MNF Voyage Highlights

Voyage #:	IN2024_V03
Voyage title:	Untangling the causes of change over 25 years in the southeast marine ecosystem - Voyage 2
Mobilisation:	Hobart, Sunday 28 April 2024 – Tuesday 30 April
Depart:	Hobart, 0800 Wednesday 1 May 2024
Return:	Sydney, 0800 Friday 31 May 2024
Demobilisation:	Sydney, 0800 Friday 31 May 2024
Voyage Manager:	Stephen Thomas
Chief Scientist:	Dr Richard Little
Affiliation:	CSIRO
Principal Investigators:	
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Voyage Highlights

The Chief Scientist

The Chief Scientist, Dr Rich Little, is a Senior Principal Research Scientist and Research Group Leader for Transforming Industries and Marine Ecosystems in CSIRO Environment, based in Hobart. His research specialises in modelling population dynamics, economics, risk management and decision-analysis in natural resource and marine environmental science.

Title

South-East Australian Marine Ecosystem Survey (SEA-MES): Untangling the causes of change over 25 years in the south-east marine ecosystem

Purpose

The marine waters of southeast Australia are one of a series of global ocean hotspots. In this region, the East Australian Current is extending pole-wards, resulting in warming of the ocean surface at a rate four times the global average. Many species have extended their distributions southward, with potential changes in local abundance. In addition, extreme events, such as marine heatwaves, are leading to additional impacts. Projections show that these changes, and the associated biological responses, are expected to continue in the next century.

In this hotspot lies the Australian Commonwealth Southeast Marine Park Network (SE-MPN; Figure 1), which was established in 2012 to protect the region's marine ecosystems and biodiversity, contribute to the National Representative System of Marine Protected Areas and help ensure the long-term ecological viability of Australia's marine ecosystems. It is unclear whether ecosystem changes observed in the region have also affected the marine parks, or whether the network has mitigated them. Understanding this better would help improve the ability of the marine park network to protect Australian heritage in the future.

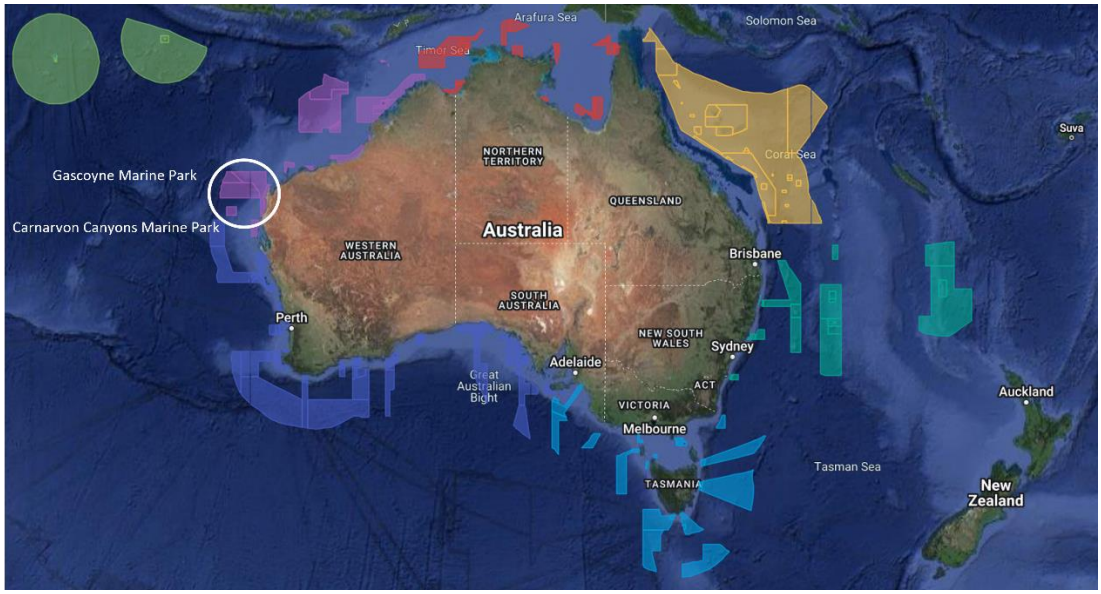

Figure 1 Australian Marine Park Network

In 2015, an expert scientific panel recommended an adaptive management approach for the Commonwealth marine reserve estate. It included the development of a research, monitoring and evaluation framework that supports robust evidence-based decision-making, and recommended, as part of the National Marine Science Plan 2015– 2025, establishment of baselines and development of early critical benchmarks to enable a sound assessment for effective management.

Also in this hotspot lie important fisheries, providing the bulk of fresh fish to Melbourne and Sydney markets. The Commonwealth-managed Southern and Eastern Scalefish and Shark Fishery (SESSF) catches about 20,000t, valued at $87 million in 2018-19, and about 20% of the value of Australian Commonwealth-managed fisheries. The trawl sector, which accounts for roughly 15,000t, spans the marine waters in the hotspot. Observations from the SESSF over the past 20 years have indicated changes in the abundance and composition of the main finfish species, manifest as declines in commercial catch rates. Concurrent with these declines, has been unprecedented high levels of catches and catch rates of other species such as ocean jackets and latchet. Additionally, stocks that were historically over-fished have not responded as expected, despite active fisheries management and a reduction in fishing effort. A recent review concluded that physical and ecosystem factors are likely to be either directly affecting the main species, or indirectly affecting other species they compete with or rely on. The general view is that the marine ecosystem has experienced and is experiencing significant change. Several hypotheses have been proposed; none have been tested but they are broadly categorised as being climate-related, or fishing-related. What is clear is that fish species from which ecosystem changes have been inferred, represent only a small part of the ecosystem under pressure, and it is not well understood. Potential changes in the abundance of tropical picoplankton extending into southern Australian waters is possible for example, which would have cascading effects since they do not support the same fish biomass as those associated with cooler waters.

SEA-MES seeks to answer 3 questions:

1. How much have habitats, fish assemblages and species abundances changed in the southeast ecosystem in 25 years?
2. How do any changes affect the multiple-use management of the region, particularly conservation and biodiversity management of Australian Marine Parks and the hive of activity from fisheries, oil & gas, and renewable energy sectors?
3. What are the implications for marine spatial planning and adaptive management in sectors that use the marine ecosystem and the managers that regulate it?

As a result, the core objectives are:

1. To determine changes in the assemblage structure (composition, abundances, distributions) of continental shelf and slope fishes (including focus on a suite of commercially important species) by comparing new survey data to historical baseline data.
2. To measure co-varying physical and biological properties of the regional ecosystem, especially metrics of changing ocean environment and exposure of benthic habitats to fishing.
3. To establish cause and effect by testing a series of hypotheses derived from a bio-physical model of the ecosystem, specifically created for the survey.
4. To establish a new baseline for future surveys.

These objectives are being addressed by a field survey and subsequent data analysis structured around three hypotheses (Figure 2) based on two impacts: (i) the physical impacts of the water column driven by changing ocean conditions (Climate Hypothesis); (ii) impacts on the habitat have been driven by exposure to bottom-contact fishing (Habitat Hypothesis). These impacts work either directly on fish species abundances, or indirectly through the food web (Trophic Hypothesis). Our prime motivation has been on commercial fish species, but we are not limited to them.

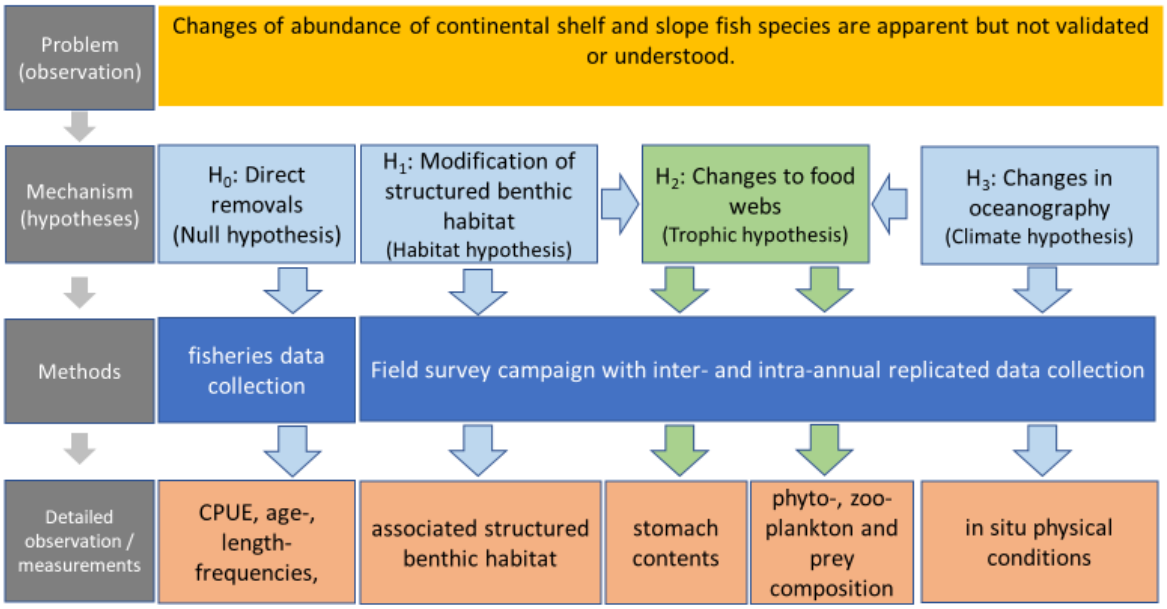

Figure 2 Direct (blue) and indirect (green) impacts on fish abundance (orange).

Contribution to the nation

The marine waters of southeast Australia are becoming increasingly valuable and congested (Figure 3). The Gippsland Basin, a sub-area encompassed by the SESSF and adjacent to the East Gippsland and Beagle Marine Parks, has aging oil and gas infrastructure in the Bass Strait field that is expected to be decommissioned. The region is also the location of field-based projects evaluating carbon sequestration techniques, and offshore renewable energy generation development proposals.

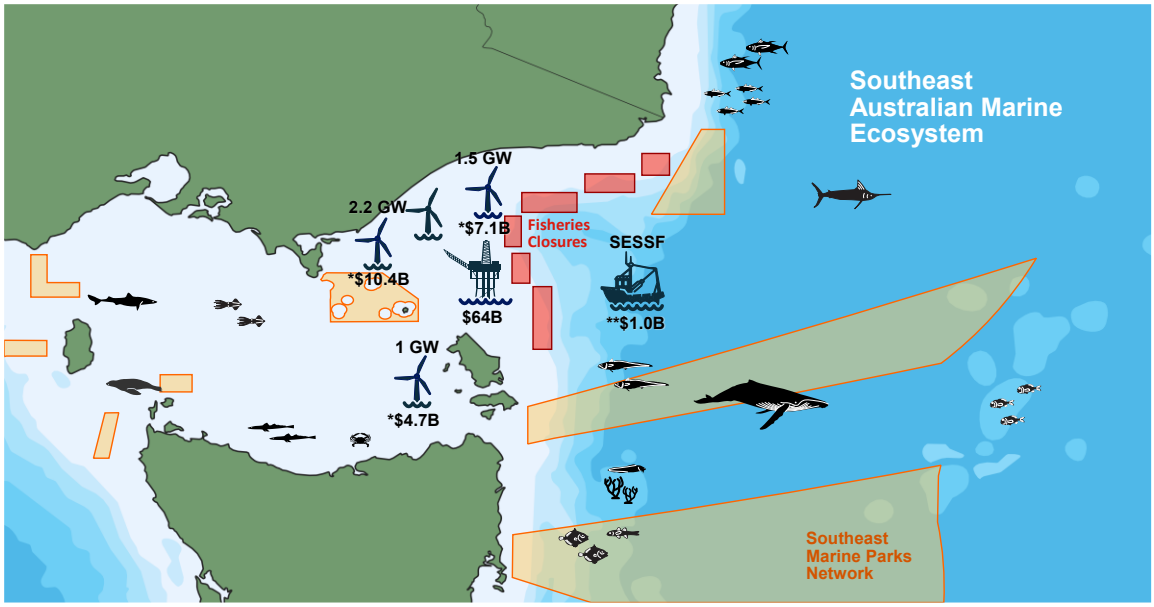

Figure 3 Economic and non-economic amenities in the SE Australian marine ecosystem

Fisheries and conservation managers, industry sectors and stakeholders have concluded that there is an urgent need in the southeast Australian marine waters to understand the impacts of changes to the marine ecosystem and prepare for the continued impending changes. The last major survey of the southeast continental shelf ecosystem was conducted 25 years ago. Comparable research on the continental slope was conducted even earlier in the 1980s. The Southeast Australian Marine Ecosystem Survey (SEA-MES) is an ambitious multi-voyage program to address the research needs and concerns in the southeast region.

This project is the foundation that underpins our attempt to document and understand what is causing the changes in the ecosystem since the previous surveys were conducted. It occurs at a time when understanding current and future changes to the ecosystem is imperative for effective adaptive operational planning and management by the multiple regional stakeholders, marine park and fisheries managers, and the renewable and non-renewable energy industries.

As a result of this voyage

1. We have improved our understanding of how the SE Australian Marine ecosystem has changed over the past 30 years.
2. We have seen that small pelagic fish species such as jack mackerel continue to show increased abundance.
3. We have mapped and sampled large areas of the Flinders and Freycinet Marine Parks and are continuing to monitor the fisheries marine closures.
4. We have commenced a program pairing two established sampling methods (demersal trawl and deep towed video) with two methods of environmental DNA (eDNA) collection.

Next steps

1. Research projects to analyse data and use the data are being developed including:
    a. Biological parameters for stock assessments in South Eastern Australia – an information and capacity uplift (FRDC project 2022-032, PI: K.Evans)
2. Data collected are being processed to the extent that resources are available including:
    a. An analysis of eDNA samples collected will focus on assessing and providing a baseline of the marine biodiversity in the survey area. Furthermore, eDNA sampling methods will be juxtaposed with conventional surveying methods (i.e trawl and tow video) to provide guidance on developing effective and scalable biomonitoring tools for Australian marine ecosystems.
    b. Plankton samples collected in the Multi-net will be identified and weighed,
    c. Sponges collected in the SE-MPs will be identified and weighed,
    d. Biological samples are being processed, including fish stomachs to understand food web,
    e. isotope analysis of tissue to better understand the predator-prey and trophic relationships in the ecosystem,
    f. gonads to understand maturity and fecundity, and
    g. otoliths to provide age distribution of our samples.
    h. Sea birds video imagery will be examined, labelled, and used to train an MLAI sea-bird detector algorithm. A prototype camera, and processor set-up will be created and tested in the lab. We will work with the MNF to install a near-real time prototype sea bird detector for SEA-MES 2.