Species Listing Eligibility and Conservation Actions for Grey Skate (*Dipturus canutus*): Catch Data from the South East Australian Marine Ecosystem Survey (SEA-MES) Voyages 1-3.

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 1-3 have been conducted in May 2023, July 2024, November 2024. Voyage 4 will take place in June 2025. Through a range of biological sampling techniques, it is capturing 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 is also undertaking water column sampling to measure the physical and chemical properties of the ocean, towing a video system over the ocean bed to describe the benthic habitat, testing new ways of measuring and monitoring the ecosystem using DNA from tissue and free-floating in the marine environment, and counting sea-birds 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 have been limited so far to daylight hours.

Preliminary SEA-MES Results

Preliminary results from SEA-MES voyages 1-3 (May 2023, July 2024, and November 2024) indicate catches of Grey Skate of 9.22 kg/ h in the SEA-MES sample locations where the species was found (300m – 700m). The species was absent from the SEFES species list of Williams and Bax (2001). Prior to being described in 2008 (Last 2008) however, *D.canutus* was known as *Raja* sp. *B*. One specimen caught on the SEFES baseline survey in 1993 at 600m depth, is now identified as *D.canutus* in the CSIRO collection (see Figure 1). The species is difficult to identify and can easily be confused with *D. grahami* (Graham's Skate) and potentially *D. gudgeri* (Bight Skate), the latter of these was also reported from SEFES surveys (see Figure 1). Here we report preliminary SEA-MES catch results for all three species.

Species	SEFES CPUE (kg/h)	Shots with species	SEA-MES 1 CPUE (kg/h)	Shots with species	SEA-MES 2 CPUE (kg/h)	Shots with species	SEA-MES 3 CPUE (kg/h)	Shots with species	Avg SEA-MES CPUE (kg/h) ± SD
Dipturus canutus	2.00	1	5.41	7	6.27	1	11.79	12	9.22 ± 7.00
D. grahami	-	0	4.72	1	6.98	5	12.37	4	8.84 ± 5.64
D. gudgeri	2.16	2	11.25	9	52.09	7	33.02	13	29.94 ± 45.74

In addition to identification, differences to the SEFES baseline surveys are also likely due to survey sample location, as shown in Figure 1. SEA-MES covers a wider range latitudinal range south than the SEFES survey, including the Freycinet and Flinders Marine Parks where Grey Skate were seen in voyages 1 and 3 (Figure 1). Similar patterns were seen for Graham's Skate and Bight Skate, although not as far south. SEA-MES also sampled more than the SEFES survey between 300m and 500m (17% for SEA-MES vs 7% for SEFES), which is the species preferred depth range (Figure 2a top panel). It is not surprisingly that it was more frequently found (Figure 2a). Results were similar for Graham's Skate (Figure 2b) and Bight Skate (Figure 2c).

Overall, the demersal fish community composition differs between the SEFES and SEA-MES surveys (Figure 3) in the region sampled by both surveys. The reason could be due to the difference in sample sites, or potentially other oceanographic factors which have changed between the surveys.

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 4). In particular, a stationary a warm core eddy is easily seen in July 1993 (Figure 5). By contrast, July 2023 (Figure 5) 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 6). Sea surface temperature (Figure 7) was also higher during July 2023 compared to July 1993. Bottom temperatures, which are likely to be less variable, have also seen increases (Figure 8). 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.

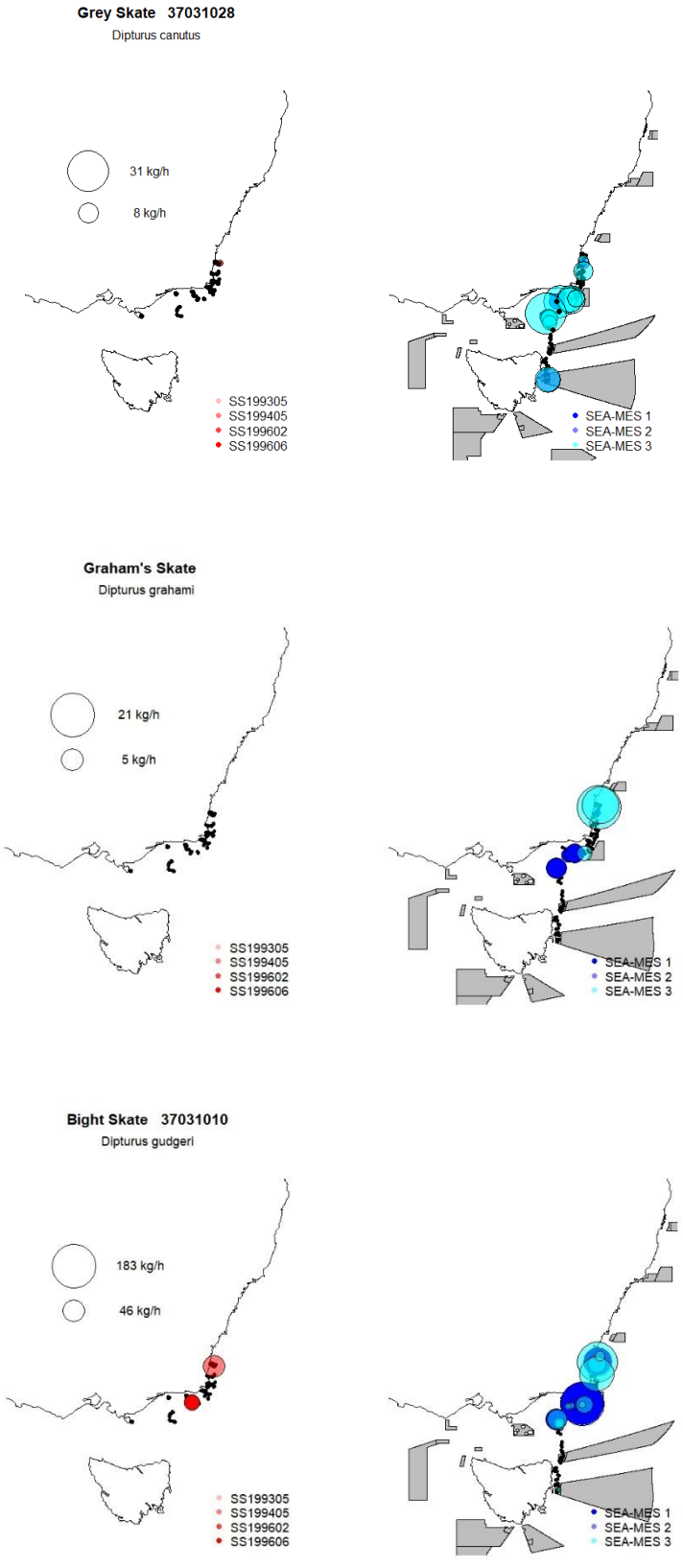

Figure 1. Catch-per-unit-effort (CPUE as kg/h) of Grey Skate (top), Graham's Skate (middle) and Bight Skate (bottom) by sampling location (solid dots) in SEFES survey (Bax and Williams 2000) and for each of the SEA-MES voyages. CPUE is shown as graduated coloured circle, zero catches as black dots. Australian Marine Parks in the South-east Marine Parks Network (shading).

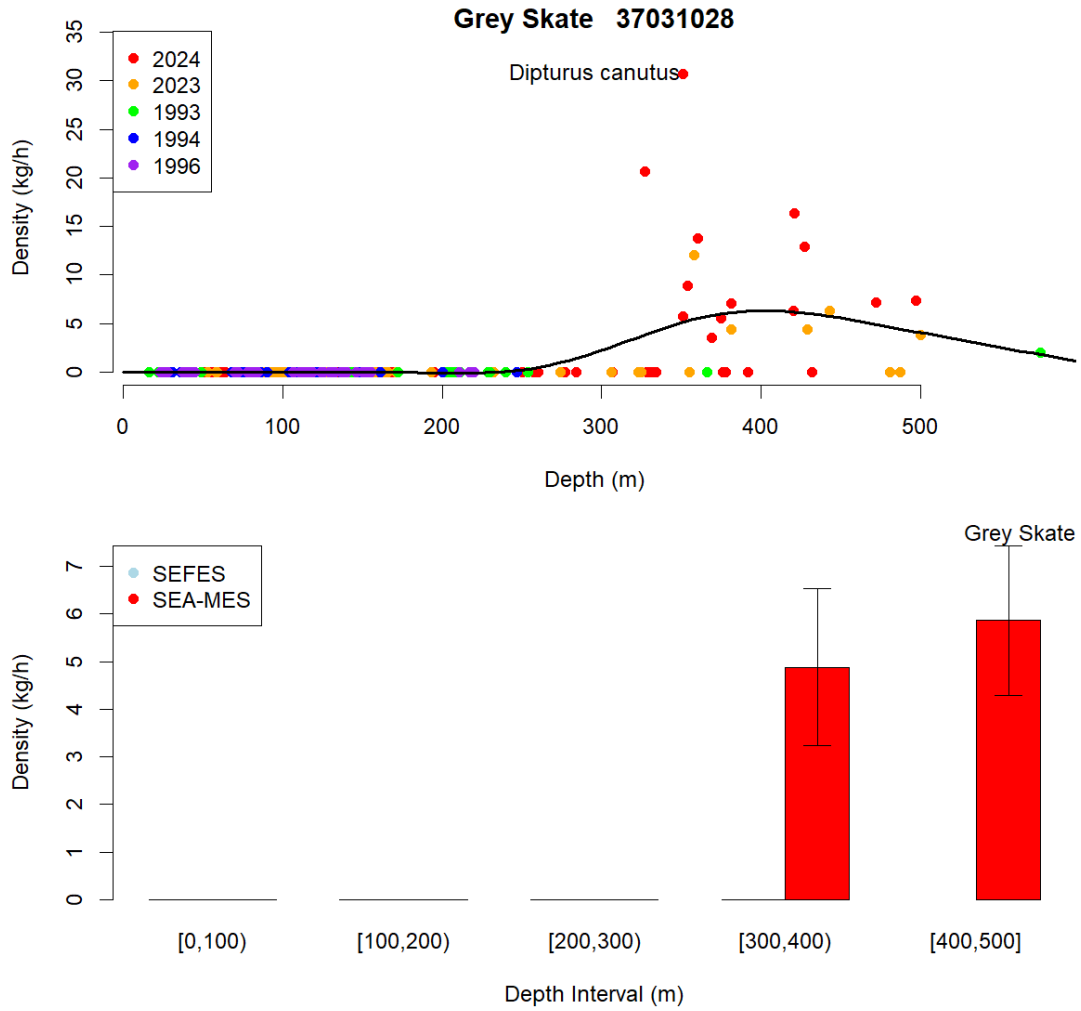

Figure 2a. Top panel: Trawl operation CPUE (kg/h) of Grey Skate by depth range and year (survey), Bottom panel CPUE (kg/h) of Grey skate by depth range by survey.

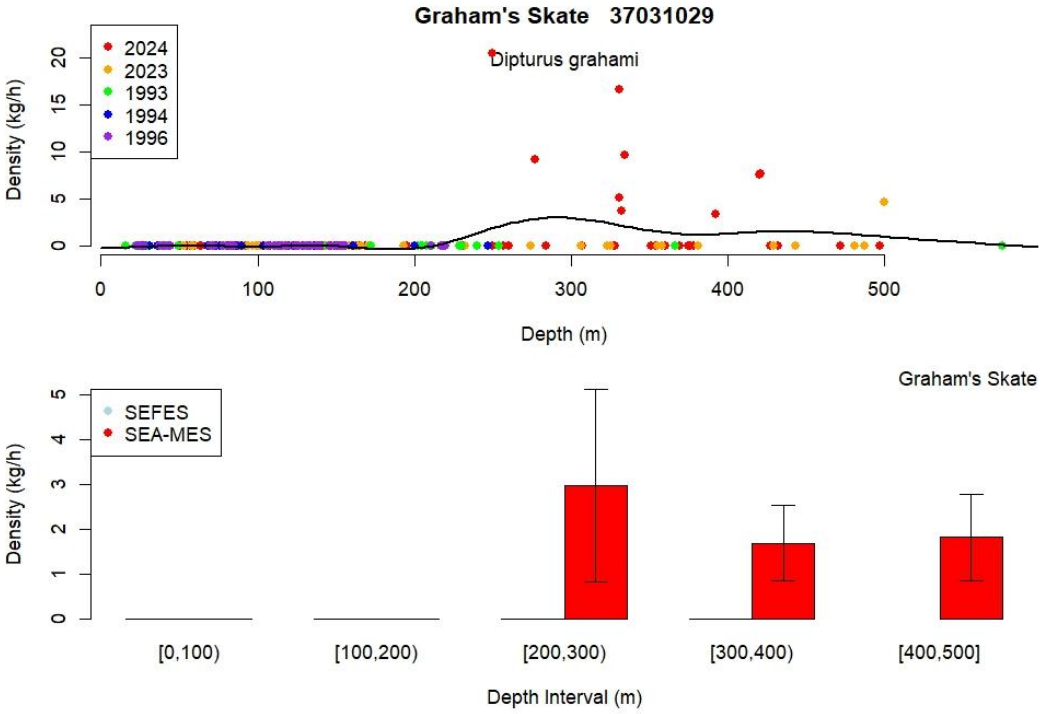

Figure 2b. Top panel: Trawl CPUE (kg/h) of Graham's Skate (top) by depth range and year (survey), Bottom panel CPUE (kg/h) by depth range by survey.

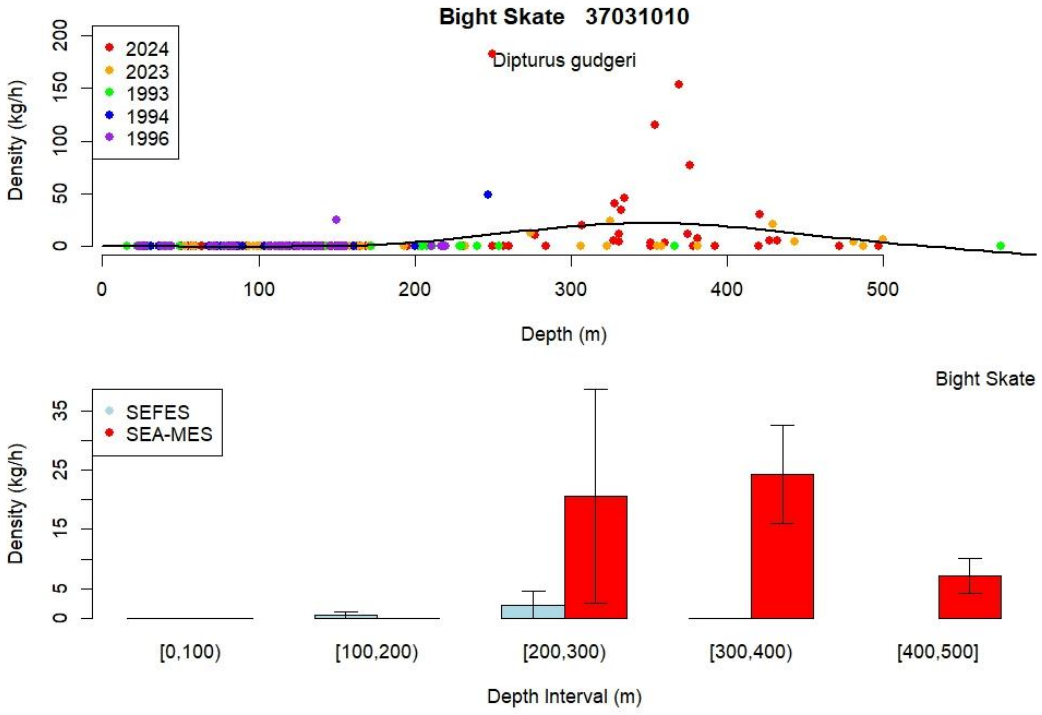

Figure 2c. Top panel: Trawl CPUE (kg/h) Bight Skate by depth range and year (survey), Bottom panel CPUE (kg/h) by depth range by survey.

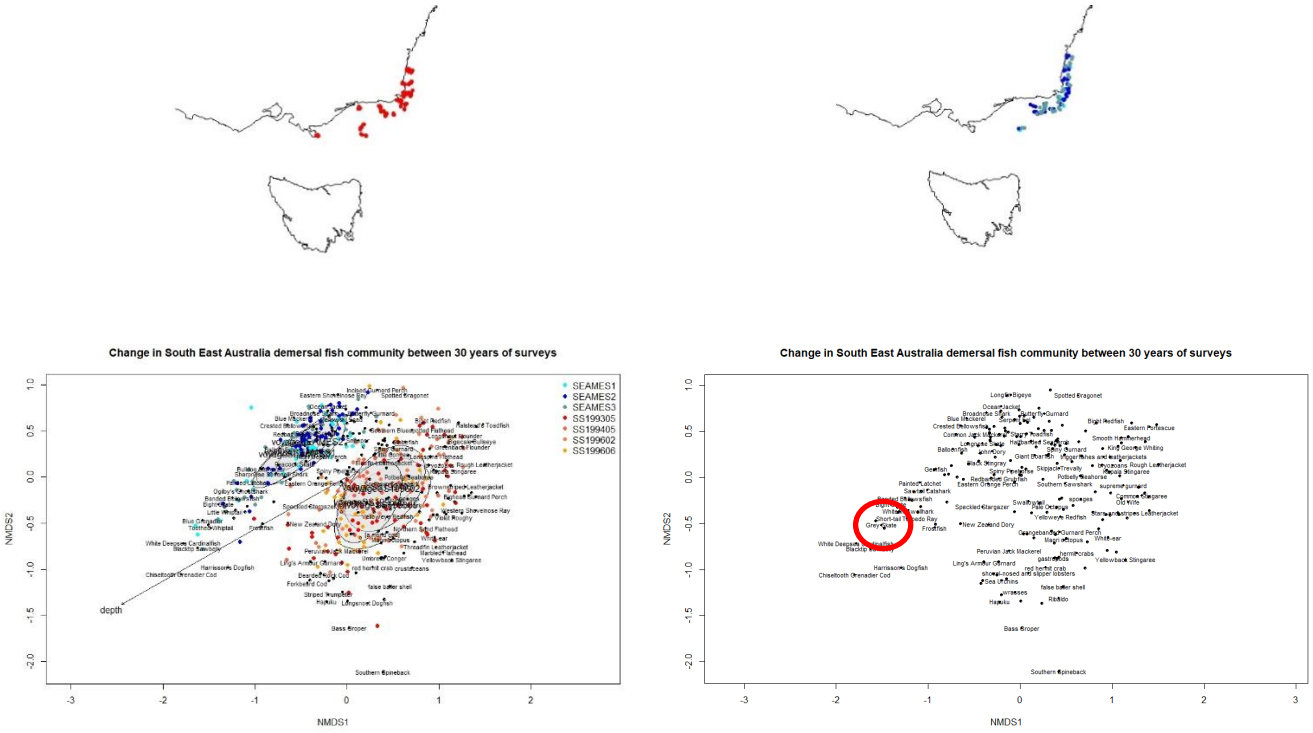

Figure 3. Top panels: SEFES trawl sites (left) and SEA-MES trawl sites (right) used for fish catch composition comparison between surveys. Bottom left panel: Ordination of species catch composition of survey voyage trawl operations (coloured symbols) using non-metric multi-dimensional scaling (left). Environmental factors (depth) are shown as vectors. Ellipses are 95% confidence representation of survey voyages. Bottom right panel: Highlighted Grey Skate in species ordination.

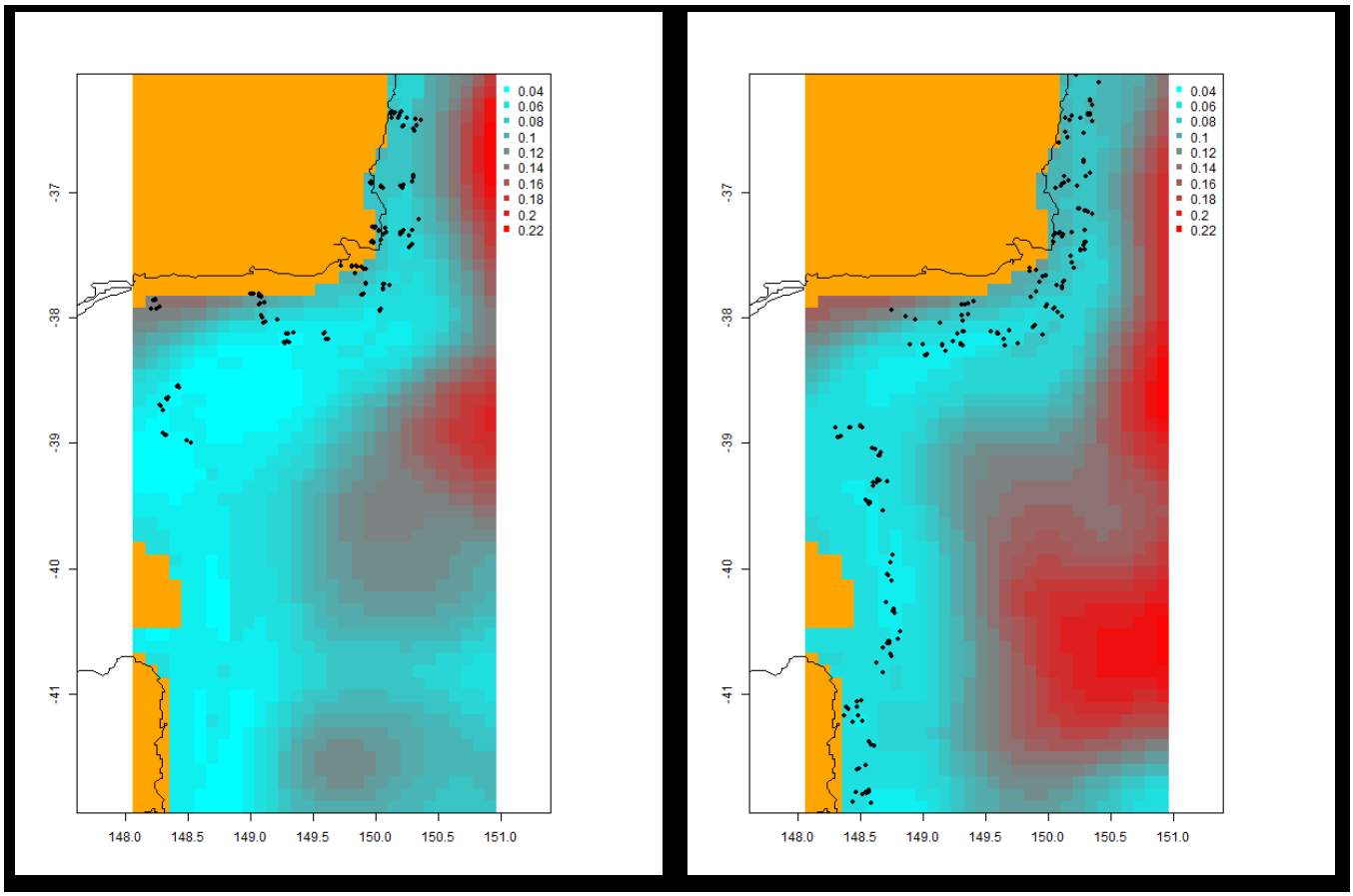

Figure 4. Annual eddy field strength measured as the annual variability (standard deviation) in daily sea surface height in calendar year 1993 (left) and 2023 (right). Dots are survey trawl sample locations: SEFES (left) and SEA-MES (right).

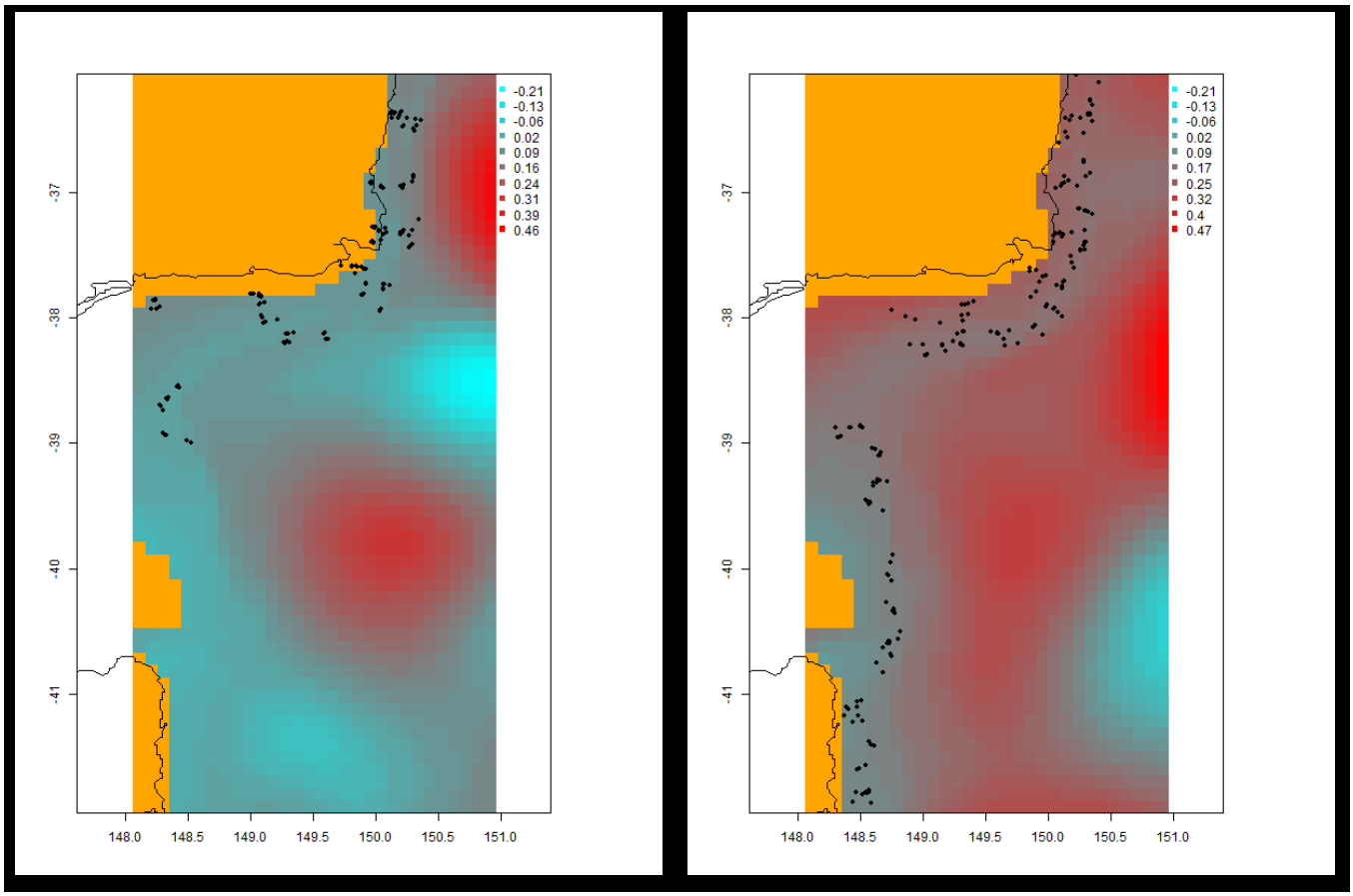

Figure 5. Mean monthly sea surface height in July 1993 (left) and July 2023 (right) showing warm core eddies (red) and cold core eddies (blue). Dots are survey trawl sample locations: SEFES (left) and SEA-MES (right).

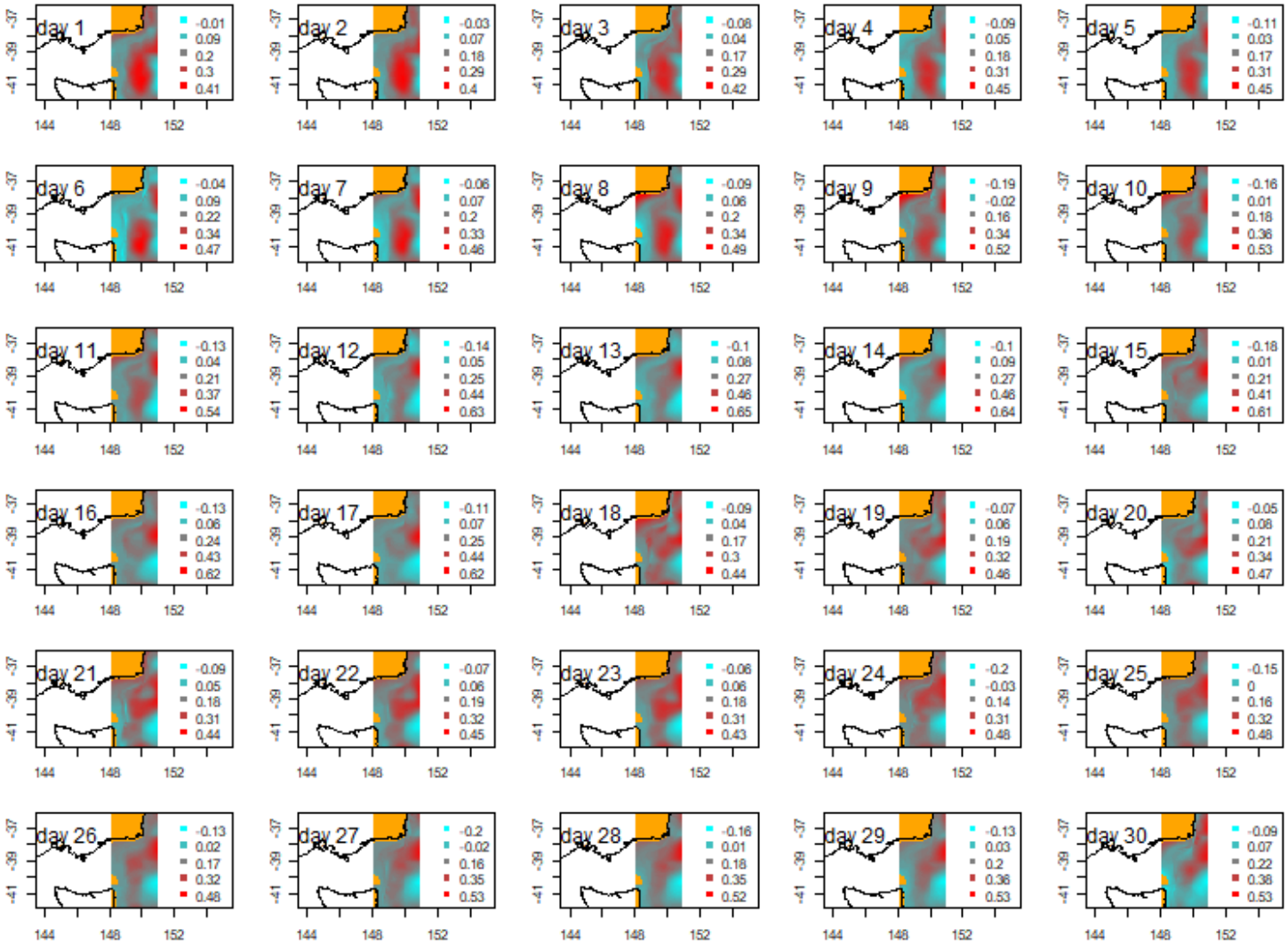

Figure 6. Daily sea surface height (m) in July 2023 showing warm core eddies (red) and cold core eddies (blue).

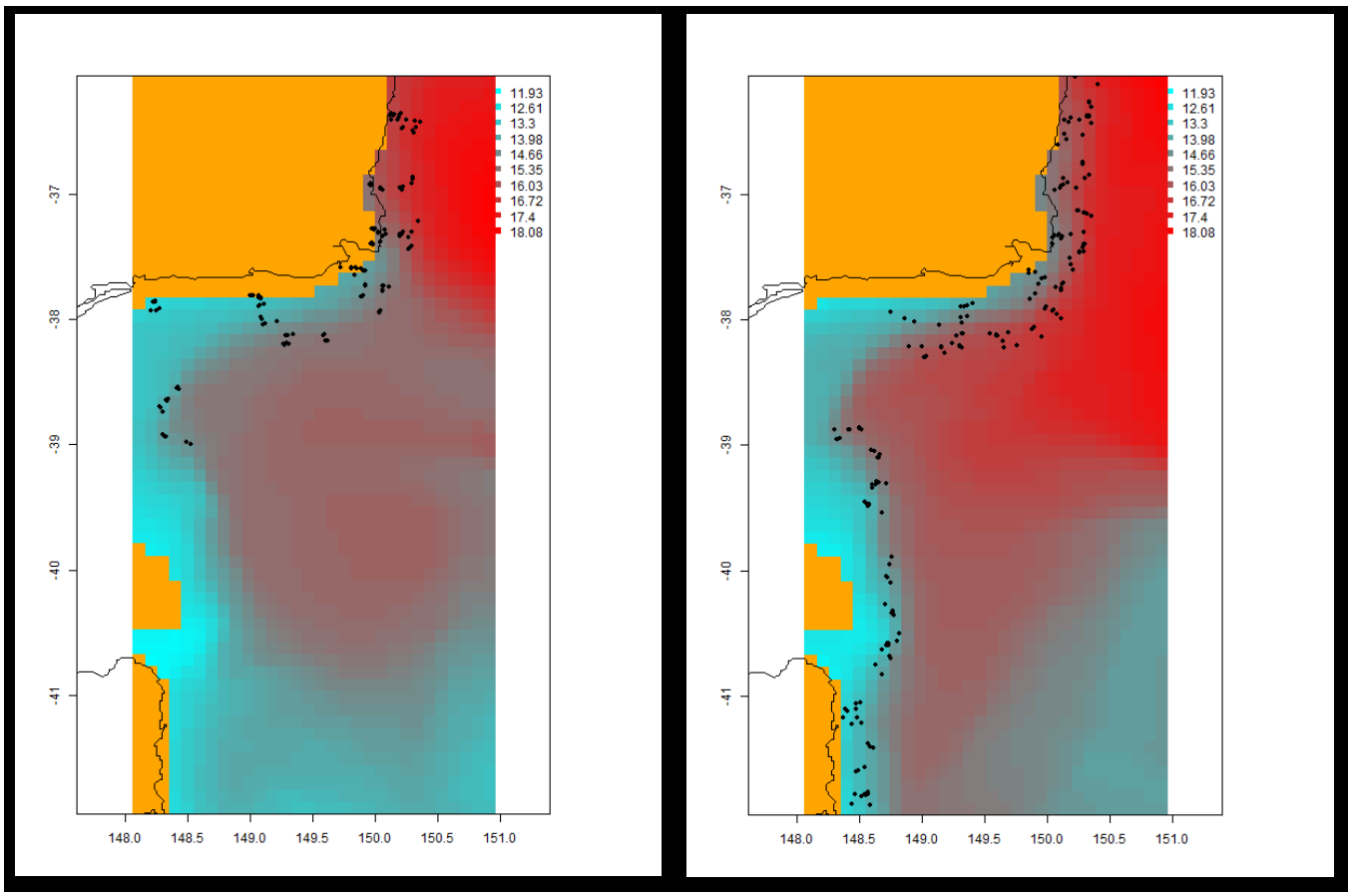

Figure 7. Mean monthly sea surface temperature (°C) in July 1993 (left) and July 2023 (right). Dots are survey trawl sample locations: SEFES (left) and SEA-MES (right).

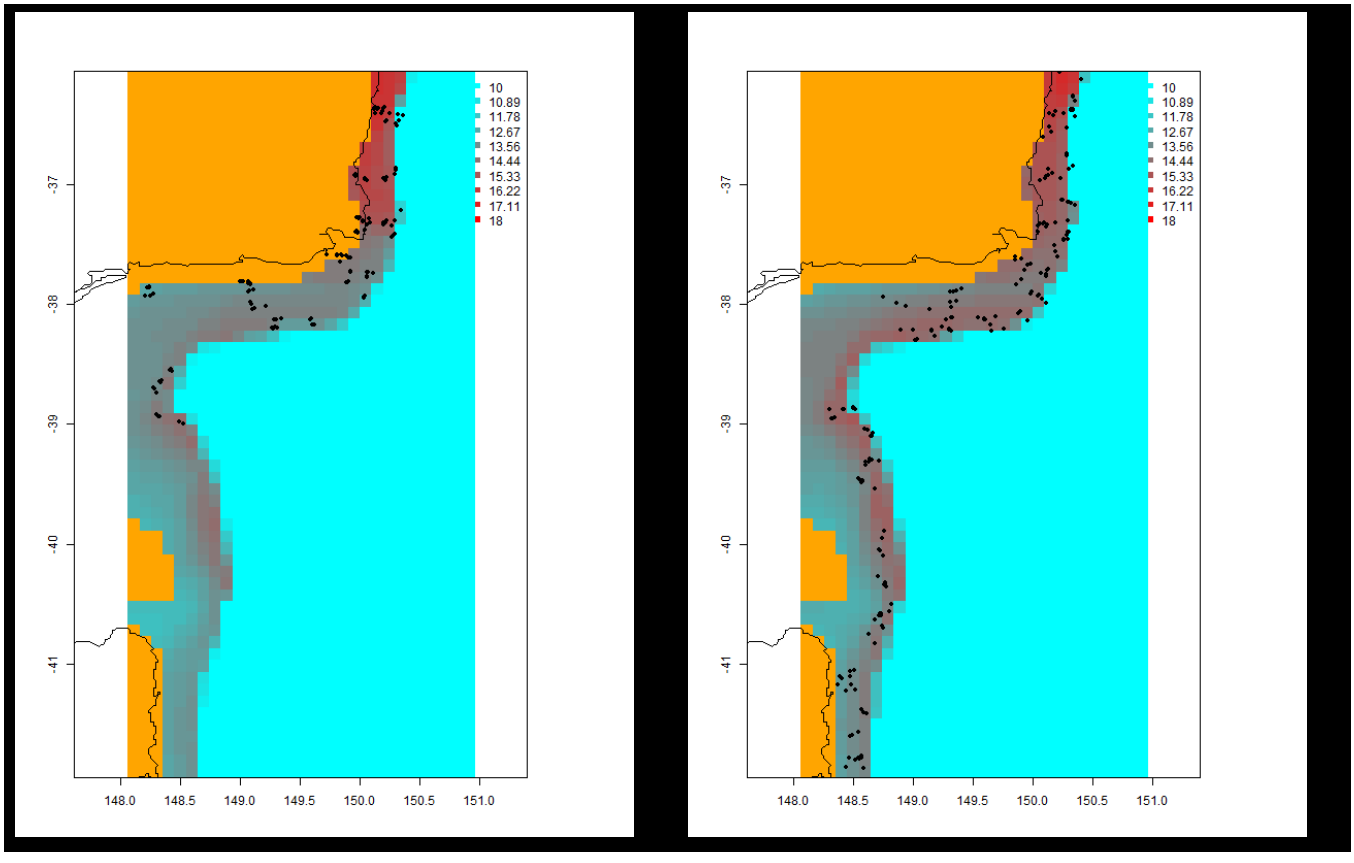

Figure 8. Mean monthly bottom temperature (°C) in July 1993 (left) and July 2023 (right). Dots are survey trawl sample locations: SEFES (left) and SEA-MES (right).

References

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