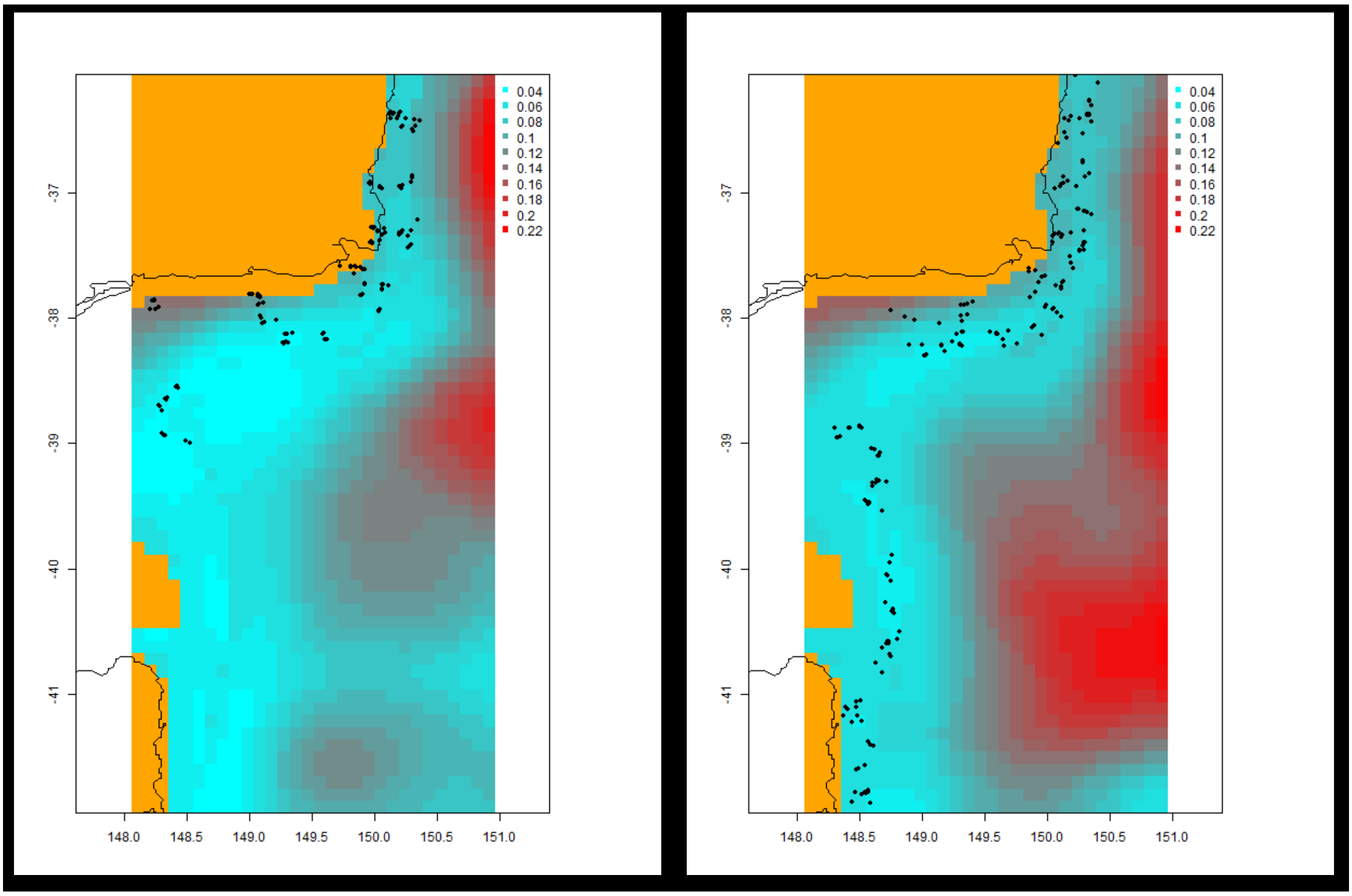

Figure 7. Annual eddy field strength measured as the annual variability (standard deviation) in daily sea surface height in calendar year 1993 (left) and 2023 (right). Dots are survey trawl sample locations: SEFES (left) and SEA-MES (right).

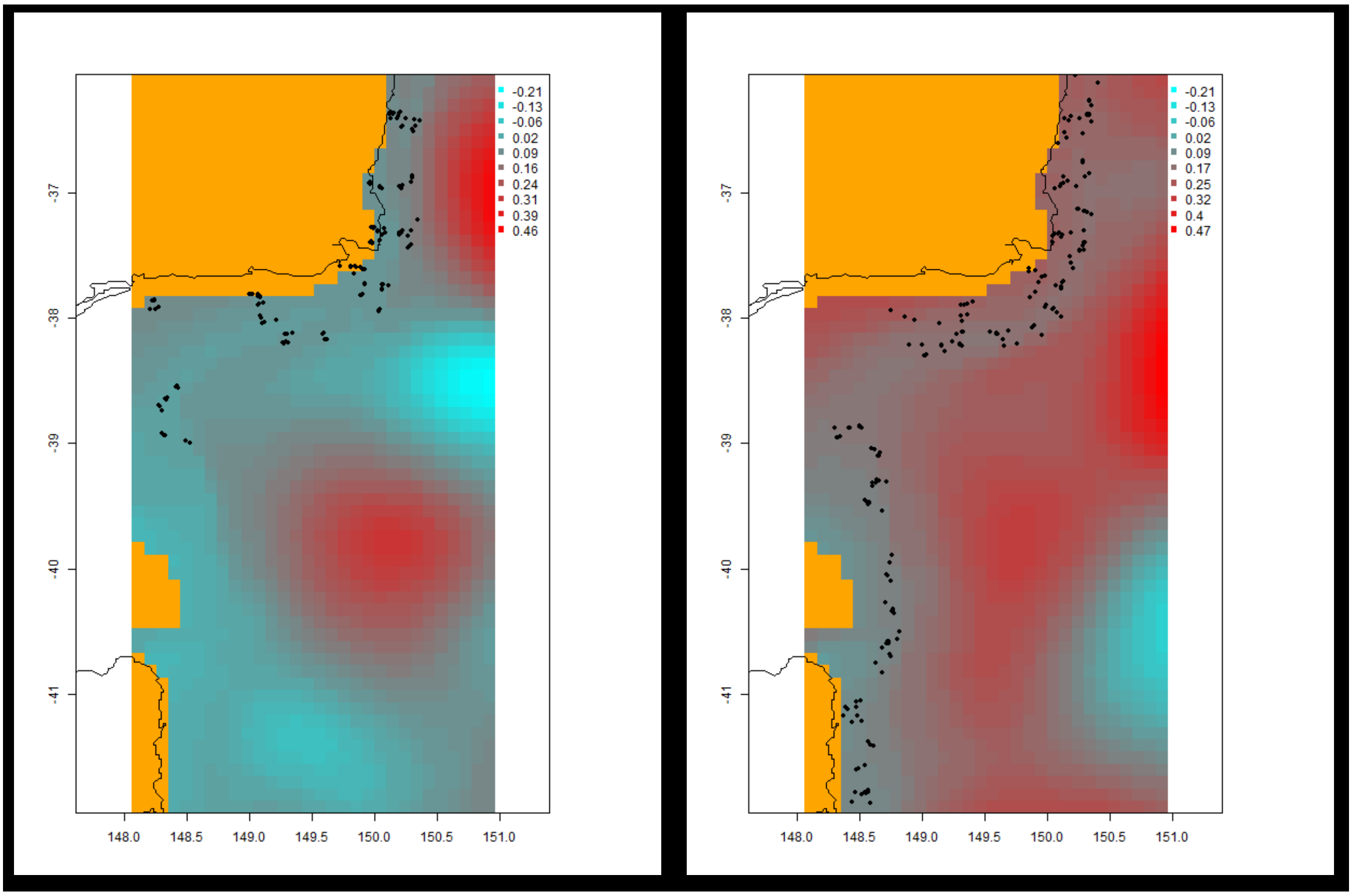

Figure 8. Mean monthly sea surface height during July 1993 (left) and July 2023 (right) showing warm core eddies (red) and cold core eddies (blue). Dots are survey trawl sample locations: SEFES (left) and SEA-MES (right).

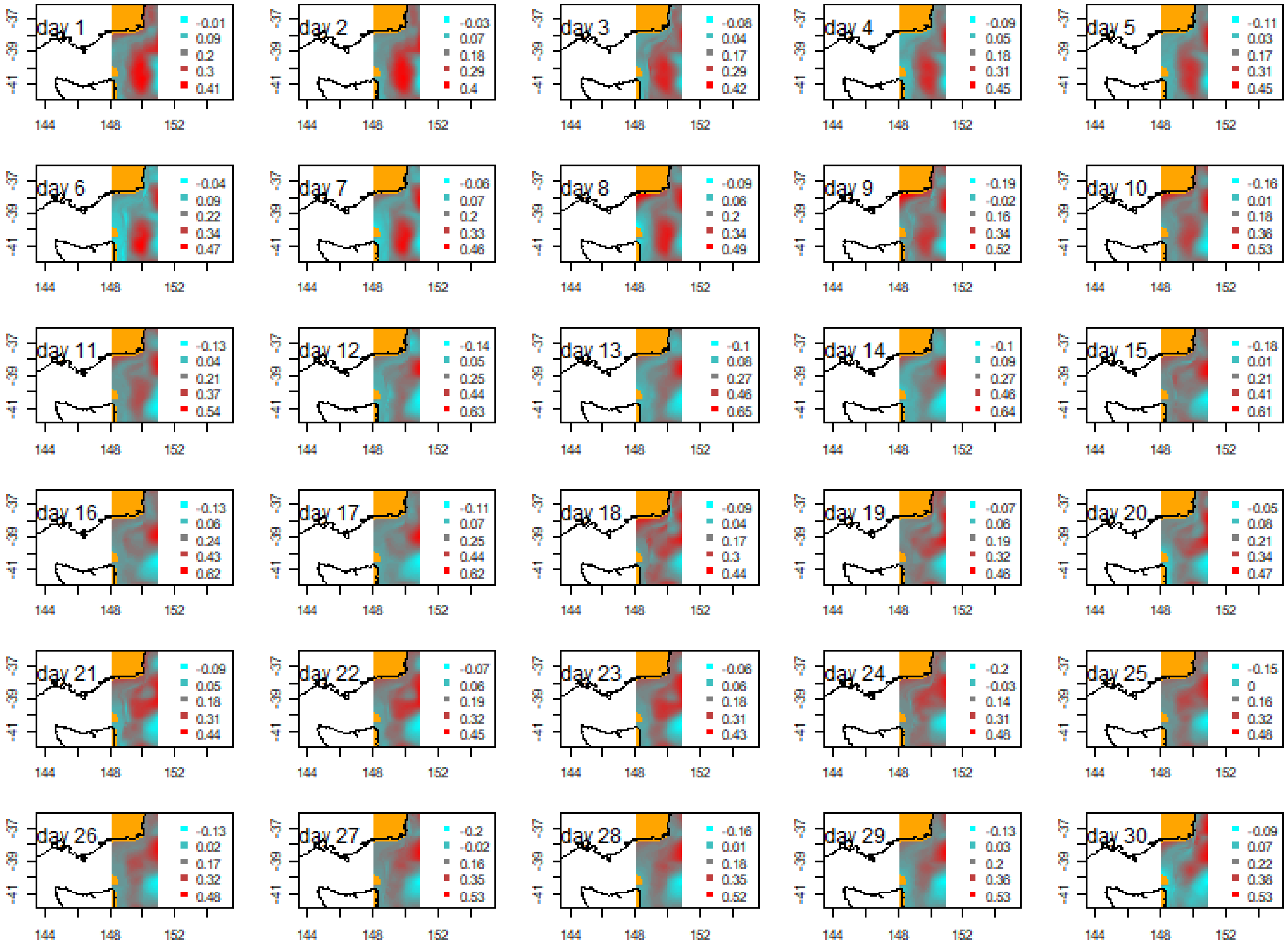

Figure 9. Daily sea surface height (m) during July 2023 showing warm core eddies (red) and cold core eddies (blue).

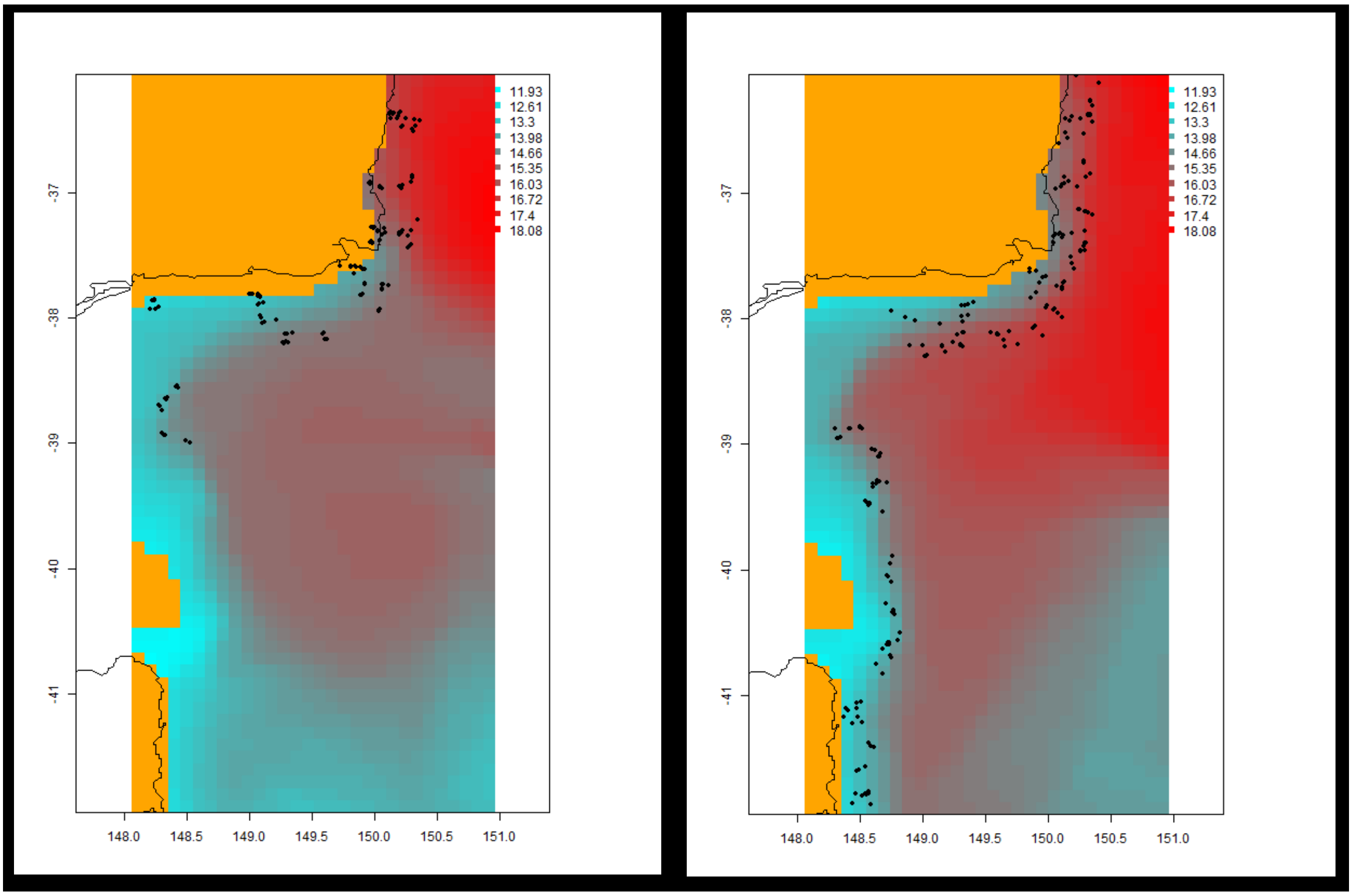

Figure 10. Mean monthly sea surface temperature (°C) during July 1993 (left) and July 2023 (right). Dots are survey trawl sample locations: SEFES (left) and SEA-MES (right).

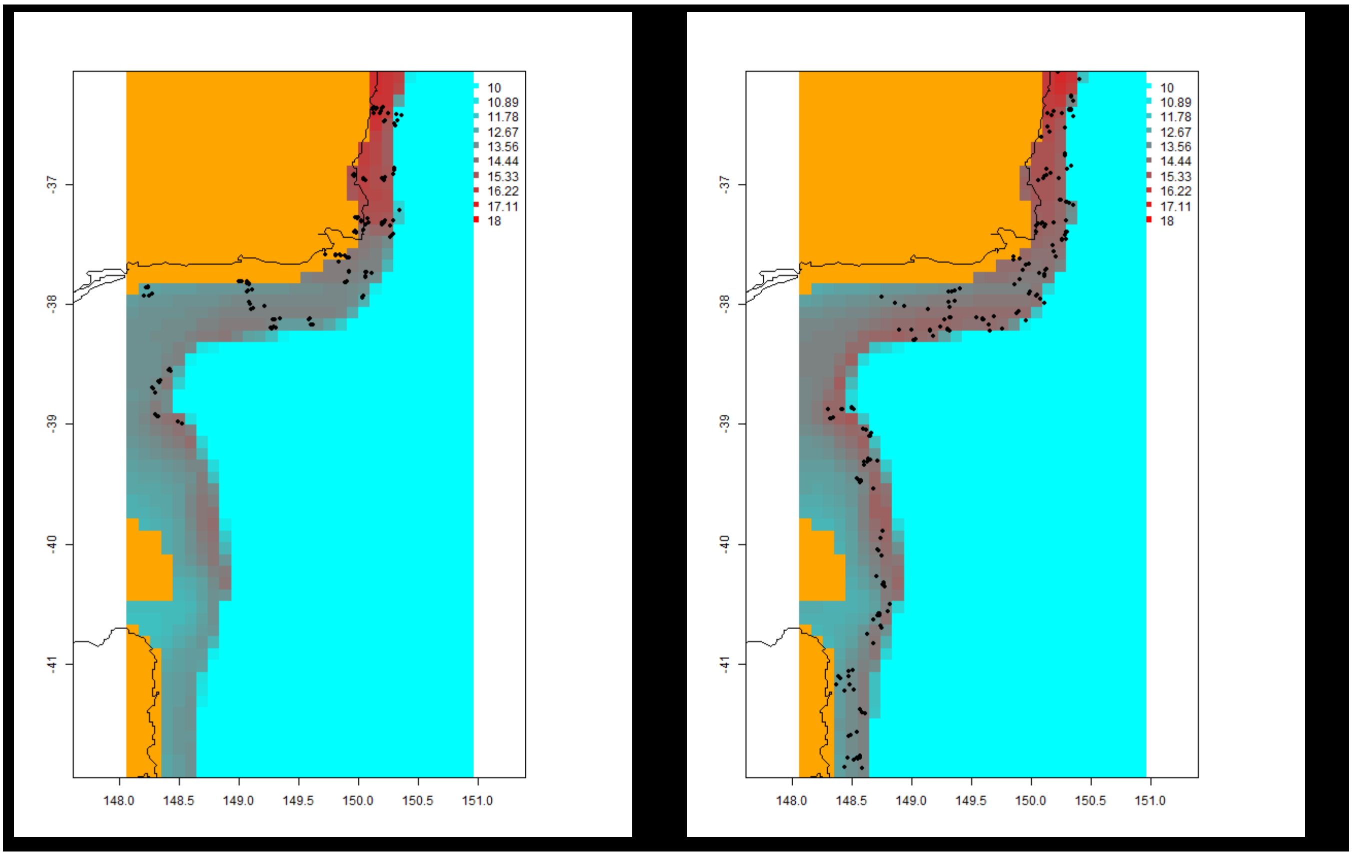

Figure 11. Mean monthly bottom temperature (°C) during July 1993 (left) and July 2023 (right). Dots are survey trawl sample locations: SEFES (left) and SEA-MES (right).

Potential and additional on-going work

On-going work on redfish as part of the SEA-MES project include a comparison of genomic contents with con-generic species (e.g. bight redfish) and an examination of individual fish condition with habitat quality. Population genomics are being profiled using samples obtained from the SEA-MES voyages. Length-weight data and biological samples (e.g. otoliths) are also available for updating stock abundance estimates.

References

Bax, Nicholas J. and Williams, A. 2000. Habitat and fisheries production in the south east fishery ecosystem. Final report to the Fisheries Research and Development Corporation. Project 94/040.

Chamberlain et al. 2021. Next generation of Bluelink ocean reanalysis with multiscale data assimilation: BRAN2020. Earth Syst. Sci. Data, 13, 5663–5688, https://doi.org/10.5194/essd-13-5663-2021

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