Department of Primary Industries
and Regional Development

Kingfish

Results Report

Climate Vulnerability Assessment

NSW GOVERNMENT

Authors

The NSW Department of Primary Industries and Regional Development Climate Vulnerability Assessment and Fisheries Research teams.

Funding

The Climate Vulnerability Assessment has been completed as part of the Primary Industries Climate Change Research Strategy funded by the NSW Climate Change Fund.

Suggested citation

NSW Department of Primary Industries and Regional Development (2024) Climate Vulnerability Assessment kingfish Results Report. https://www.dpi.nsw.gov.au/dpi/climate/climate-vulnerability-assessment/publications-and-reports/Climate-Vulnerability-Assessment-Kingfish-Results-Report.pdf, accessed on [insert access date].

Acknowledgement of Country

The NSW Department of Primary Industries and Regional Development acknowledges that it stands on Country which always was and always will be Aboriginal land. We acknowledge the Traditional Custodians of the land and waters and show our respect for Elders past, present and emerging. We are committed to providing places where Aboriginal people are included socially, culturally and economically through thoughtful and collaborative approaches to our work.

TITLE: Kingfish Results Report
ISBN: 978-1-76058-876-2

Table of Contents

Contact us

For more information, please get in touch with vulnerability.assessment@dpird.nsw.gov.au

Introduction

Primary industries in NSW operate in one of the most variable climates in the world and are already dealing with a changing and variable climate. The Primary Industries Climate Change Research Strategy invested $29.2 million in projects to help the state's primary industries sector adapt to climate change. As part of this work, the Climate Vulnerability Assessment project undertook impact assessments for primary industries in the broadacre cropping, marine fisheries, forestry, extensive livestock, horticulture and viticulture sectors, in order to improve our understanding of the sensitivity to changes in climate of their commodities.

The Climate Vulnerability Assessment has delivered consistent and comparable understandings of potential climate change impacts across the state, providing a deep insight into sectoral impacts. This strategic information is invaluable for policymakers and industry bodies, providing insights into 28 commodities and 14 biosecurity risks considered as valuable or important to NSW.

This comprehensive assessment allows primary industries to understand the risks ahead, to prepare for and adapt to identified climate vulnerabilities, and to take advantage of future opportunities to expand in NSW.

Purpose of this report

This report contains results for the kingfish study within the Climate Vulnerability Assessment. The report introduces the kingfish industry in NSW and provides an overview of the kingfish model, its key features, assumptions and exclusions. The main results and findings are presented to provide insights into future climate vulnerabilities and opportunities. Where appropriate, the report also provides adaptation options.

Climate within NSW

The East Australian Current, a significant oceanographic feature, flows southwards and brings warm water from the Coral Sea and equatorial region to the NSW coast. This current not only influences the marine environment but also has a direct impact on NSW's climate.

Coastal waters are subject to seasonal variations, with occasional upwelling events bringing cooler, nutrient-rich waters to the surface.

The changing climate is impacting primary industries

Australia has one of the most variable climates in the world and primary producers have always managed for climate variability, and now they are planning for and adapting to future climate change. Climate change refers to human-induced changes in long-term climate patterns at global and regional scales. Human induced climate change is adding a new dimension to the challenge of producing food and fibre within Australia's variable climate. Its effects include increasing temperatures, changes in rainfall patterns and the intensification of extreme weather events such as heatwaves and heavy rain.

The $23.1 billion primary industries sector supports economic growth and development, contributes to food security at the state and national scale and plays a vital role in biosecurity management. The limited availability of practical and targeted information on the impact of climate change on commodity productivity or the changing prevalence of biosecurity risks has limited adaptation to climate change in this sector.

Projected climate change impacts

A review of research literature on the impacts of projected climate change on primary industries in Australia revealed disparities in research efforts across the primary industry sectors and in our understanding of what is likely to occur.

There have been few studies assessing the impact of climate change on fisheries; only 17 of 188 climate change impact papers published looked at this sector in Australia[1]. The research indicates that climate change is likely to already be driving a poleward extension of the East Australian Current resulting in subsequent marine warming[2,3,4]. Coastal and pelagic environments adjacent to south-eastern Australia are warming at a rate that is between 3 and 4 times more rapid than the global average, placing the NSW marine environment among the top 10% of fastest warming regions of the global ocean[5]. Furthermore, these studies have identified probable collective impacts from multiple aspects of climate change, such as rising ocean temperatures, ocean acidification, and alteration of ocean current characteristics[5]. These changes may exceed the suitability thresholds for some species and change marine ecosystem structure and function[6]. Variation in the degree of climate change exposure among NSW estuarine, freshwater, coastal and pelagic environments is poorly understood, highlighting the need for further research.

Assessing the impacts of climate change

The Climate Vulnerability Assessment examined the potential impacts of climate change on a wide range of economically important primary industry commodities and biosecurity risks in NSW. This enabled us to identify those industries most at risk and, thus, most in need of adaptation strategies, as well as those where climate change might bring new opportunities.

[1] Darbyshire, R. O., Johnson, S. B., Anwar, M. R., Ataollahi, F., Burch, D., Champion, C., Coleman, M. A., Lawson, J., McDonald, S. E., & Miller, M. (2022). Climate change and Australia's primary industries: factors hampering an effective and coordinated response. *International Journal of Biometeorology*, 1-12.

[2] Cai, W., Shi, G., Cowan, T., et al. (2005) The response of the southern annular mode, the East Australian Current, and the southern mid-latitude ocean circulation to global warming. *Geophysical Research Letters*, **32**.

[3] Ridgway, K. (2007) Long-term trend and decadal variability of the southward penetration of the East Australian Current. *Geophysical Research Letters*, **34**.

[4] Cetina-Heredia, P., Roughan, M., Van Sebille, E. and Coleman, M.A., 2014. Long-term trends in the East Australian Current separation latitude and eddy driven transport. *Journal of Geophysical Research: Oceans*, *119*(7), pp.4351-4366.

[5] Hobday, A. J., and Pecl, G. T. 2014. Identification of global marine hotspots: sentinels for change and vanguards for adaptation action. Reviews in Fish Biology and Fisheries, 24: 415–425.

[6] Walther, G.-R., Post, E., Convey, P., et al. (2002) Ecological responses to recent climate change. *Nature*, **416:**389-395.

Kingfish in NSW

Yellowtail kingfish (*Seriola lalandi*; Figure 1), hereafter referred to as kingfish, is an iconic medium to large bodied marine fish species distributed throughout temperate waters of the Pacific and Indian oceans. Kingfish are renowned for being an excellent sport and table fish and are one of the most popular species targeted within south-eastern Australian commercial and recreational fisheries. Kingfish are one of the more valuable commercially fished species in New South Wales (NSW). Approximately 100 tonnes of kingfish worth an estimated $1 million dollars are caught annually in the NSW commercial Ocean Trap and Line Fishery[7]. Furthermore, recreational anglers are estimated to catch approximately 120 tonnes of kingfish annually, highlighting that the value of kingfish to NSW recreational anglers is approximately equal to, if not greater than, the commercial industry[8].

Figure 1: Yellowtail kingfish (Seriola lalandi): An iconic marine fish targeted throughout NSW coastal waters by commercial and recreational fishers. Image by P. Tully, NSW DPIRD.

Marine bioregions

The Integrated Marine and Coastal Regionalisation of Australia classifies Australia's marine environment into bioregions that have a useful spatial scale for undertaking climate vulnerability assessments. NSW coastal waters are divided into five marine bioregions (Figure 2), which include all coastal and offshore waters to the edge of the continental shelf. Each bioregion has unique oceanographic and ecological features, supporting diverse marine life and fishing opportunities.

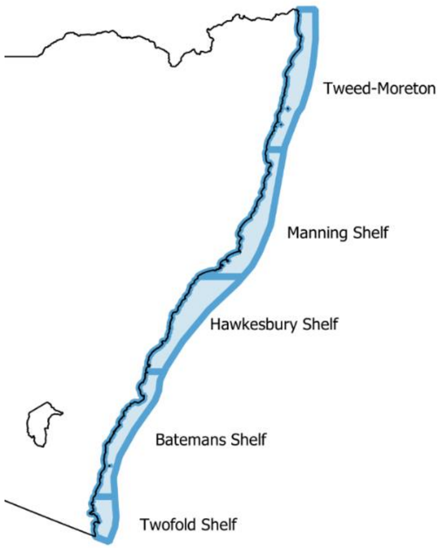


Figure 2 : Marine bioregions of New South Wales.

[7] Mobsby, D. (2018), Australian fisheries and aquaculture statistics 2017, Fisheries Research and Development Corporation project 2018-134, ABARES, Canberra, December.

[8] . West, LD, Stark, KE, Murphy, JJ, Lyle, JM, Ochwada-Doyle, FA (2016) Survey of Recreational Fishing in New South Wales and the ACT, 2013/14. Fisheries final report series no. 149, NSW Department of Primary Industries, Wollongong.

Climate Vulnerability Assessment framework

The Climate Vulnerability Assessment was intended to provide an overview of the impact of future climate change on all stages of production for the commodities and biosecurity risks assessed. To achieve this, a modelling approach was adopted that would produce assessments for the commodities and biosecurity risks in a consistent, and therefore comparable, way.

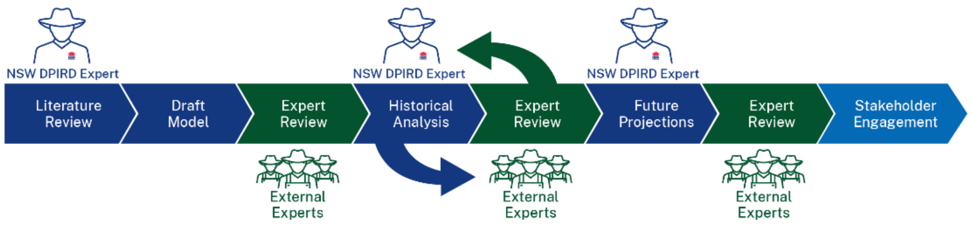


Figure 3: Outline of expert engagement in the assessment framework developed by the Climate Vulnerability Assessment Project. Internal and external experts are involved throughout the process, helping to develop and refine the model of their primary industry commodity or biosecurity risk.

The assessment framework, outlined in Figure 3, provides a rigorous, flexible and transparent process for assessing vulnerability to climate change. It begins with a literature review, used to inform a draft model of the commodity or biosecurity risk. External experts review the model at three points during the model development, as a small focus group. The participation of experts throughout the process was critical for integrating expert knowledge into the models developed by the Climate Vulnerability Assessment.

Over 100 NSW Department of Primary Industries staff contributed to this process, and almost 200 experts participated in focus groups to support the review and refinement of the models. External experts were drawn from industry bodies, producers, academia, and elsewhere.

MCA modelling approach

The steps in the framework developed for the Climate Vulnerability Assessment are designed to identify and compare the climate variables important in the production of each commodity and the survival of each biosecurity risk assessed. The chosen modelling approach, using multi-criteria analysis (MCA) models, allows knowledge obtained about these climate variables from scientific literature, expert focus group knowledge and other sources to be combined in a way that is consistent across all commodities and biosecurity risks.

A simple MCA model with customisable assumptions and exclusions was developed for kingfish. A hierarchical structure underpins the MCA modelling approach, and the model were developed using a combination of empirical data and expert judgment. The commodity sits at the top of the hierarchy, which is then divided into the key oceanographic variables.

Each climate variable is weighted relative to the others to reflect the importance of its contribution to the overall success in the growth of the commodity or the survival of the biosecurity risk. The weightings are derived using the analytical hierarchy process[9] and reflect the consensus reached by the focus group experts.

[9] Saaty, T.L. (1980) The Analytic Hierarchy Process, McGraw-Hill, New York

The MCA model is designed to estimate climate suitability for fish species of interest. *Climate suitability* is defined as the conditions that satisfy the requirements of the species to persist in their environment in the absence of other limiting factors.

The fisheries models were applied to each season, with the reported climate suitability representing the average for a given season over all years in the dataset. The MCA model provides an assessment of climate suitability (ranging from unsuitable to highly suitable). Climate suitability is modelled for both historical (recent past) conditions and for projected (near future) climate to understand how the climate suitability for the commodity may be affected by climate change.

Experts reviewed the historical and future assessments and provided insights and interpretations, highlighting findings of importance for future planning. The following sections of this report provide an overview of the model structure for kingfish and key results showing important changes to future climate suitability for kingfish, as identified by the assessment.

For further details on the Climate Vulnerability Assessment Project framework, MCA models, and climate data (historical observations and future projections), please refer to the Climate Vulnerability Assessment Methodology Report.

The project limitations and exclusions are briefly summarised to the right and the kingfish model assumptions are summarised on the next page.

Project scope and exclusions

The scope was limited to the assessment of vulnerability to future climate change. The assessment captures the response of kingfish to changes in future average climatic conditions. The project was designed to support policy and regional investment decisions. The following were not considered:

- other biophysical parameters
- socio-economic factors such as fishery infrastructure, worker availability and market access

These factors should be considered alongside the project's findings when examining the ongoing or future viability at a given location.

Certain climate data were excluded due to future climate projection data limitations. Extreme weather events such as marine heatwaves were also excluded due to their unpredictable nature and the complexities of their interaction with the climate. Future work incorporating more sophisticated future climate projections as they become available is likely to provide an improved capacity for describing the impacts of extreme weather events and climate variability.

Kingfish model assumptions and limitations

A model represents a simplified version of reality. Assumptions and exclusions are used to simplify complex systems by reducing the number of influencing factors enabling model development. The fisheries' assumptions and exclusions were as follows:

- The distribution of environmental conditions preferred by the fish is assumed to be a reliable proxy for the distribution and occurrence of the species itself.
- Ocean primary productivity and the availability of food sources for the fish are assumed to remain consistent between historical and future periods.

The marine fisheries MCA models were designed to estimate suitability for the occurrence of adult fish off eastern Australia. Understanding environmental influences on sub-juvenile and juvenile marine fishes is a key challenge in fisheries science. The subsequent recruitment of these life stages to the harvestable population is variable and difficult to predict accurately[10]. For these reasons, life stages other than the adult were deemed out of scope.

Fisheries static structural habitat

The occurrence of kingfish off eastern Australia is underpinned by a combination of structural habitat and oceanographic drivers. Structural habitat encompasses the effects of ocean depth (bathymetry) and seafloor shape (vertical relief) on suitability for kingfish. Unlike other dynamic variables included in the MCA model that change over short-term seasonal and longer-term climate change time-scales (for example, sea surface temperature), structural habitat variables are static and therefore remain fixed within both historical analyses and future projections.

Final kingfish model

The final MCA model with weightings for kingfish is shown on the following page (Figure 4). The climate variables used in the marine fisheries models include sea surface temperature, sea surface height and current strength. Marine fisheries models also included the geophysical elements of seafloor depth (bathymetry) and vertical relief.

[10] Munch, S.B., Giron-Nava, A., and Sugihara, G. (2018) Nonlinear dynamics and noise in fisheries recruitment: A global meta-analysis. Fish and Fisheries 19(6), 964-973.

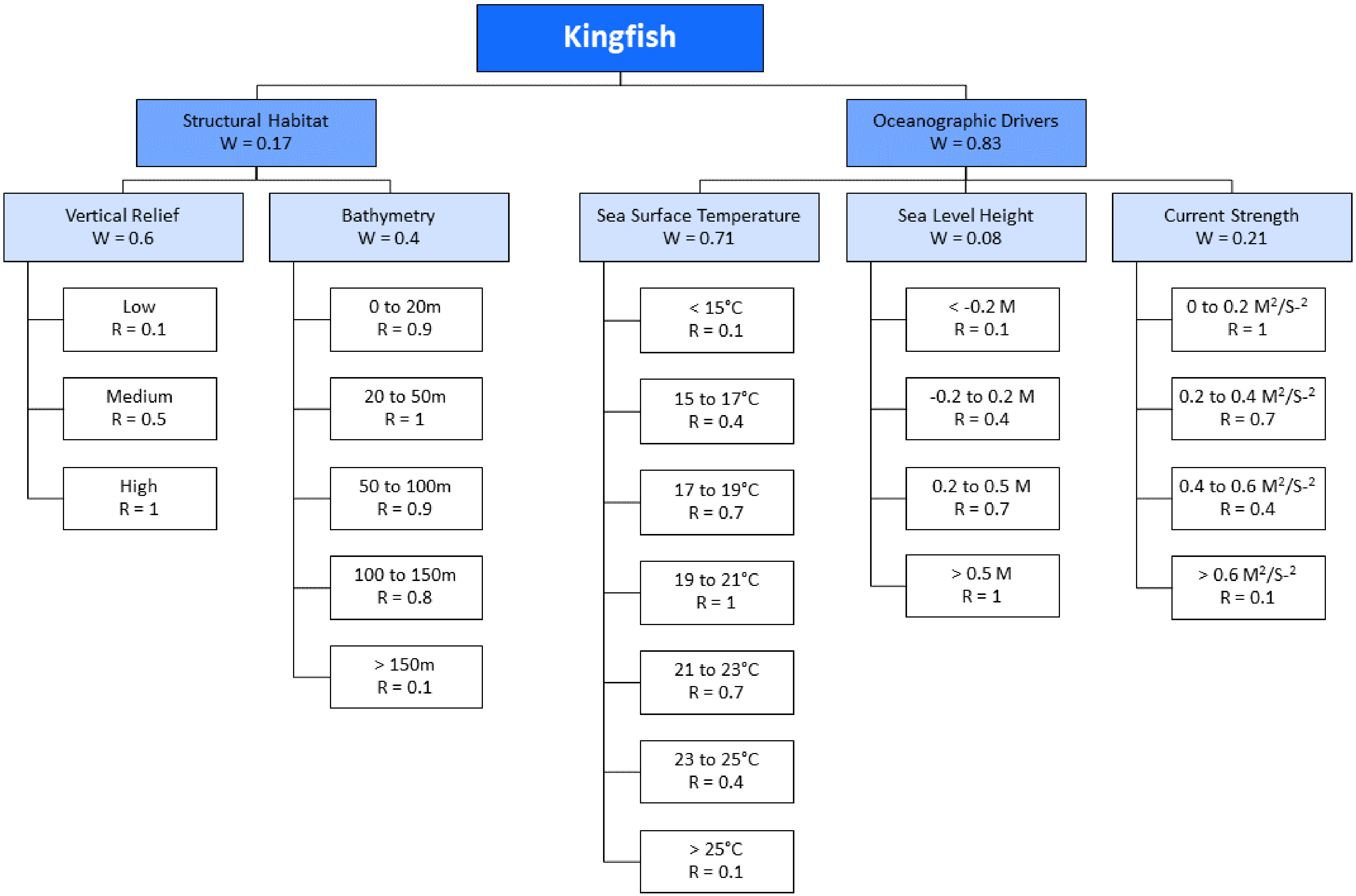


Figure 4: MCA model hierarchical structure and model components for kingfish. The top-level of the hierarchy is the fish species. The second level defines suitability according to oceanographic climate and structural habitat. The third level contains climate variables.

Interpreting the results

The results are presented as panels of 7 maps, comparing historical climate suitability with climate suitability under the two future emissions scenarios (RCP4.5, an intermediate emissions scenario and RCP8.5, a high emissions scenario). For the future emissions scenarios, maps of change and confidence in change in climate suitability are also presented. The NSW marine bioregions are displayed on each map to indicate the areas where kingfish are currently found.

The historical climate suitability map shows the mean suitability for 20 years (1993 to 2012). For future projections, the mean suitability for 20 years (2040 to 2059) was calculated for five global climate models, and the median of these models was used to produce ensemble future projection climate suitability maps.

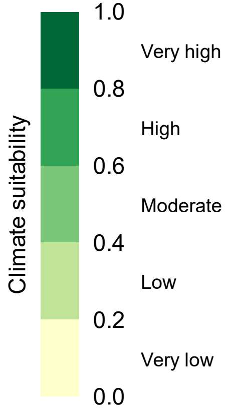


Figure 5: Colour scheme for the climate suitability maps

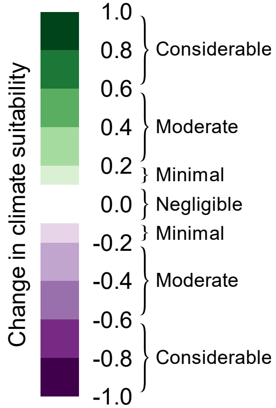


Figure 6: Colour scheme for the change in climate suitability maps

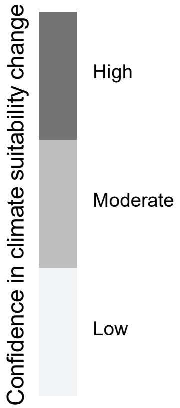


Figure 7: Colour scheme for the confidence in the change in climate suitability maps

Historical and future climate suitability maps

The 'climate suitability' maps show the climate suitability on a scale of 0 to 1. Pale yellow is very low suitability, and dark green is very high suitability.

Change in climate suitability maps

The 'change in climate suitability' maps use a green-white-purple colour scheme with 11 categories: positive change, where the future climate becomes more suitable, is shown in shades of green; negative change is shown in shades of purple. Negligible change is represented by white and occurs for values between −0.1 and 0.1; in these areas, the future climate suitability will be very similar to the historical suitability.

Confidence in the change in climate suitability maps

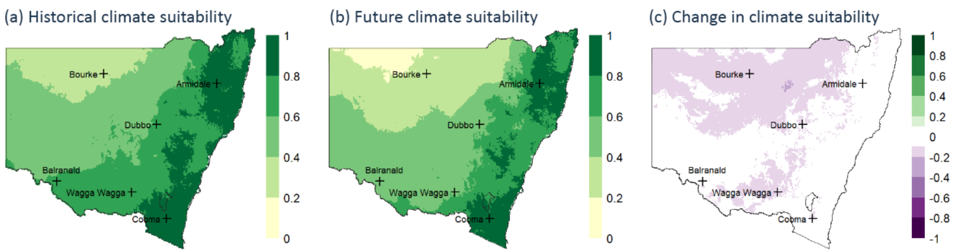
The 'confidence in change in climate suitability' maps represent the level of agreement across the ensemble of five global climate models on the direction and magnitude of change in climate suitability. The lightest shade of grey represents low confidence, and the darkest shade of grey represents high confidence.

Understanding climate suitability: a guide to map interpretation

The Climate Vulnerability Assessment has strived for accuracy and clear interpretation in our data representation, particularly when there is uncertainty. The MCA models produce continuous climate suitability values. To help readers interpret the maps, these suitability values have been grouped into 5 categories between 0 and 1 (each shown in a different colour). Changes in climate suitability values are also continuous but have been grouped into 11 categories between -1 and 1. Negligible change is shown in white and is defined as -0.1 to 0.1, and the values within this range are considered uncertain. However, this categorisation can occasionally lead to our maps showing results that are not immediately intuitive. Below are two circumstances that arise, and we have described why and how this occurs.

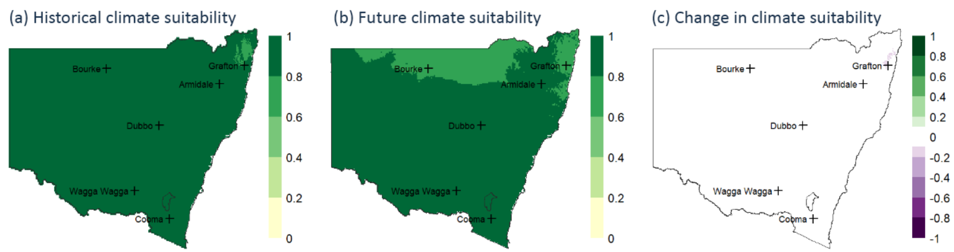
Why does the 'change in climate suitability' map show changes in some places where the historical and future climate suitability maps have the same colour? There are instances where historical and future climate suitability maps show the same category of climate suitability, yet the change in suitability maps indicates a positive or negative shift. This occurs when the climate suitability has changed, but not sufficiently to move it from one category to another.

In the example below, you can see this south of Bourke when comparing the historical, future and change maps. The climate suitability of Bourke changes from 0.35 in the historical map to 0.22 in the future map. This leads to no change in the suitability category (both maintain low suitability), but as the change is 0.13, this is categorised as minimal change and is shown in the change in suitability map in purple.



Why is there negligible change (white) on the change map in places where the historical and future climate suitability maps have different colours? Sometimes, the categories change between the historical and future climate suitability, but the 'change in suitability' maps show negligible change (white). This happens when the climate suitability changes enough to move into a different category, but the change in the value is small (less than 0.10).

For example, you can see this around Bourke when comparing the historical, future, and change maps below. The climate suitability of Bourke changes from 0.85 in the historical map to 0.79 in the future map, leading to a change from very high to high climate suitability, but as the change is 0.06, this is considered negligible.



Projected changes in climate suitability for kingfish

Climate change offers opportunities and challenges for kingfish fisheries within NSW, with some changes to the seasonal distribution of fishing opportunities expected.

The section provides a selection of key results for the kingfish model. The section begins with an overview of the overall impacts and a breakdown of the seasonal impacts, followed by key maps. The relevant interpretation and findings are provided in the text on the bottom left corner of each map panel. Due to the large number of outputs, not all results have been provided. Findings have been summarised herein; key figures included.

Overall climate impacts

Climate change offers opportunities and challenges for kingfish fisheries within NSW, with some changes to the seasonal distribution of fishing opportunities expected.

Sea surface temperature is the primary factor determining climate suitability for kingfish and is also the variable contained in the MCA model that is undergoing the most rapid climate-driven change in NSW waters. Projected changes to sea surface temperature were responsible for the spatial pattern of negative change in suitability for kingfish within central to northern region of the NSW coastal ocean and positive or negligible change within southern regions. Therefore, climate-driven changes to the sea surface temperature off eastern Australia is the key driver of potential future risks or opportunities associated with changes to suitability for kingfish identified by the MCA model.

Seasonal climate impacts

Future climate change affects kingfish via rising ocean temperatures, resulting in differing seasonal impacts for fisheries in NSW coastal waters:

Summer

The historical climate suitability for kingfish during summer (Figure 8) ranges from low-moderate in northern NSW coastal waters, increasing to high-very high in the south. By 2050, central and southern coastal waters are likely to experience minimal negative change in climate suitability (*high confidence*), with their climate suitability shifting to moderate and high, respectively. These changes are likely to occur in regions where climate suitability for kingfish is projected to be moderate to high, suggesting that climate-driven changes to environmental suitability for kingfish off central and southern NSW in summer are likely to only have minor implications for fishing opportunity for kingfish in this region.

Autumn

The climate suitability for kingfish during autumn (Figure 9) is likely to remain high within NSW coastal waters in 2050. Projections suggest only minimal negative changes to climate suitably for kingfish are likely to occur within central to northern regions of NSW's marine environment under RCP8.5 (*high confidence)*. Negligible change is projected under RCP4.5 (*moderate to high confidence*). Given these regions are only likely to experience a reduction from good to moderate suitability for kingfish, there likely to be only minor (if any) implications to fishing opportunity for kingfish in response to the changes projected for autumn.

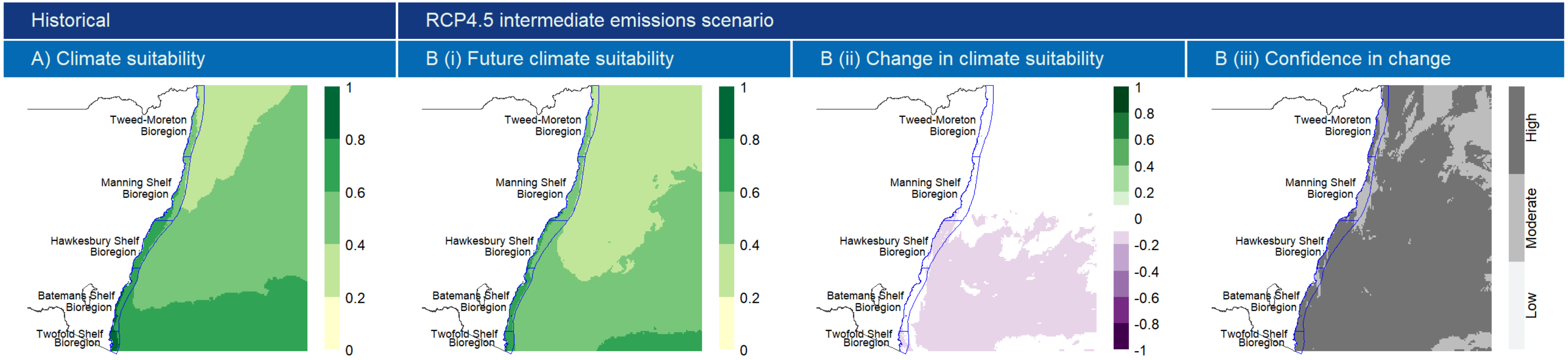
Winter

The climate suitability for kingfish during winter (Figure 10) is likely to remain high within NSW coastal waters into the future, which is similar to the historical climate suitability for kingfish within this region (*moderate to high confidence*). Associated changes to fishing opportunity during this season are likely to be negligible given the small magnitude of projected changes and retention of moderate to high climate suitability for kingfish during winter under climate change.

Spring

The historical climate suitability for kingfish during spring (Figure 11) is high in southern and northern NSW coastal waters and very high in central waters. A southern shift in very high climate suitability for kingfish is projected for the marine environmental adjacent to NSW in spring. This shift is projected to result in minimal negative changes to climate suitability in central and northern regions, and minimal positive changes in southern regions (*moderate to high confidence*). These changes may result in minimal reductions in fishing in northern and central regions, and minimal increases in fishing opportunity for kingfish in southern regions, during spring.

Kingfish – summer



Findings: Minimal negative changes in climate suitability are projected for the central and southern regions of the NSW coastal waters in summer. These changes are likely to occur where climate suitability for kingfish is projected to be moderate to high, suggesting that climate-driven changes to suitability for kingfish off central and southern NSW in summer are likely to only have minor implications for fishing opportunity for kingfish in this region.

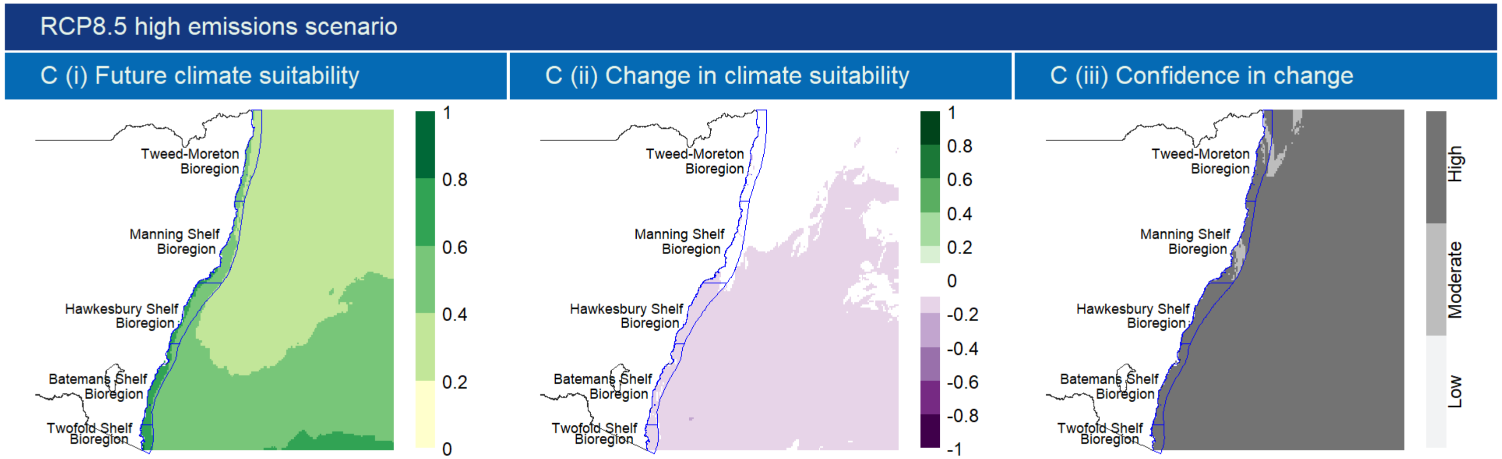
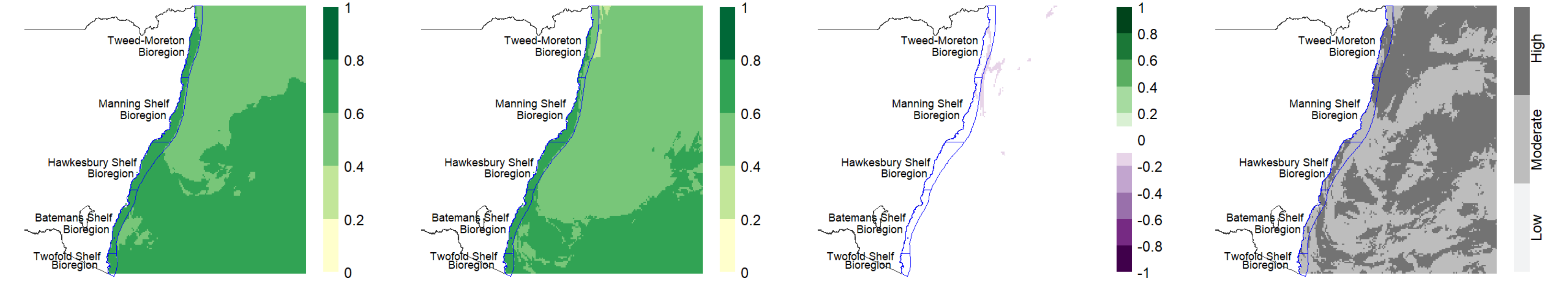


Figure 8: The future projections panel of environmental suitability for kingfish in summer off NSW: A) the mean historical climate suitability (1993 to 2012), B) the future climate suitability (median of five GCMs (2040 to 2059)); i) for RCP4.5 and ii) for RCP8.5, C) the change in climate suitability between future and historical climate suitability maps; i) for RCP4.5 and ii) for RCP8.5 and D) the confidence in the change in climate suitability; i) for RCP4.5 and ii) for RCP8.5.

Kingfish – autumn

Historical	RCP4.5 intermediate emissions scenario		
A) Climate suitability	B (i) Future climate suitability	B (ii) Change in climate suitability	B (iii) Confidence in change



Findings: Projections suggest only minimal negative change to climate suitability is likely to occur within central to northern regions of the NSW coast under RCP8.5. Negligible change is projected under RCP4.5. Given these regions are only likely to experience a reduction from good to moderate suitability for kingfish, there is likely to be only minor (if any) implications to fishing opportunity for kingfish in response to the changes projected for autumn.

RCP8.5 high emissions scenario		
C (i) Future climate suitability	C (ii) Change in climate suitability	C (iii) Confidence in change

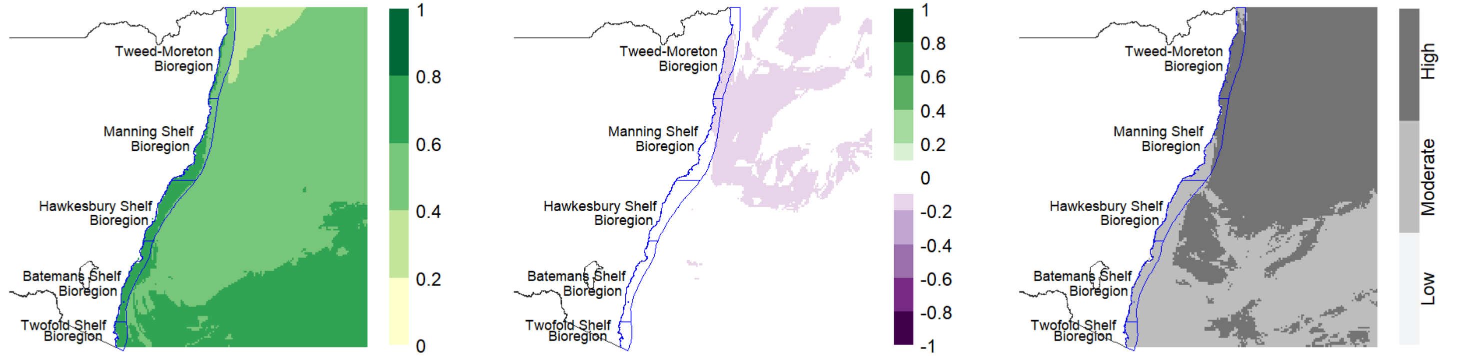
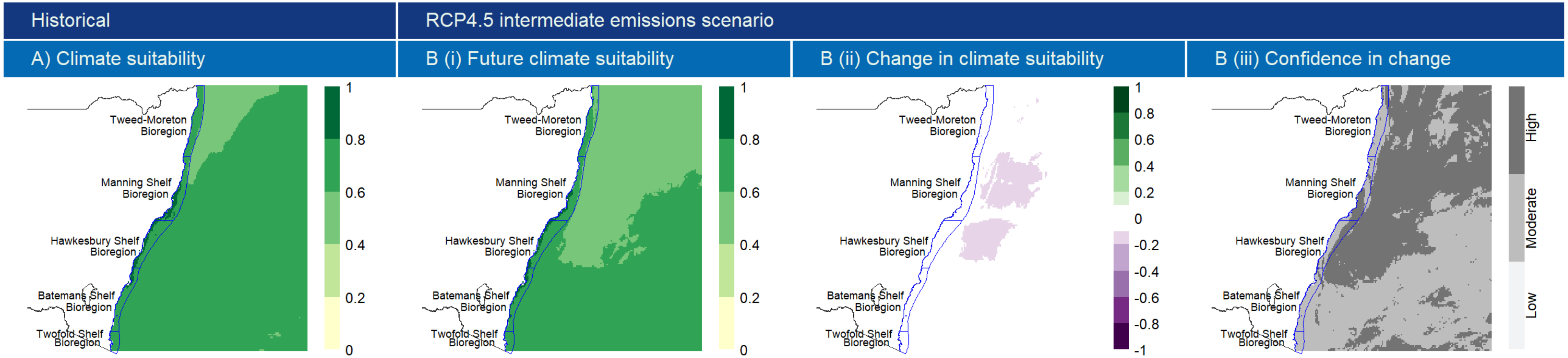


Figure 9: The future projections panel of environmental suitability for kingfish in autumn off NSW: A) the mean historical climate suitability (1993 to 2012), B) the future climate suitability (median of five GCMs (2040 to 2059)); i) for RCP4.5 and ii) for RCP8.5, C) the change in climate suitability between future and historical climate suitability maps; i) for RCP4.5 and ii) for RCP8.5 and D) the confidence in the change in climate suitability; i) for RCP4.5 and ii) for RCP8.5.

Kingfish – winter



Findings: Minimal negative changes to suitability are projected for the central region of the NSW coast in winter under both emissions scenarios. Associated changes to fishing opportunities during winter are likely to be negligible given the small magnitude of projected changes and retention of moderate to high climate suitability for kingfish during winter under climate change.

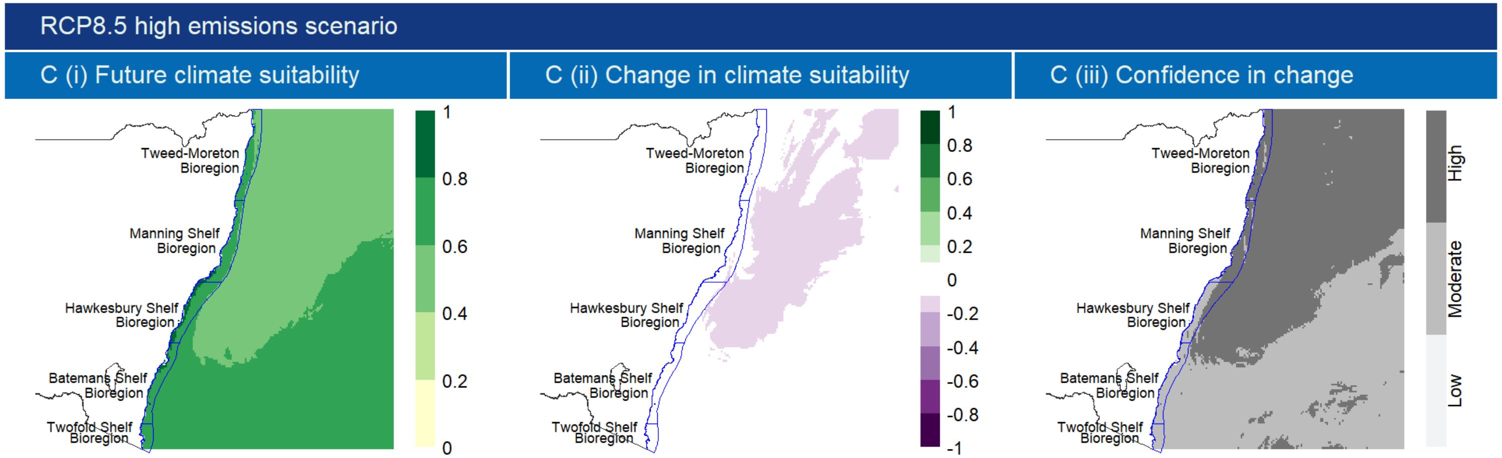
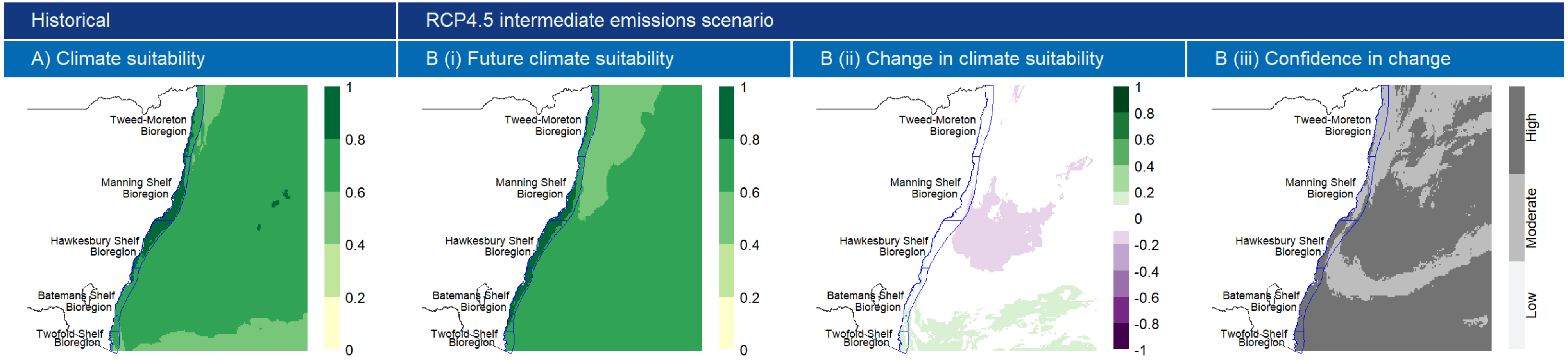


Figure 10: The future projections panel of environmental suitability for kingfish in winter off NSW: A) the mean historical climate suitability (1993 to 2012), B) the future climate suitability (median of five GCMs (2040 to 2059)); i) for RCP4.5 and ii) for RCP8.5, C) the change in climate suitability between future and historical climate suitability maps; i) for RCP4.5 and ii) for RCP8.5 and D) the confidence in the change in climate suitability; i) for RCP4.5 and ii) for RCP8.5.

Kingfish – spring



***Findings*:** A southern shift in very high climate suitability for kingfish is projected for the marine environmental adjacent to NSW in spring. This shift is projected to result in minimal negative changes to climate suitability in central and northern regions, and minimal positive changes in southern regions. These changes may result in minimal reductions in fishing opportunities in northern and central regions, and minimal increases in fishing opportunity in southern regions, during spring.

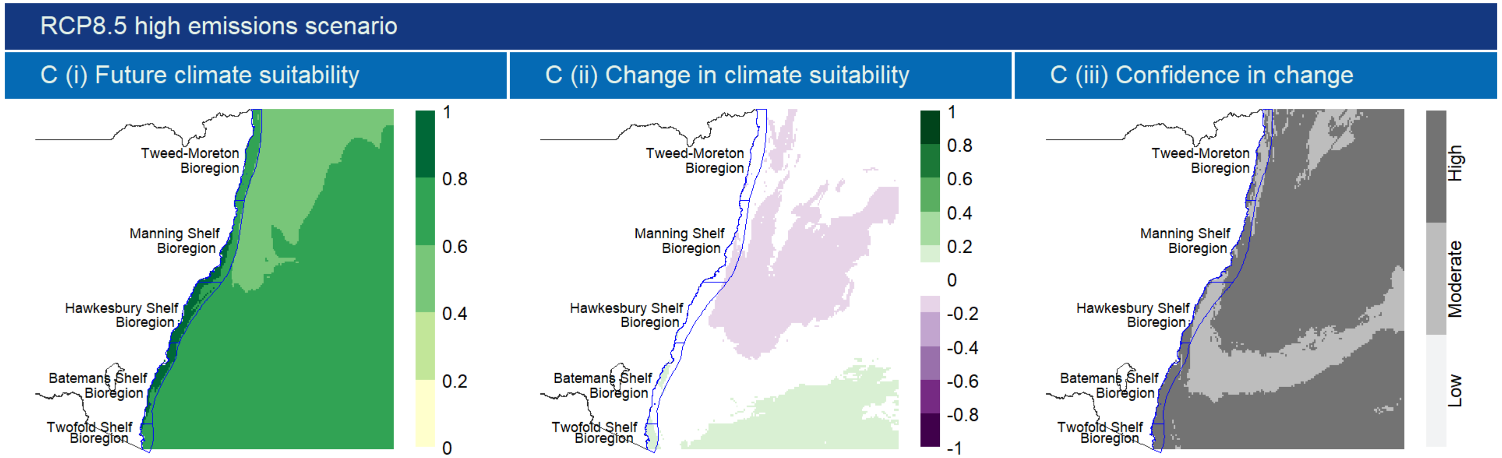


Figure 11: The future projections panel of environmental suitability for kingfish in spring off NSW: A) the mean historical climate suitability (1993 to 2012), B) the future climate suitability (median of five GCMs (2040 to 2059)); i) for RCP4.5 and ii) for RCP8.5, C) the change in climate suitability between future and historical climate suitability maps; i) for RCP4.5 and ii) for RCP8.5 and D) the confidence in the change in climate suitability; i) for RCP4.5 and ii) for RCP8.5.

Key findings and insights from a changing climate

The results of this study provide valuable insights into the historical and potential future climate suitability for kingfish, with implications for NSW fisheries targeting this iconic species.

Historical and future trends

Changes to climate suitability for NSW bioregions during different seasons are likely to shift the spatial distribution of kingfish along the coast of NSW.

Future climate vulnerabilities

Minimal negative changes in climate suitability for kingfish are likely for northern coastal waters during autumn, and central and southern coastal waters during summer. These decreases in climate suitability may lead to minor reductions in fishing opportunity for kingfish during autumn within northern marine bioregions and during summer within central and southern bioregions.

Future climate opportunities

Climate suitability for kingfish in spring is likely to experience minimal positive change within the southern NSW coastal regions, specifically within the Batemans Shelf bioregion and the northern portion of the Twofold Shelf bioregion. These changes may provide even greater fishing opportunities for kingfish off southern NSW in the future.

Adapting to the changing climate

Assessing future climate suitability is a prerequisite to making effective decisions around planning for primary industries and developing effective adaptation or management strategies for addressing future climate change.

Future changes in fish species distributions and seasonal availability may require adaptation from fisheries industries, such as adjustment of quota shares or changes to the timing of fishing for target species. Recreational fishers may see changes within their favoured coastal regions, including opportunities for catching different species.

Kingfish: where to from here?

Future priorities

We have assessed the future climate suitability for kingfish as it is a prerequisite for making effective planning decisions and developing management strategies to address future climate change impacts.

The results presented in this report have identified changes in climate suitability for kingfish that may influence future fishing opportunities for this species along the NSW coast. More research and development are needed to best advise the industry on managing kingfish, looking forward to 2050. Effective management approaches must be carefully planned, evaluated, and deployed. The following option merits early consideration:

- Future changes in fish species distributions and seasonal availability may require adaptation from fisheries industries, such as adjustment of quota shares or changes to the timing of fishing for target species.

Important consideration

The model assumptions, project exclusions and limitations should be considered alongside the project's findings when examining the future impacts on kingfish. Please refer to the kingfish model assumptions section on page 7 for more information.

Addressing the gaps, barriers and challenges

The new information generated by this project has helped identify some climate vulnerabilities and opportunities for kingfish. However, many knowledge gaps were identified during the development of the MCA model.

In some cases, these knowledge gaps were barriers to developing the models. In some instances, they led to the exclusion of key climate criteria because there was a lack of data to justify their inclusion in the model. The following were challenging for marine fisheries;

- New downscaling of future climate projection data specific to the NSW marine environment was required to enable projections of climate suitability for coastal-pelagic fishes in this region.
- Only coastal-pelagic fish were considered due to the lack of climate projection data along nearshore and within estuarine habitats.
- Understanding the environmental drivers of the occurrence of sub-juvenile and juvenile marine fishes is a key challenge in fisheries science.
- Food source is an important driver of the species' occurrence and thus it is important to also understand the future changes to the seasonal availability of food sources for kingfish off NSW.

This report aims to highlight these gaps to assist in directing future research and project development. It was not possible to cover all fish species or marine industries important to NSW. Consideration should be given to modelling other significant or emerging marine species in NSW waters and expanding the range of the current modelling extent to Australia-wide to inform future industry planning nationally.

Conclusion

The Climate Vulnerability Assessment provides important baseline information to support state, regional and strategic industry-level planning for future climate change, highlighting where management and investment should be prioritised to sustain and enhance fisheries and adapt to the impacts of climate change on kingfish.

The results presented in this report provide a comprehensive assessment of how climate suitability for kingfish is likely to shift under climate change in NSW. This research also sets out the challenges ahead, which will require investment in management strategies and education to underpin the industry's future growth and sustainability.

NSW DPIRD will use these findings to work with industry to prioritise future efforts, strategic partnerships, and networks across the state to support effective policies and programs that keep primary industries resilient and productive in the changing climate.

For more information

For detailed information on the methodology and marine data used in this project please see the Climate Vulnerability Assessment Methodology Report.

Results from other commodities and biosecurity risk assessments can be found in the Climate Vulnerability Assessment Summary Report or on the website.

Other Climate Vulnerability Assessments that may be of particular interest are:

- bonito
- dolphinfish
- Spanish mackerel
- spotted mackerel

Contact us

For further information, please get in touch with vulnerability.assessment@dpird.nsw.gov.au

Acknowledgements

We thank the five experts who participated in the kingfish focus groups. These experts ensured that the model contents reflected published knowledge and lived experiences and determined the relative influence or importance of different climate variables in the model.

Thanks to all the DPIRD staff who participated from the DPIRD Fisheries Team: Melinda Coleman and Curtis Champion.

We thank the Climate Vulnerability Assessment team for driving this project from inception to completion over the last five years, individually acknowledging each team member: Joanna Pardoe, Rebecca Darbyshire, Gary Allan, Mary Timms, James Lawson, Lachlan Philips, Bethany Ellis, Jane Kelley, Samantha Currie, Rachael Young, Paris Capell, David Allingham, and Chris Nunn.

Cover image by NSW Department of Planning and Environment / Jaime Plaza Van Roon. p.3 image by Lowan Turton, NSW DPI © State of New South Wales. p.11 image by Gary Bell, Oceanside Images. p.17 image by NSW Department of Planning and Environment / Jaime Plaza Van Roon.

NSW GOVERNMENT