TWAP
TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

Transboundary Waters: A Global Compendium

Water system Information Sheets: Pacific Island Countries, Australia & Antarctica

Volume 6 - Annex K: Pacific Island Countries, Australia & Antarctica

UNEP

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Volume 6-Annex K

Transboundary Waters: A Global Compendium

Water System Information Sheets: Pacific Island Countries, Australia & Antarctica

Acknowledgements

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UNESCO – United Nations Educational, Scientific and Cultural Organization · International Hydrological Programme

igrac – International Groundwater Resources Assessment Centre

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UNEP-DHI Partnership – Centre on Water and Environment – UNEP · DHI

Global IGBP Change – International Geosphere-Biosphere Programme

IUCN

SIWI

CUNY – The City University of New York

OSU – Oregon State University

Center for International Earth Science Information Network – Earth Institute | Columbia University

CESR – Center for Environmental Systems Research

Delta Alliance

Assessment Team: Large Marine Ecosystems

UNESCO – United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

Global IGBP Change – International Geosphere-Biosphere Programme

NOAA

GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

Dalhousie University – Inspiring Minds

Center for Marine Assessment and Planning, UCSB

UNEP WCMC

CERMES

UBC · Sea Around Us

TAT – Tokyo University of Agriculture and Technology

Assessment Team: The Open Ocean

UNESCO – United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

GOOS – Global Ocean Observing System

WCRP – World Climate Research Programme

GACS – Global Alliance of CPR Surveys

PML – Plymouth Marine Laboratory

CERMES

UBC · Sea Around Us

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GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

Dalhousie University – Inspiring Minds

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Administrative Boundaries: Source of administrative boundaries used throughout the assessment: The Global Administrative Unit Layers (GAUL) dataset, implemented by FAO within the CountrySTAT and Agricultural Market Information System (AMIS) projects.

Contents (Volume 6, Annex K)
Oceania-Melanesia-Central Pacific (Part A)

Australia-New Zealand
(Part B)

Antarctica
(Part C)

NASA World Wind

Preface

The Global Environment Facility (GEF) approved a Full Size Project (FSP), "A Transboundary Waters Assessment Programme: Aquifers, Lake/Reservoir Basins, River Basins, Large Marine Ecosystems, and Open Ocean to catalyze sound environmental management", in December 2012, following the completion of the Medium Size Project (MSP) "Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme" in 2011. The TWAP FSP started in 2013, focusing on two major objectives: (1) to carry out the first global-scale assessment of transboundary water systems that will assist the GEF and other international organizations to improve the setting of priorities for funding; and (2) to formalise the partnership with key institutions to ensure that transboundary considerations are incorporated in regular assessment programmes to provide continuing insights on the status and trends of transboundary water systems.

The TWAP FSP was implemented by UNEP as Implementing Agency, UNEP's Division of Early Warning and Assessment (DEWA) as Executing Agency, and the following lead agencies for each of the water system categories: the International Hydrological Programme (IHP) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) for transboundary aquifers including groundwater systems in small island developing states (SIDS); the International Lake Environment Committee Foundation (ILEC) for lake and reservoir basins; the UNEP-DHI Partnership – Centre on Water and Environment (UNEP-DHI) for river basins; and the Intergovernmental Oceanographic Commission (IOC) of UNESCO for large marine ecosystems (LMEs) and the open ocean.

The five water-category specific assessments cover 199 transboundary aquifers and groundwater systems in 43 small island developing states, 204 transboundary lakes and reservoirs, 286 transboundary river basins; 66 large marine ecosystems; and the open ocean, a total of 756 international water systems. The assessment results are organized into five technical reports and a sixth volume that provides a cross-category analysis of status and trends:

Volume 1 – ***Transboundary Aquifers and Groundwater Systems of Small Island Developing States: Status and Trends***
Volume 2 – ***Transboundary Lakes and Reservoirs: Status and Trends***
Volume 3 – ***Transboundary River Basins: Status and Trends***
Volume 4 – ***Large Marine Ecosystems: Status and Trends***
Volume 5 – ***The Open Ocean: Status and Trends***
Volume 6 – ***Transboundary Water Systems: Crosscutting Status and Trends***

A ***Summary for Policy Makers*** accompanies each volume.

Volume 6 presents a unique and first global overview of the contemporary risks that threaten international water systems in five transboundary water system categories, building on the detailed quantitative indicator-based assessment conducted for each water category. As a supplement to Volume 6, this global compendium of water system information sheets provides baseline relative risks at regional and system scales. The fact sheets are organized into 14 TWAP regions and presented as 12 annexes. Volume 6 and the compendium are published in collaboration among the five independent water-category based TWAP Assessment Teams under the leadership of the Cross-cutting Analysis Working Group, with support from the TWAP Project Coordinating Unit.

The technical teams of the Transboundary Waters Assessment Programme(TWAP) assessed transboundary aquifers, lakes & reservoirs, river basins, and large marine ecosystems and prepared information (fact) sheets for water systems that were evaluated. Each fact sheet provides basic geomorphological information and presents baseline values of quantitative indicators that were used to establish relative risk levels. The water system fact sheets are organized into 14 TWAP regions that were used in the Crosscutting Analysis described in Volume 6. The regional compilations are presented as 11 annexes (A-K) of a global compendium, combining Southern & Southeastern Asia into one annex (I), and the Pacific Island Countries, Australia & Antarctica into another (Annex K). Each annex highlights contemporary regional risks as well as water system-specific risks. The annexes are:

Annex A. Transboundary waters of Northern America
Annex B. Transboundary waters of Central America & the Caribbean
Annex C. Transboundary waters of Southern America
Annex D. Transboundary waters of Eastern, Northern & Western Europe
Annex E. Transboundary waters of Eastern Europe
Annex F. Transboundary waters of Western & Middle Africa
Annex G. Transboundary waters of Eastern & Southern Africa
Annex H: Transboundary waters of Northern Africa & Western Asia
Annex I: Transboundary waters of Southern & Southeastern Asia
Annex J: Transboundary waters of Eastern & Central Asia
Annex K: Transboundary waters of the Pacific Island Countries, Australia & Antarctica

In the case of the open ocean, which is the largest transboundary water system of planet earth, selected quantitative indicator maps prepared by the Open Ocean Assessment Team, are compiled in Annex L to highlight the contemporaneous state of the global ocean.

Annex L: Selected indicator maps for the open ocean

All information sheets and indicator maps for the open ocean may be downloaded individually from the following websites:

Transboundary Aquifers: http://twapviewer.un-igrac.org
Transboundary Lakes/ Reservoirs: http://ilec.lakes-sys.com/
Transboundary River Basins: http://twap-rivers.org
Large Marine Ecosystems: http://onesharedocean.org
Open Ocean: http://onesharedocean.org

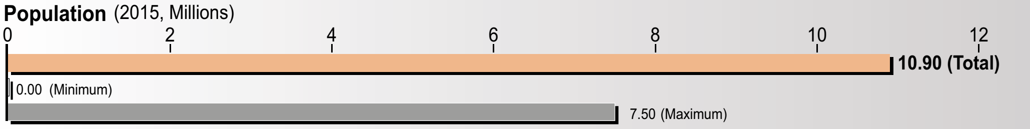
All TWAP publications are available for download at http://www.geftwap.org

Over the long term, it is envisioned that these baseline information sheets will continue to be updated by future assessments at multiple spatial and temporal scales to better track the changing states of transboundary waters that are essential in sustaining human wellbeing and ecosystem health.

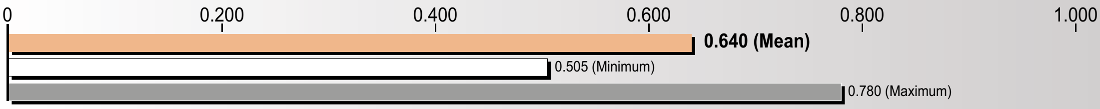
TRANSBOUNDARY WATERS: OCEANIA, MICRONESIA & CENTRAL PACIFIC

The region is classified as Medium HDI with a regional average HDI of 0.640 and a population of 11 million in 2015. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Across nine transboundary waters and the Western Pacific Warm Pool (WPWP) area (bottom left), 69% experience low socioeconomic risk, 50% moderate to highest governance risk, and 75% are subject to low biophysical risk and another 25% moderate biophysical risk. On average (bottom right), transboundary waters are at low socioeconomic and biophysical risk, but are at moderate governance risks. Both river basins and LME and the WPWP are at moderate risk averaging across all risk themes.

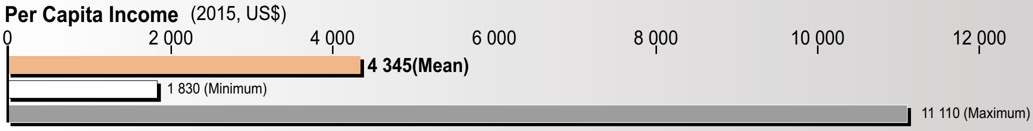
Population (2015, Millions)



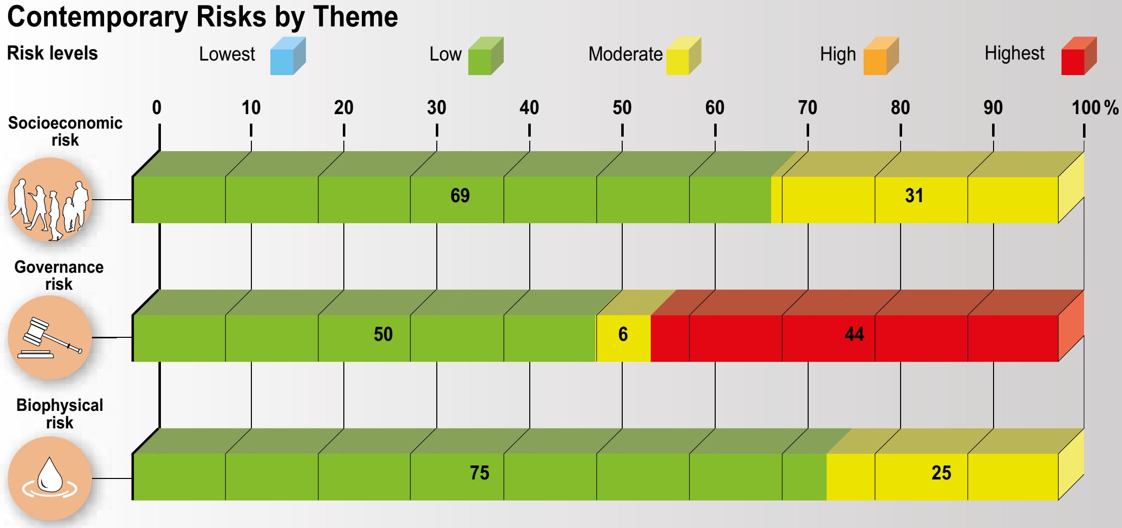
Human Development Index (2014)



Per Capita Income (2015, US$)

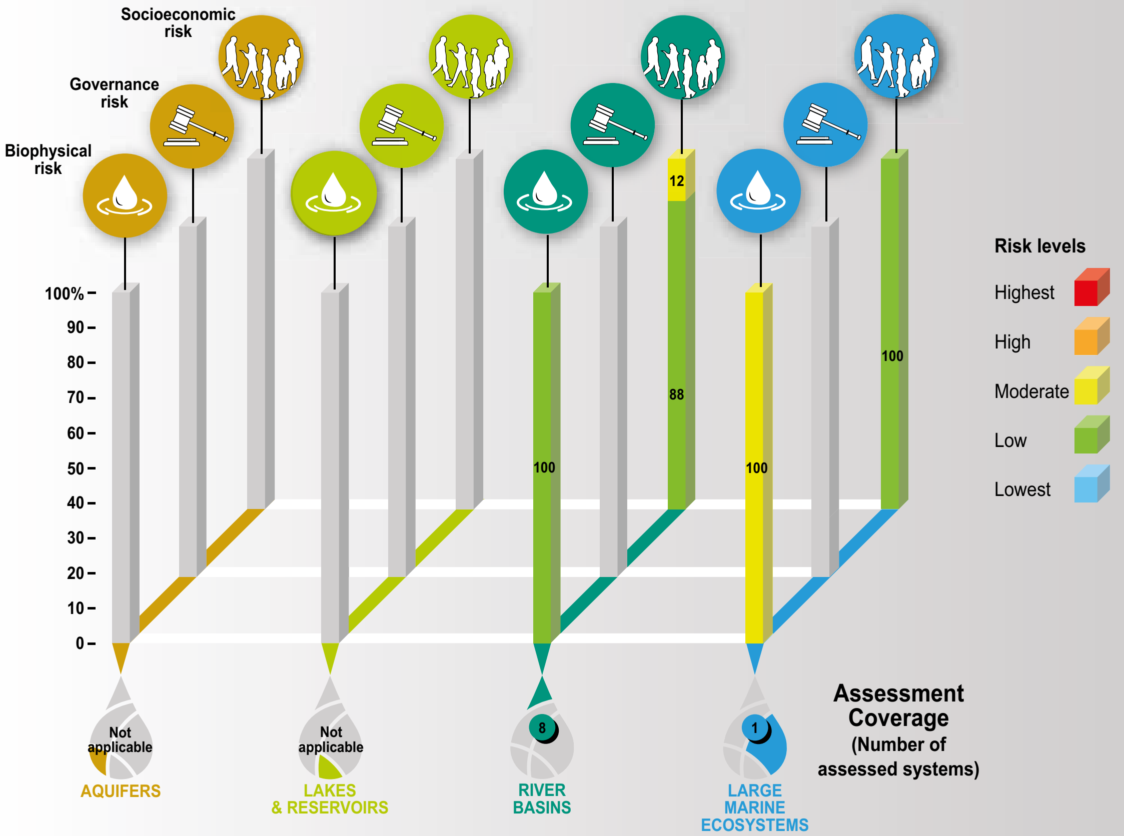


Contemporary Risks by Theme

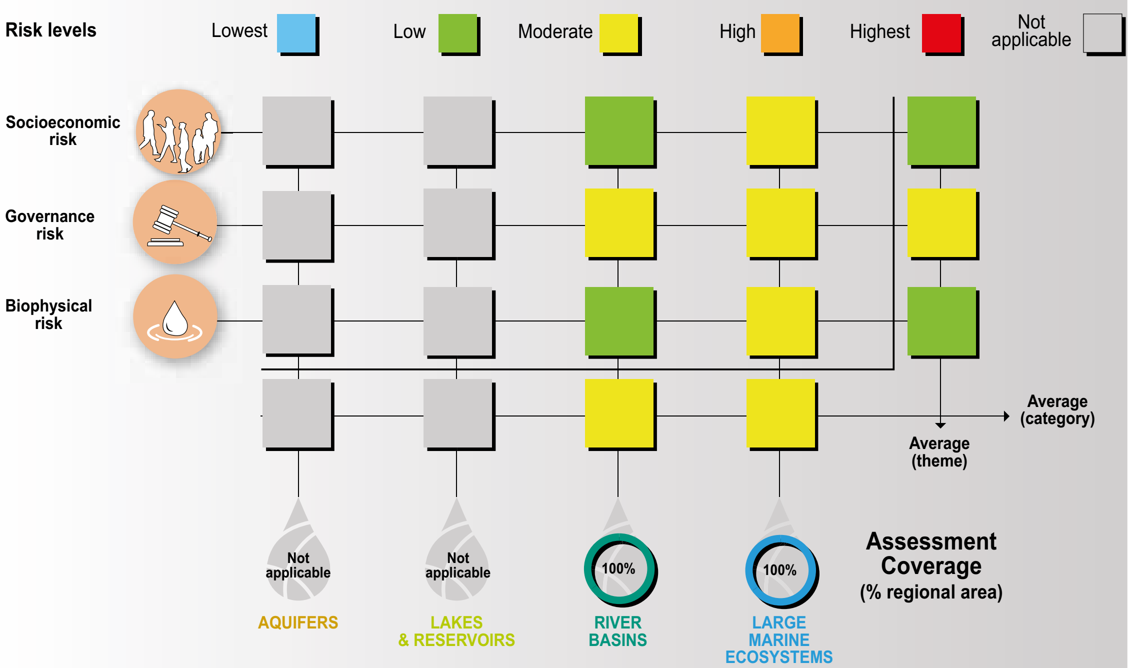


Regional Risks by Water Category

Contemporary Risks by Water Category



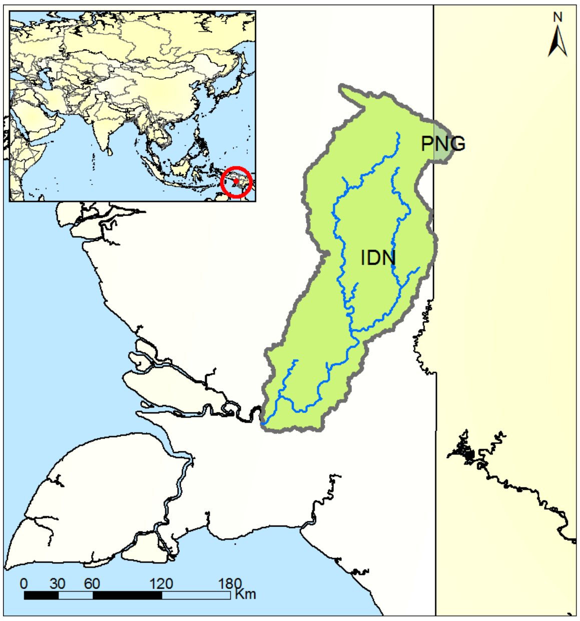
Average Risks



Transboundary River Basins of Oceania-Melanesia-Central Pacific

1. Digul
2. Fly
3. Jayapura
4. Maro
5. Sepik
6. Tami
7. Tjeroaka-Wanggoe
8. Vanimo-Green

Digul Basin



Geography

Total drainage area (km^2)	25,484
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	65,143
Country at mouth	Indonesia
Average rainfall (mm/year)	3,732

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	2
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
DIGL_IDN		2,723.86				
DIGL_PNG						
Total in Basin	69.42	2,723.86			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
DIGL_IDN	8.82	0.32	0.14	3.24	0	5.12	137.93	
DIGL_PNG								

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	8.82	0.32	0.14	3.24	0.00	5.12	135.36	0.01

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
DIGL_IDN	25	0.98	64	2.56				0	3,475.25	0	0.00
DIGL_PNG	1	0.02	1	2.38				0	2,088.35	0	0.00
Total in Basin	25	1.00	65	2.56	1.23	0.00	0.00	0	3,449.45	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DIGL_IDN	1	1	1		5	5	1	3	1	5	3	3	1	3	3
DIGL_PNG					5	1			1	5	3		1	3	1
River Basin	1	1	1	2	5	5	1	4	1	5	3	3	1	3	3

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
DIGL_IDN	2	2	1	1					3
DIGL_PNG									3
River Basin	2	2	1	1	2	2			3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

Disclaimer

The results and information of factsheet is produced and maintained by the River Basins Component of the GEF Transboundary Water Assessment Programme (GEF TWAP).

GEF TWAP is the first global-scale assessment of all transboundary water systems. The TWAP consists of five independent indicator-based water system assessments and the linkages between them, including their socioeconomic and governance-related features. The United Nations Environment Programme (UNEP) is the implementing agency of TWAP. Project Coordination Unit (PCU) in Nairobi, Kenya coordinates the work of UNESCO-IHP, ILEC, UNEP-DHI and the IOC of UNESCO on Transboundary Aquifers, Lake Basins, River Basins, Large Marine Ecosystems and Open Ocean respectively. Each executing partner engages a broad network of data and information rich partners with responsibilities either of a thematic or geographic nature. More on TWAP full size project at http://www.geftwap.org .

The TWAP River Basins component (TWAP RB) carried out a global comparison of 286 transboundary river basins, in order to enable the prioritisation of funds for basins at risk from a variety of issues, covering water quantity, water quality, ecosystems, governance and socio-economics. It also considered risks to deltas from threats of a transboundary nature, and considered the relative influence of lakes on these river basins. TWAP RB is an indicator–based assessment, allowing for an analysis of basins, based on risks to both societies and ecosystems. It also includes provisional outlook projections to 2030 and 2050 for a limited number of indicators.
Values given in the present fact-sheet represent an approximate guide only and should not replace recent local assessments.

Country Boundaries Under TWAP
TWAP RB assessment uses country delineations provided by FAO GAUL (Global Administrative Unit Layers) (FAO 2014). GAUL uses the International Boundary dataset of the UNCS (UN Cartographic Section) and inland boundaries are same for both datasets. Some differences occur in coastlines, where FAO GAUL dataset offers more detail.

Disputed areas
The GAUL project and original dataset maintains disputed areas in such a way to preserve national integrity for all disputing countries. The GAUL Set reports the international, first level and second level administrative boundaries delimiting, or falling within, the disputed areas in a way to enable the re-construction of the administrative units as they are specified by the individual disputing countries. Disputed areas are therefore shown as individual entities, not dependent from countries, with corresponding coding. Same approach has been taken by TWAP RB, reporting on disputed territories, as well as presentation of Basin Country Units.

Basin Delineation
TWAP RB assessment includes 286 transboundary river basins. Information on this layer and delineation methodology can be retrieved by downloading metadata sheet for the Basins layer from TWAP Rivers Data Portal at http://twap-rivers.org/indicators/ or by direct download from http://twap-rivers.org/assets/Basin%20and%20BCU%20Creation%20Documentation.pdf

For more information on data sources, indicator calculation methodologies, limitations and more consult indicator metadata sheets available on TWAP RB Data portal on http://twap-rivers.org . To view sources of data included in this Factsheet download the Factsheet Reference file at http://twap-rivers.org/assets/Factsheet_template_with_references.pdf.

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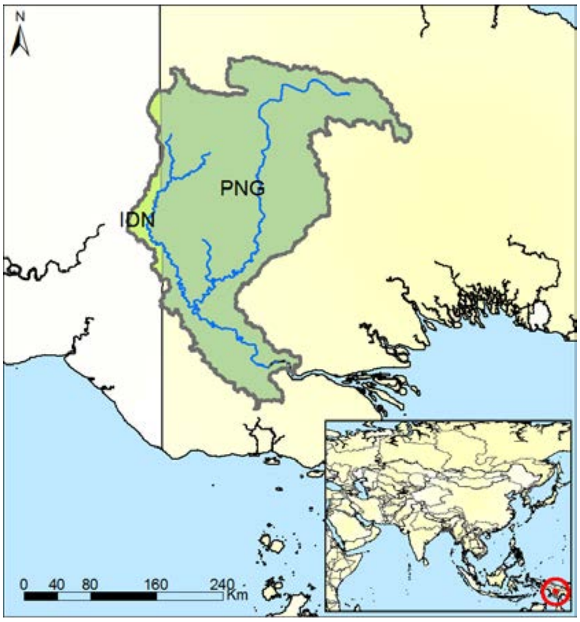
Fly Basin



Geography

Total drainage area (km^2)	63,886
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	349,358
Country at mouth	Papua New Guinea
Average rainfall (mm/year)	3,476

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	1

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	3
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
FLYX_IDN		2,142.01				
FLYX_PNG		2,563.17			782.00	4.07
Total in Basin	162.82	2,548.65			782.00	4.07

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
FLYX_IDN	0.30	0.00	0.01	0.00	0	0.30	56.56	
FLYX_PNG	25.32	0.00	0.56	13.47	0	11.28	73.60	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	25.62	0.00	0.57	13.47	0.00	11.58	73.33	0.02

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
FLYX_IDN	3	0.04	5	2.07	1.08			0	3,475.25	0	0.00
FLYX_PNG	61	0.96	344	5.61	2.36	0.00	100.00	0	2,088.35	0	0.00
Total in Basin	64	1.00	349	5.47	2.12	0.00	98.46	0	2,109.69	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FLYX_IDN	1	1	1		5	5	1	3	1	4	2	3	1	3	2
FLYX_PNG	1	1	1		5	4	1	3	1	4	2		1	3	2
River Basin	1	1	1	2	5	5	1	3	1	4	2		1	4	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
FLYX_IDN	2	2	1	1			1	2	2
FLYX_PNG	2	2	1	1			2	4	2
River Basin	2	2	1	1	2	2	2	4	2

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

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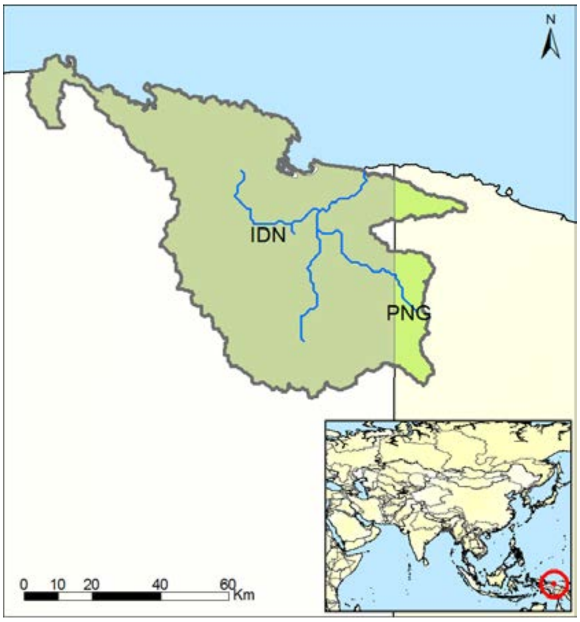
Jayapura Basin



Geography

Total drainage area (km^2)	5,253
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	328,736
Country at mouth	Indonesia
Average rainfall (mm/year)	2,151

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
JAPR_IDN		738.36			100.70	0.62
JAPR_PNG						
Total in Basin	3.88	738.36			100.70	0.62

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
JAPR_IDN	14.66	0.16	0.11	1.79	0	12.60	45.01	
JAPR_PNG								

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	14.66	0.16	0.11	1.79	0.00	12.60	44.60	0.38

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km^2)
JAPR_IDN	5	0.91	326	68.35		0.00	100.00	1	3,475.25	0	0.00
JAPR_PNG	0	0.09	3	6.18				0	2,088.35	0	0.00
Total in Basin	5	1.00	329	62.58	1.22	0.00	99.08	1	3,462.52	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
JAPR_IDN	1	1	1		5		2	3	1	5	3	3	1	3	2
JAPR_PNG					5				1	5	3		1	3	1
River Basin	1	1	1	2	5		1	3	1	5	3	3	1	3	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
JAPR_IDN	1	2	1	1					3
JAPR_PNG									3
River Basin	1	2	1	1	2	2			3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	2				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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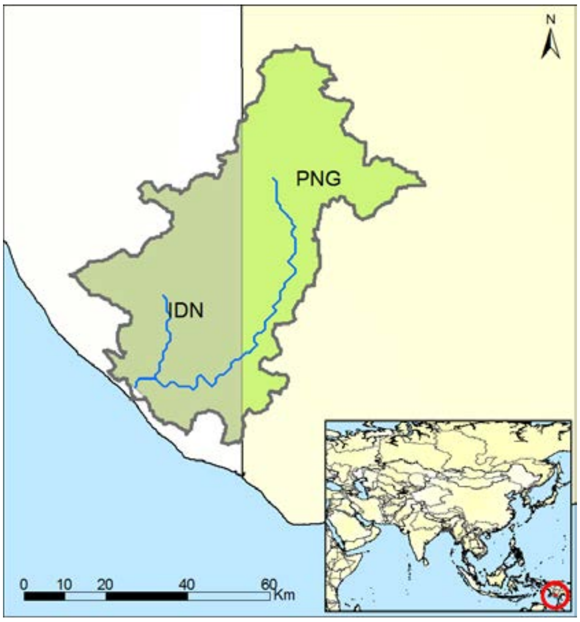
Maro Basin



Geography

Total drainage area (km^2)	3,319
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	6,672
Country at mouth	Indonesia
Average rainfall (mm/year)	1,761

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
MARO_IDN		999.97				
MARO_PNG		1,212.86				
Total in Basin	3.67	1,106.42			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
MARO_IDN	18.61	16.33	0.04	0.00	0	2.25	4,973.72	
MARO_PNG	0.31	0.19	0.01	0.00	0	0.11	106.37	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	18.93	16.52	0.05	0.00	0.00	2.36	2,836.77	0.52

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
MARO_IDN	2	0.50	4	2.25				0	3,475.25	0	0.00
MARO_PNG	2	0.50	3	1.77				0	2,088.35	0	0.00
Total in Basin	3	1.00	7	2.01	1.61	0.00	0.00	0	2,866.35	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MARO_IDN	1		2		5	5			1	5	3	3	3	3	1
MARO_PNG	1		1		5	5			1	5	3		4	3	2
River Basin	1		2	2	5				1	5	3		3	4	2

Indicators

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Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
MARO_IDN	2	2							3
MARO_PNG	2	2							3
River Basin	2	2			2	2			3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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Sepik Basin

Geography

Total drainage area (km²)	79,778
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	970,816
Country at mouth	Papua New Guinea
Average rainfall (mm/year)	2,963

Governance

No. of treaties and agreements[1]	1
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	1
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km³/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km³/year)	Av. Groundwater Discharge (km³/year)	Lake and Reservoir Surface Area (km²)	Lake and Reservoir Volume (km³)
SEPK_IDN		5,805.71				
SEPK_PNG		1,684.61			177.30	0.53
Total in Basin	144.06	1,805.78			177.30	0.53

Water Withdrawals

BCU	Total (km³/year)	Irrigation (km³/year)	Livestock (km³/year)	Electricity (km³/year)	Manufacture (km³/year)	Domestic (km³/year)	Per capita (m³/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
SEPK_IDN	0.96	0.06	0.03	0.00	0	0.88	47.70	
SEPK_PNG	37.22	0.00	1.42	3.54	2	30.22	39.15	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	38.18	0.06	1.45	3.54	2.04	31.10	39.32	0.03

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500 ,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000 .000 km²)
SEPK_IDN	3	0.04	20	5.83	1.08			0	3,475.25	0	0.00
SEPK_PNG	76	0.96	951	12.46	2.36	0.00	100.00	0	2,088.35	0	0.00
Total in Basin	80	1.00	971	12.17	2.11	0.00	97.92	0	2,117.15	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
SEPK_IDN	1	1	1		5	4	1	4	1	4	3	3	1	3	2
SEPK_PNG	1	1	1		5	4	1	3	1	4	3		1	3	2
River Basin	1	1	1	2	5	4	1	4	1	4	3		1	4	2

Indicators

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Very low | Low | Medium | High | Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**P-2030**	**P-2050**	**Projected**
SEPK_IDN	2	2	1	1					3
SEPK_PNG	2	2	1	1			2	4	3
River Basin	2	2	1	1	2	2	2	4	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	**17**	**18**	**19**	**20**	**21**
River Basin	1				

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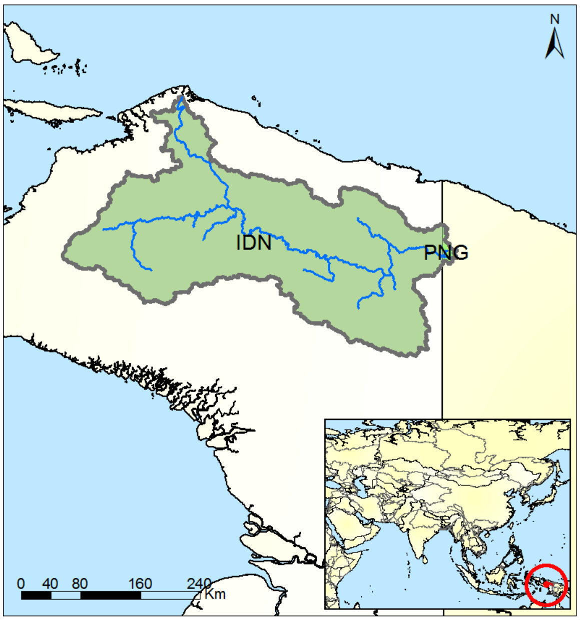
Tami Basin



Geography

Total drainage area (km^2)	78,667
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	535,821
Country at mouth	Indonesia
Average rainfall (mm/year)	2,841

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	2
Large Marine Ecosystems	0

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Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
TAMI_IDN		1,801.52			134.10	1.38
TAMI_PNG						
Total in Basin	141.72	1,801.52			134.10	1.38

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
TAMI_IDN	48.25	0.83	0.85	2.71	0	43.86	90.55	
TAMI_PNG								

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Total in Basin	48.25	0.83	0.85	2.71	0.00	43.86	90.06	0.03

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
TAMI_IDN	78	0.99	533	6.81	1.08			0	3,475.25	0	0.00
TAMI_PNG	0	0.01	3	6.19	2.36			0	2,088.35	0	0.00
Total in Basin	79	1.00	536	6.81	1.21	0.00	0.00	0	3,467.66	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TAMI_IDN	1	1	1		5	4	2	3	1	5	3	3	1	3	2
TAMI_PNG					5	2			1	5	3		1	3	1
River Basin	1	1	1	2	5	4	2	3	1	5	3	3	1	3	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low	Low	Medium	High	Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
TAMI_IDN	2	2	1	1			1	2	3
TAMI_PNG									3
River Basin	2	2	1	1	2	2	1	2	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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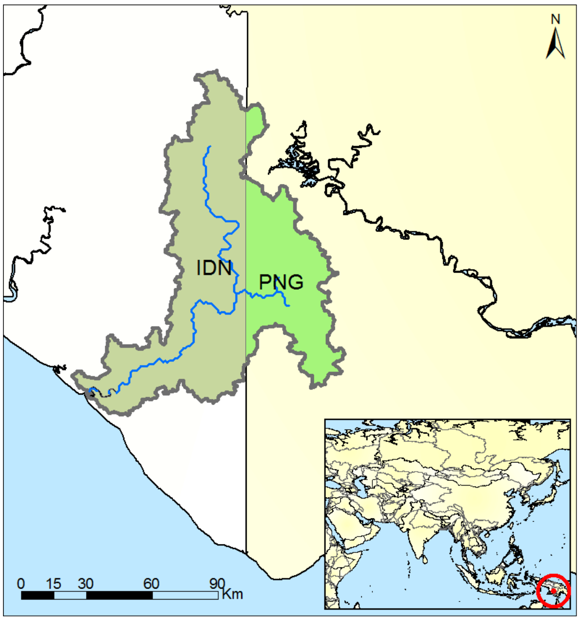
Tjeroaka-Wanggoe Basin



Geography

Total drainage area (km²)	8,049
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	60,982
Country at mouth	Indonesia
Average rainfall (mm/year)	2,066

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	1

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
TJWA_IDN		916.89				
TJWA_PNG		1,155.35				
Total in Basin	7.76	964.55			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
TJWA_IDN	6.02	1.24	0.10	0.00	0	4.68	106.80	
TJWA_PNG	0.12	0.00	0.01	0.00	0	0.11	25.91	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
[2] For details on River Basin Organisations (RBOs) and Commissions please visit http://www.transboundarywaters.orst.edu/

Total in Basin	6.14	1.24	0.11	0.00	0.00	4.79	100.66	0.08

Socioeconomic Geography

BCU	Area ('000 km²)	BCU area in basin (%)	Population ('000 people)	Population density (people/ km²)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km²)
TJWA_IDN	5	0.68	56	10.36	1.08			0	3,475.25	0	0.00
TJWA_PNG	3	0.32	5	1.77	2.36			0	2,088.35	0	0.00
Total in Basin	8	1.00	61	7.58	1.28	0.00	0.00	0	3,369.99	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
TJWA_IDN	1	1	1		5	4	1	2	1	5	3	3	1	3	2
TJWA_PNG	1	1	1		5	5	1	2	1	5	3		1	3	2
River Basin	1	1	1	2	5	5	1	2	1	5	3		1	4	2

Indicators

1 - Environmental water stress **2** – Human water stress **3** – Agricultural water stress **4** – Nutrient pollution **5** – Wastewater pollution **6** – Wetland disconnectivity **7** – Ecosystem impacts from dams **8** – Threat to fish **9** – Extinction risk **10** – Legal framework **11** – Hydropolitical tension **12** – Enabling environment **13** – Economic dependence on water resources **14** – Societal well-being **15** – Exposure to floods and droughts

Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
TJWA_IDN	2	2	1	1			1	2	3
TJWA_PNG	2	2	1	1			2	4	3
River Basin	2	2	1	1	2	2	1	2	3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

[3] Lined (or dotted) cells indicate a lower degree of confidence in results due to global modelling limitations and other gap-filling methods.

Indicators

17 – Lake influence indicator **18** – Relative sea level rise (RSLR) **19** – Wetland ecological threat **20** – Population pressure **21** – Delta governance

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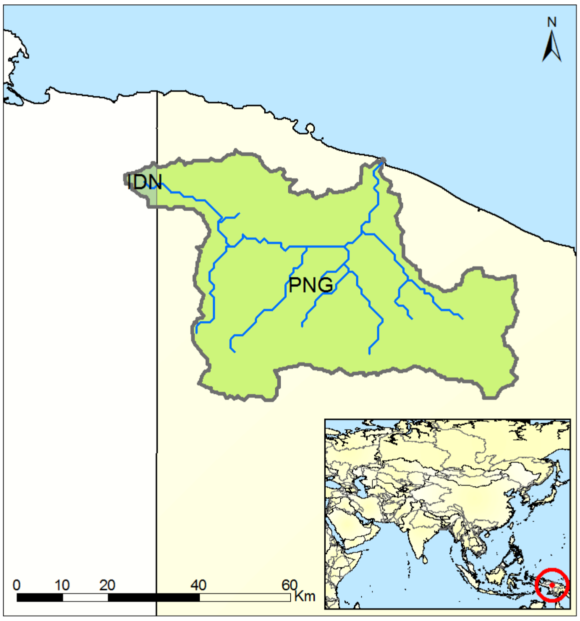
Vanimo-Green Basin



Geography

Total drainage area (km^2)	2,670
No. of countries in basin	2
BCUs in basin	Indonesia (IDN), Papua New Guinea (PNG)
Population in basin (people)	16,208
Country at mouth	Papua New Guinea
Average rainfall (mm/year)	2,442

Governance

No. of treaties and agreements[1]	0
No. of RBOs and Commissions[2]	0

Geographical Overlap with Other Transboundary Systems

(No. of overlapping water systems)

Groundwater	
Lakes	0
Large Marine Ecosystems	0

A BCU (Basin Country Unit) is defined as the portion of a country within a particular river basin.
All BCUs have a BCU code which includes a Basin Code of four letters and a Country Code of three letters: XXXX-XXX

Water Resources

BCU	Annual Discharge (km^3/year)	Annual Runoff (mm/year)	Av. Groundwater Recharge (km^3/year)	Av. Groundwater Discharge (km^3/year)	Lake and Reservoir Surface Area (km^2)	Lake and Reservoir Volume (km^3)
VAGR_IDN						
VAGR_PNG		860.41				
Total in Basin	2.30	860.41			0.00	0.00

Water Withdrawals

BCU	Total (km^3/year)	Irrigation (km^3/year)	Livestock (km^3/year)	Electricity (km^3/year)	Manufacture (km^3/year)	Domestic (km^3/year)	Per capita (m^3/year)	Total withdrawal as a % of Total Actual Renewable Water Resources (%)
VAGR_IDN								
VAGR_PNG	1.20	0.00	0.04	0.50	0	0.67	74.49	

[1] For details on Treaties and Agreements please see http://www.transboundarywaters.orst.edu/
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Total in Basin	1.20	0.00	0.04	0.50	0.00	0.67	73.99	0.05

Socioeconomic Geography

BCU	Area ('000 km^2)	BCU area in basin (%)	Population ('000 people)	Population density (people/km^2)	Annual pop. growth (%)	Rural population ratio (% pop. rural)	Urban population ratio (% pop. urban)	Large Cities (>500,000)	GDP per capita (USD)	No. of dams	Dam Density (No./000.000 km^2)
VAGR_IDN	0	0.01	0	2.79				0	3,475.25	0	0.00
VAGR_PNG	3	0.99	16	6.12				0	2,088.35	0	0.00
Total in Basin	3	1.00	16	6.07	2.12	0.00	0.00	0	2,097.75	0	0.00

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Indicator[3]

Thematic group	Water Quantity			Water Quality			Ecosystems			Governance			Socioeconomics		
BCU	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
VAGR_IDN					5				1	5	3	3	1	3	1
VAGR_PNG	1		1		5				1	5	3		1	3	2
River Basin	1		1	2	5				1	5	3		1	4	2

Indicators

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Very low Low Medium High Very high

TWAP RB Assessment Results: BCU and Basin Relative Risk Category per Projected Indicator

Projected Indicator	1.Environmental water stress		2.Human water stress		4.Nutrient pollution		16.Change in population density		11.Hydropolitical tension
Basin BCU	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	P-2030	P-2050	Projected
VAGR_IDN									3
VAGR_PNG	2	2							3
River Basin	2	2			2	2			3

TWAP RB Assessment results: Water System Linkages

Thematic group	Lake Influence Indicator	Delta Vulnerability Index			
Basin/Delta	17	18	19	20	21
River Basin	1				

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Transboundary river basins of New Guinea

LME 10 – Insular Pacific Hawaiian

Western Pacific Warm Pool (not an LME)

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

Center for Marine Assessment and Planning, UCSB

NASA Earth Observatory

LME 10 – Insular Pacific Hawaiian

Bordering country: United States of America.
LME Total area: 975,493 km^2

List of indicators

LME overall risk

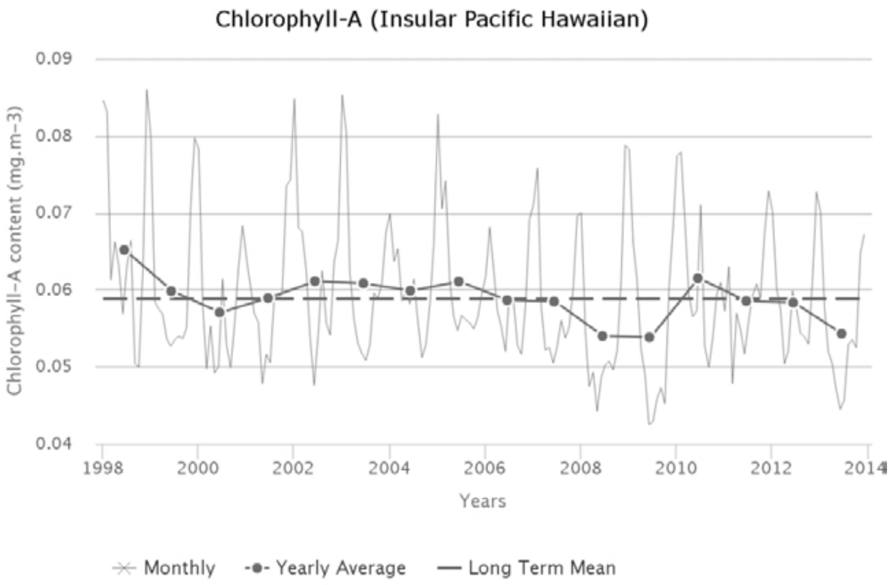
This LME falls in the cluster of LMEs that exhibit medium numbers of collapsed and overexploited fish stocks, as well as very high proportions of catch from bottom impacting gear.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low.

Very low	Low	Medium	High	Very high
▲				

Productivity

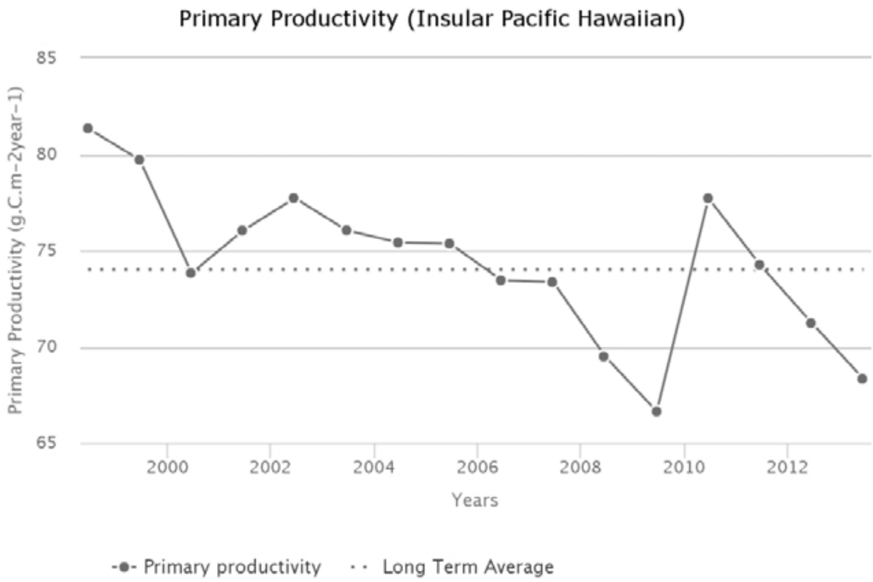
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.0735 mg.m^{-3}) in January and a minimum (0.0519 mg.m^{-3}) during June. The average CHL is 0.0588 mg.m^{-3}. Maximum primary productivity (81 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (67 g.C.m^{-2}.y^{-1}) during 2009. There is a statistically insignificant decreasing trend in Chlorophyll of -7.50 % from 2003 through 2013. The average primary productivity is 74 g.C.m^{-2}.y^{-1}, which places this LME in Group 1 of 5 categories (with 1 = lowest and 5= highest).



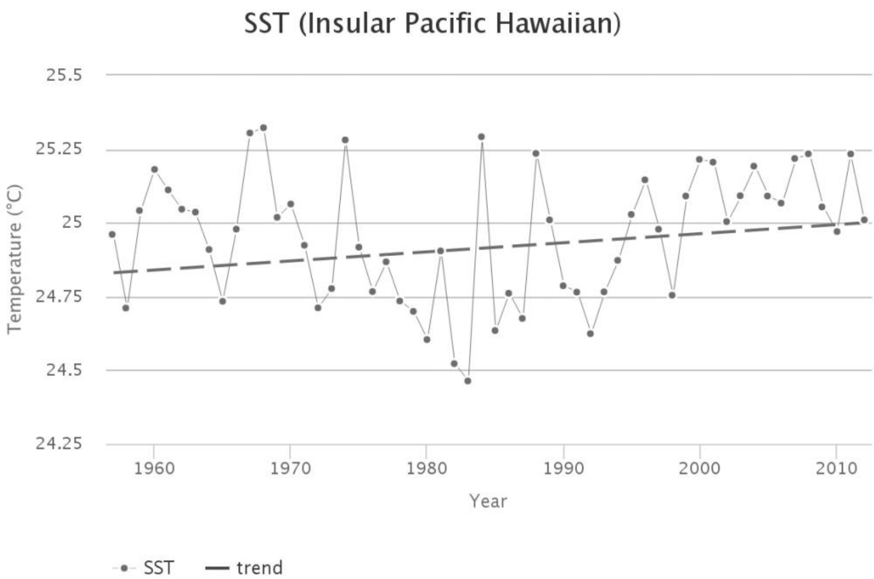
Very low	Low	Medium	High	Very high
▲				

Primary productivity



Sea Surface Temperature

Between 1957 and 2012, the Insular Pacific Hawaiian LME #10 has warmed by 0.12°C, thus belonging to Category 4 (slow warming LME). This is the only mid-ocean LME. Even though this LME encompasses a large island chain, the oceanic environment is typical of the deep open ocean. Moreover, the Hawaiian LME is characteristic of the most stable oceanic environment within a large-scale anticyclonic subtropical gyre. This stability might help explain the most striking feature of the Hawaiian SST time series: the lack of significant long-term warming over the last 50 years. However, after the all-time minimum of <24.5°C in 1982-83, SST rose significantly to stay at 25°C or warmer from 2000 until present. Interannual variability is not substantial in absolute terms, usually <0.5°C, although it appears important when compared with the slow long-term warming of this LME.

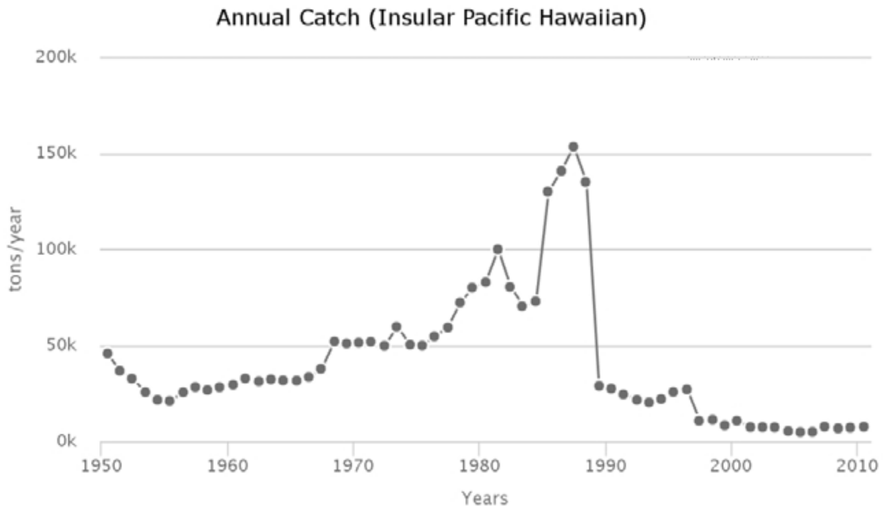


Fish and Fisheries

The LME's fisheries are on a relatively small scale compared to US mainland fisheries. Most fishery resources (bottom fishes, nearshore reef fishes, and invertebrates) are concentrated in the coastal waters of the narrow shelf areas surrounding the islands, but there is also a fishery for highly migratory pelagic species, and tuna (bigeye, yellowfin, skipjack, albacore) are the LME's most valuable resource.

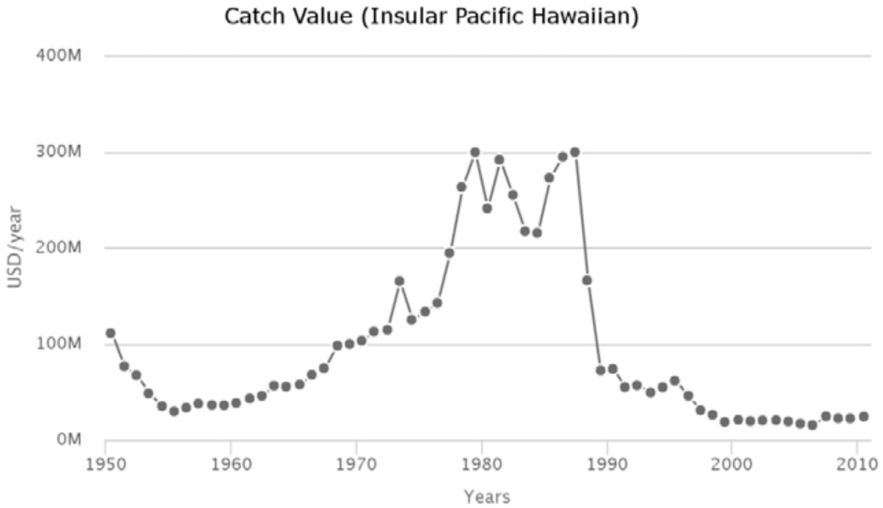
Annual Catch

Total reported landings in this LME reached 150,000 t in 1987, with extremely high landings of grunts (*Haemulidae*), but have since declined to below 10,000 t in recent 10 years. Catches of inshore fish by small-scale and recreational fishery is considerable, however, and were they to be included, the trend in the reported landings would change considerably.



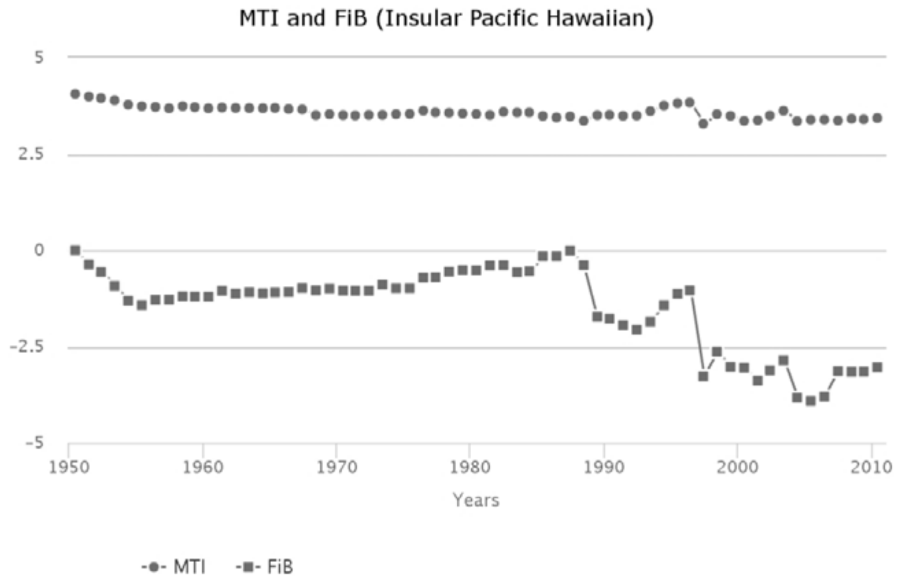
Catch value

The value of reported landings peaked at nearly 300 million US$ (in 2005 real US$) in 1987.



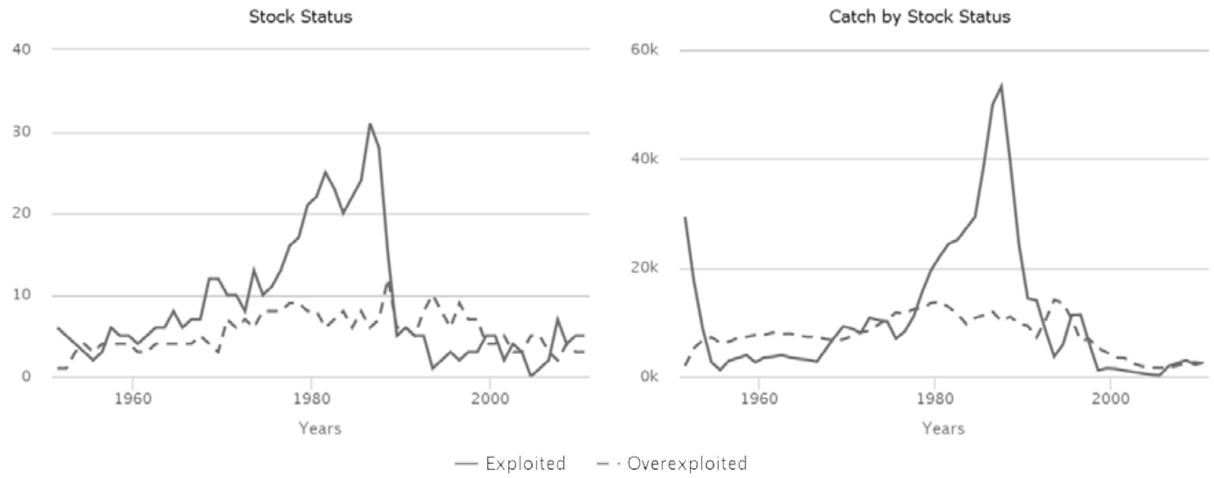
Marine Trophic Index and Fishing-in-Balance index

The MTI shows a steady decline, an indication of a "fishing down" of the food web in the LME. The FiB index also showed an initial increase, followed by a decline since the late 1980s.



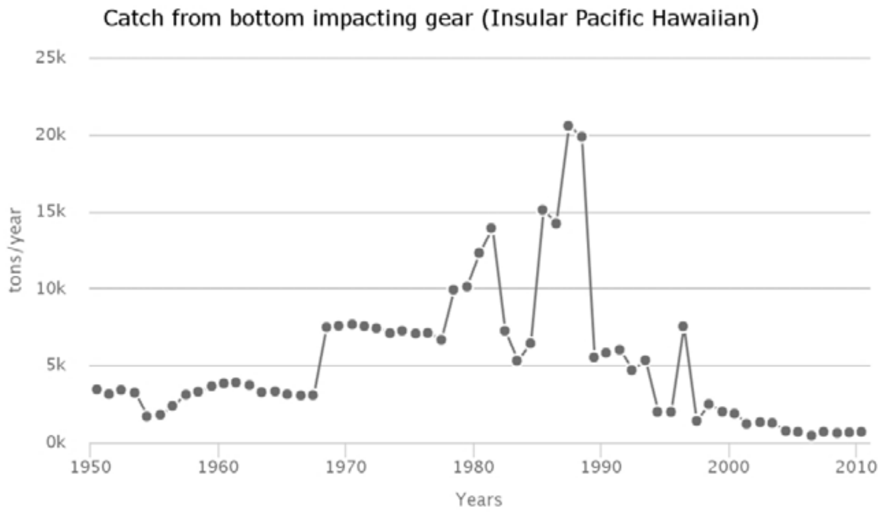
Stock status

The problem of the misreporting in the underlying statistics probably also affect the Stock-Catch Status Plots, which indicate that about 60% of commercially exploited stocks have collapsed, with about 60% of the reported landings biomass supplied by either collapsed or overexploited stocks.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated around 7 to 15% from 1950 to the mid-1980s. Then, this percentage reached its first maximum at 27% in 1993 and then fluctuated between 7 and 28% in the recent few decades.

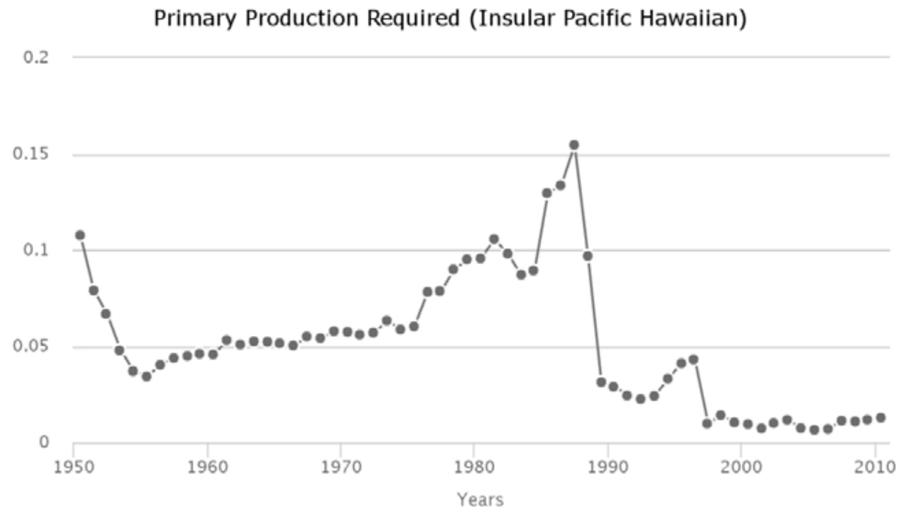


Fishing effort

The total effective effort increased steadily from around 10 million kW in the 1950s to its peak at 67 million kW in the mid- 2000s.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in the LME reached 7% of the observed primary production in the late 1980s, but has declined to below 1% in recent years.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans. An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	1	1	1	1	1	1	1	1

Legend:

Very low Low Medium High Very high

POPs

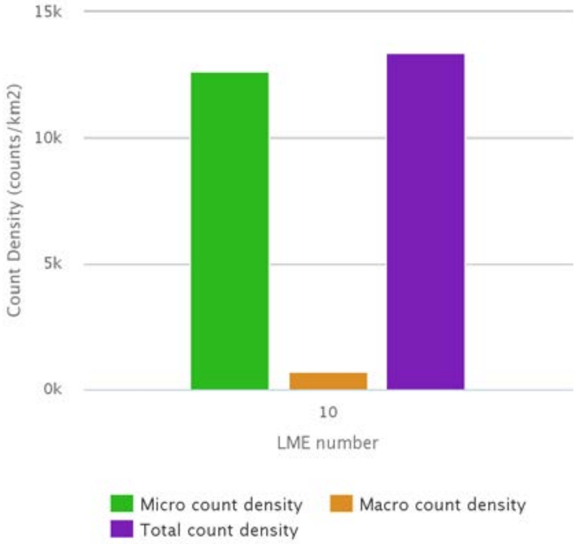
The Insular Pacific-Hawaiian LME has 4 samples at 4 locations. The average concentration (ng.g^{-1} of pellets) was 3 (range 0.1 – 9 ng.g^{-1}) for PCBs, 2 (range 1 – 3 ng.g^{-1}) for DDTs, and 0.3 (range 0.3 – 0.4 ng.g^{-1}) for HCHs. All averages correspond to risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This is probably due to minimal anthropogenic activities involving the use of POPs (PCBs in industries and DDT and HCH pesticides in agriculture) and remoteness from areas with high anthropogenic activities. Most of these could have been derived from long-range atmospheric transport, and these concentrations can be considered as a reflection of global background pollution of POPs.

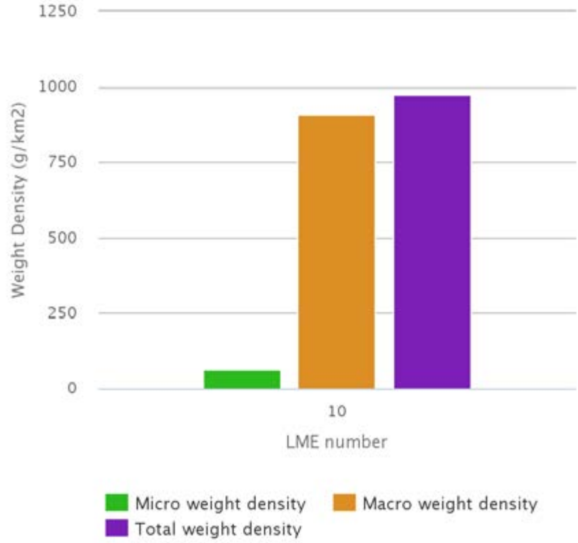
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
4	3	**1**	2	**1**	0.3	**1**

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively high levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category there is good evidence from sea-based direct observations and towed nets to support this conclusion.





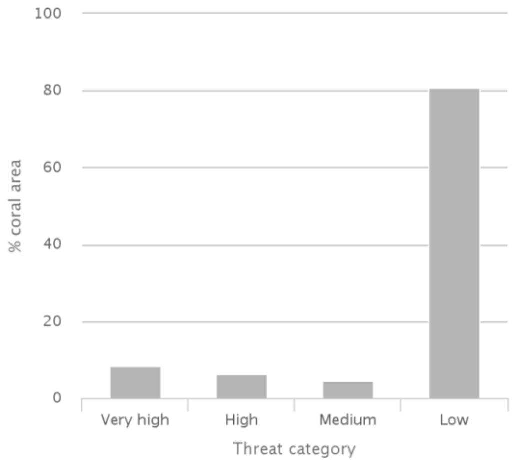
Ecosystem Health

Mangrove and coral cover

0.0007% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.41% by coral reefs (Global Distribution of Coral Reefs, 2010).

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 142. 8% of coral reefs cover is under very high threat, and 6% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 9% and 7% for very high and high threat categories respectively. By year 2030, 15% of coral cover in this LME is predicted to be under high to critical level of threat from warming and acidification; remaining at 15% by 2050.

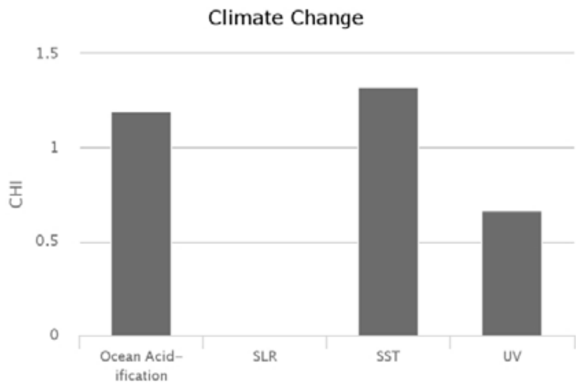


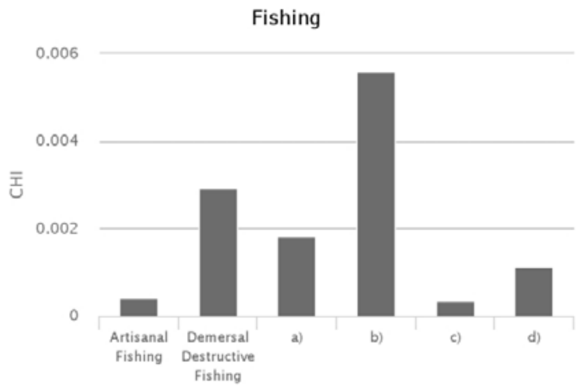
Marine Protected Area change

The Insular Pacific-Hawaiian LME experienced an increase in MPA coverage from 2,672 km^2 prior to 1983 to 370,253 km^2.

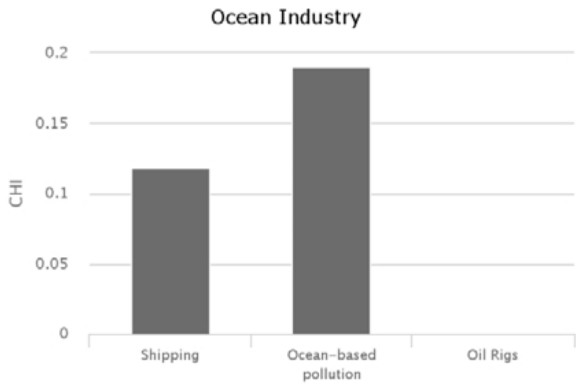
Cumulative Human Impact

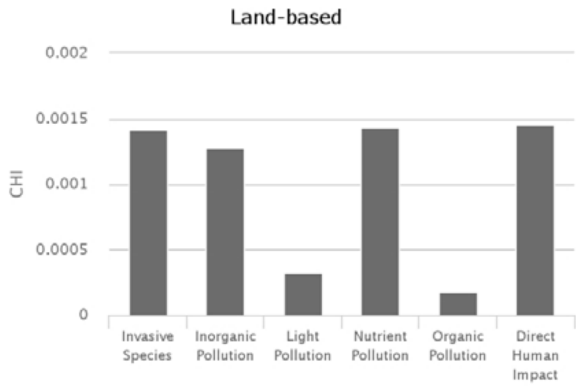
The Insular Pacific-Hawaiian LME experiences an average overall cumulative human impact (score 3.52; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 3 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (1.20; the maximum score seen for any LME), UV radiation (0.67; maximum in other LMEs was 0.76), and sea surface temperature (1.33; maximum in other LMEs was 2.16). Other key stressors include commercial shipping and ocean based pollution.

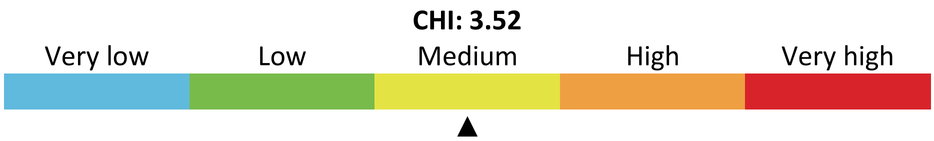




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing



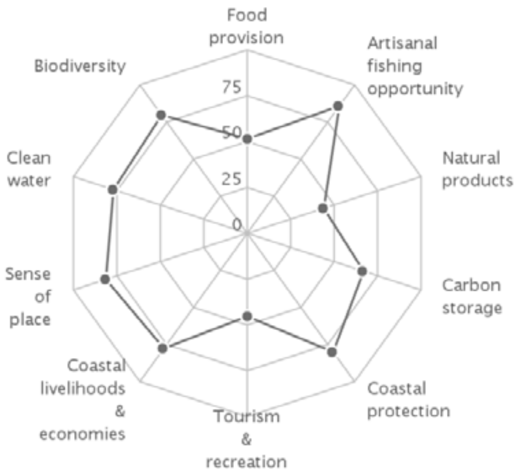




Ocean Health Index

The Insular Pacific-Hawaiian LME scores above average on the Ocean Health Index compared to other LMEs (score 72 out of 100; range for other LMEs was 57 to 82) but still relatively low. This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 9 points compared to the previous year, due in large part to changes in the scores for clean waters. This LME scores lowest on food provision, natural products, coastal livelihoods, and tourism & recreation goals and highest on artisanal fishing opportunities, coastal economies, and lasting special places goals. It falls in risk category 2 of the five risk categories, which is a moderate level of risk (1 = lowest risk; 5 = highest risk).

Ocean Health Index (Insular Pacific Hawaiian)



OHI: 68.94

Very low	Low	Medium	High	Very high
			▲	

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for the Insular Pacific-Hawaiian LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The area includes the Pacific coasts of southern Mexico, Central America, and the South American nations of Colombia, Ecuador and northernmost portion of Peru, covering a total of 585,973 km^2. A current population of 50 million is projected to almost double to 98 million in 2100, as reflected in density increasing from 86 persons per km^2 in 2010 to 167 per km^2 by 2100. About 47% of coastal population lives in rural areas, and is projected to increase in share to 52% in 2100.

Total population		Rural population	
2010	2100	2010	2100
1,367,394	2,569,510	84,631	66,160

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 44% of the LME's coastal dwellers. The Insular Pacific-Hawaiian LME places in the highest-risk category based on percentage and absolute number of coastal poor (present day estimate).

Coastal poor
234,334

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. The Insular Pacific-Hawaiian LME ranks in the high revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $24 million for the period 2001-2010. Fish protein accounts for 7% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $6096 million places it in the low revenue category. On average, LME-based tourism income contributes 8% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for the Insular Pacific-Hawaiian LME falls in the category with low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
24,041,807	7.4	6,096,412,200	8.4	0.5365

Legend: Very low | Low | Medium | High | Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day Insular Pacific-Hawaiian LME HDI belongs to the highest HDI and lowest risk category. Based on an HDI of 0.909, this LME has an HDI Gap of 0.091, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). The Insular Pacific-Hawaiian LME is projected to maintain its position in the lowest risk category (highest HDI) in 2100 under a sustainable development pathway or scenario. Under a fragmented world scenario, this LME is estimated to place in the high risk category (low HDI) because of reduced income level and increased population size compared to estimated income and population values in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9094	0.9662	0.6971

Legend: Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

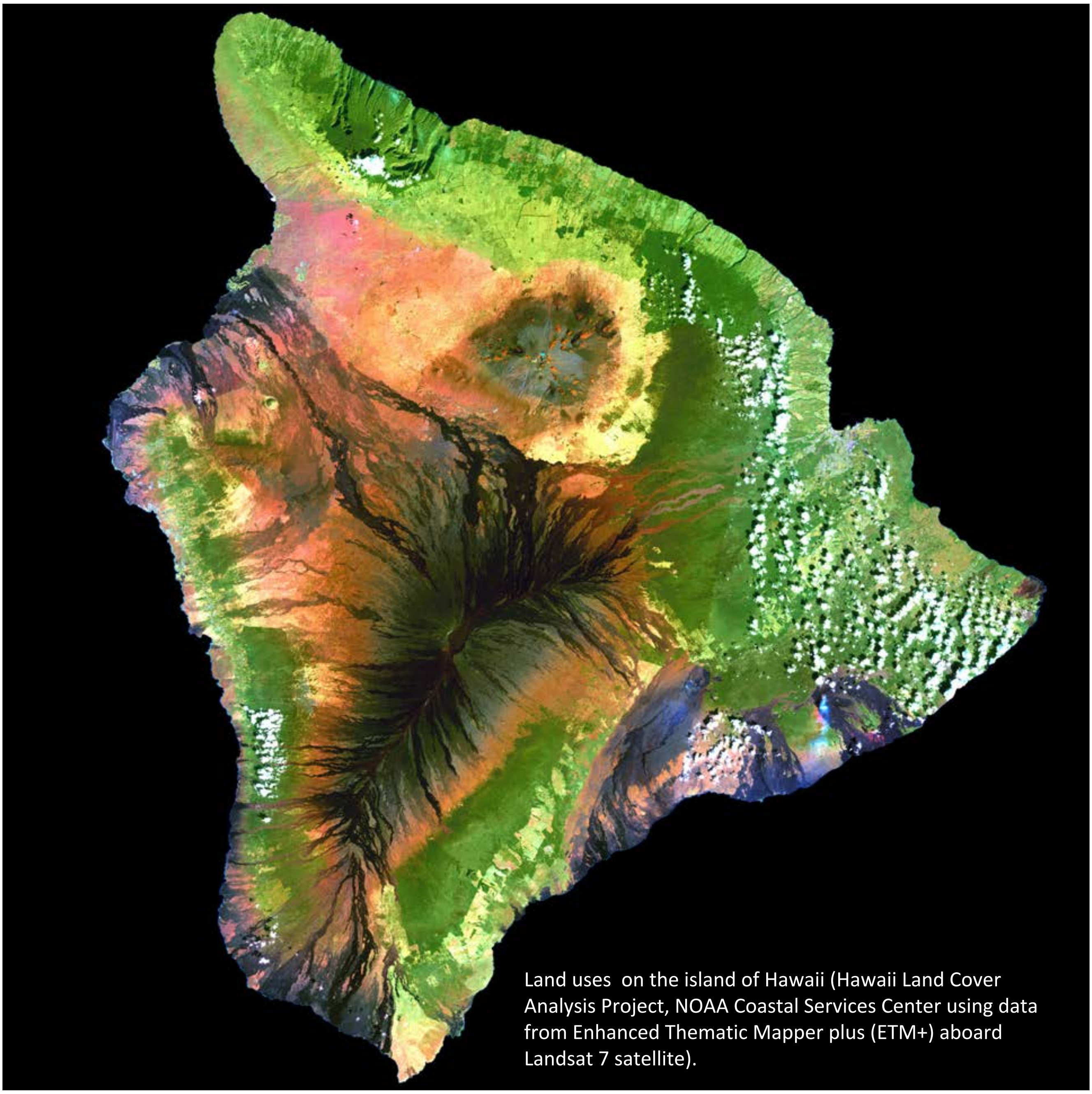
The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index to the Insular Pacific-Hawaiian LME is within the low-risk (low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is low. In a sustainable development scenario, the risk index from sea level rise in 2100 is lowest, and increases to medium risk under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.4765	0.2618	0.2609	0.5295

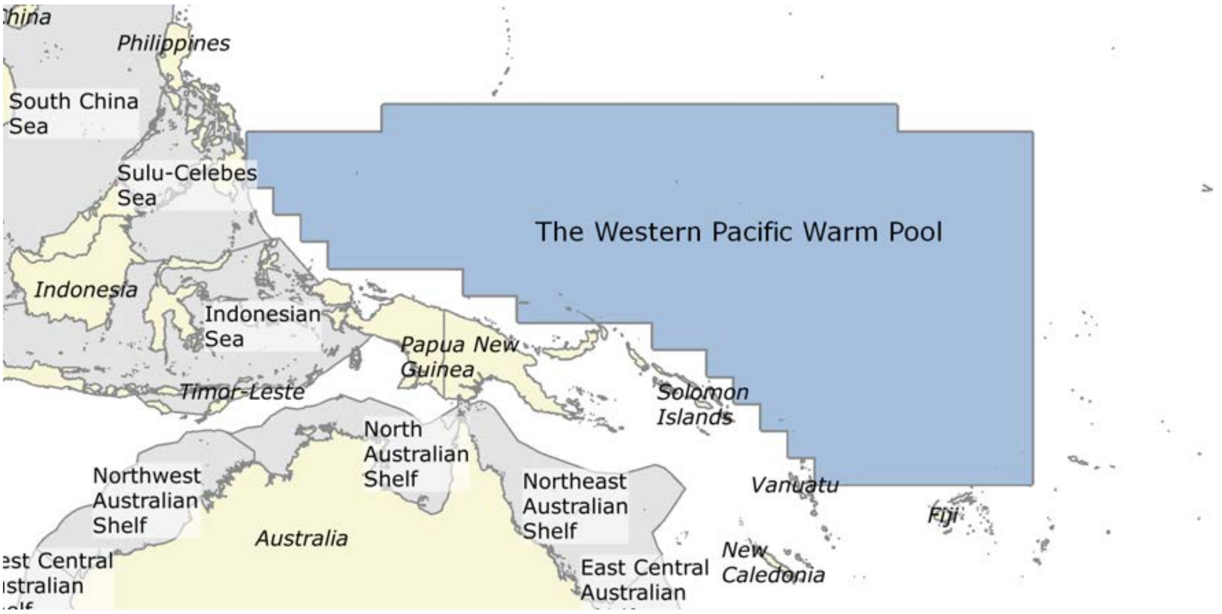
Legend:

Very low | Low | Medium | High | Very high

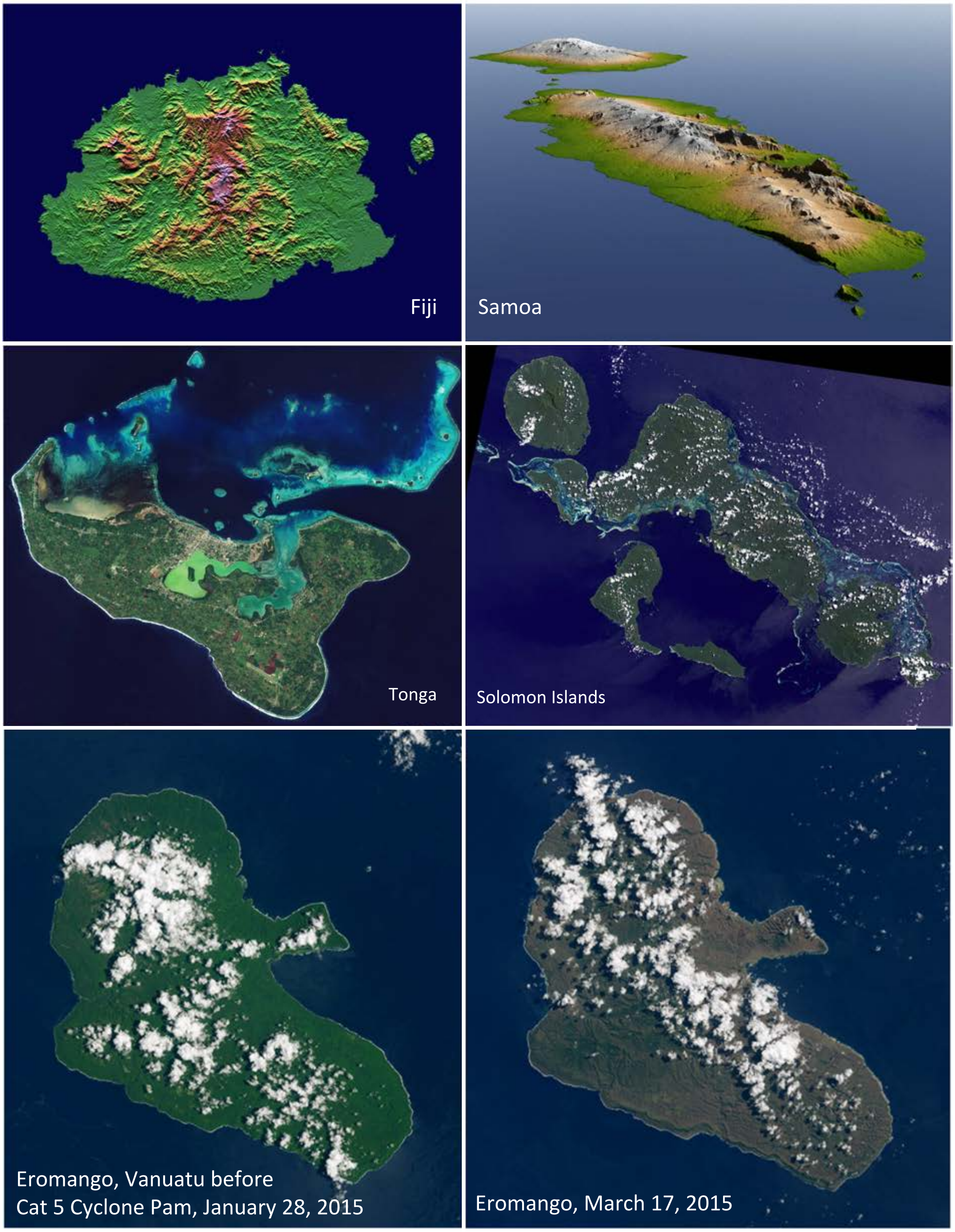


Land uses on the island of Hawaii (Hawaii Land Cover Analysis Project, NOAA Coastal Services Center using data from Enhanced Thematic Mapper plus (ETM+) aboard Landsat 7 satellite).

Western Pacific Warm Pool



List of indicators



NASA/ JPL

NASA/ JPL/ NGA

ESA

Robert Simmon, NASA

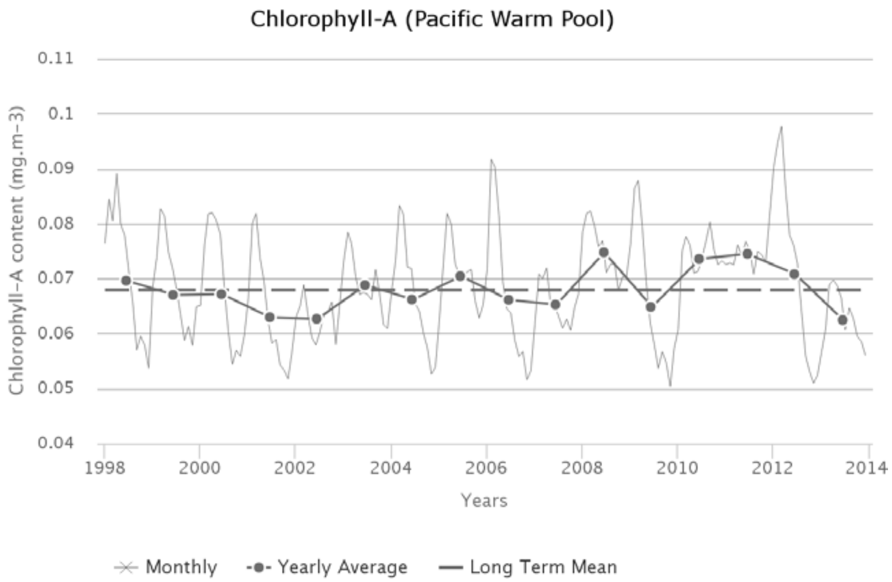
Joshua Stevens, NASA Earth Observatory

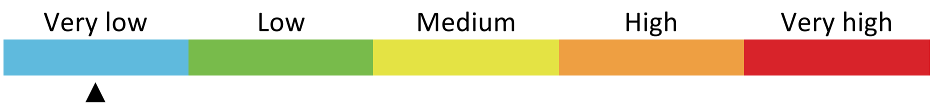
Note: Data on the island nations of Fiji, Samoa, Solomon Islands, Tonga and Vanuatu were available to support the socio-economic assessment of the Western Pacific Warm Pool.

Productivity

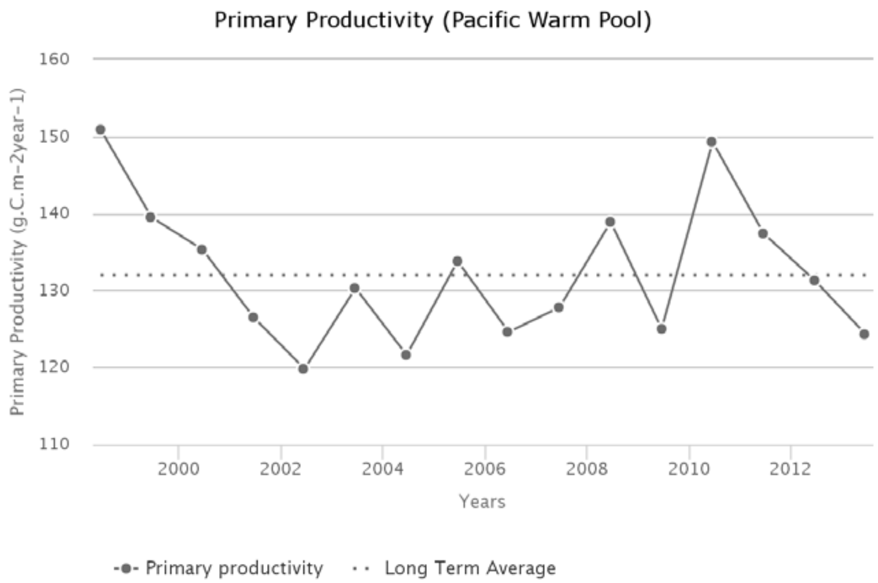
Chlorophyll A

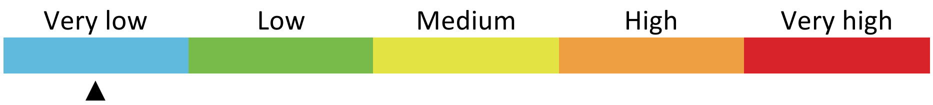
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.0799 $mg.m^{-3}$) in March and a minimum (0.0590 $mg.m^{-3}$) during November. The average CHL is 0.0679 $mg.m^{-3}$. Maximum primary productivity (151 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (120 $g.C.m^{-2}.y^{-1}$) during 2002. There is a statistically insignificant increasing trend in Chlorophyll of 7.66 % from 2003 through 2013. The average primary productivity is 132 $g.C.m^{-2}.y^{-1}$, which places the Western Pacific Warm Pool in Group 1 of 5 categories (with 1 = lowest and 5= highest).





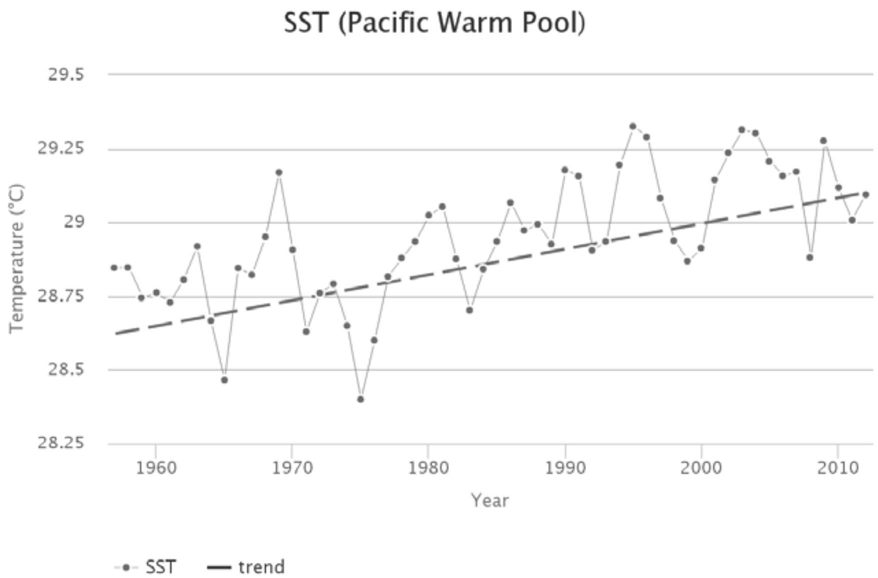
Primary productivity





Sea Surface temperature

From 1957 to 2012, the West Pacific Warm Pool Province has warmed by 0.48°C, thus belonging to Category 3 (moderate warming region). The thermal history of this vast region consisted of two epochs separated by a regime change with a breakpoint in 1975. A cooling epoch can be identified from 1957 through 1975, during which SST decreased by 0.5°C, after which SST warmed sharply in 1976-1977. This abrupt warming could be tentatively linked to the North Pacific regime shift of 1976-1977 (Hare and Mantua, 2000), although the onset of warming occurred in this province about one year before it occurred elsewhere. Two warm events can be identified, in 1995 and 2003. The El Niño 1997-1998 did not manifest in this province. In many LMEs the El Niño 1997-1998 manifested as a warm peak of extreme magnitude. Thus, this province belongs to a very small subset of Pacific regions, where the El Niño 1997-1998 did not manifest the same way as elsewhere.

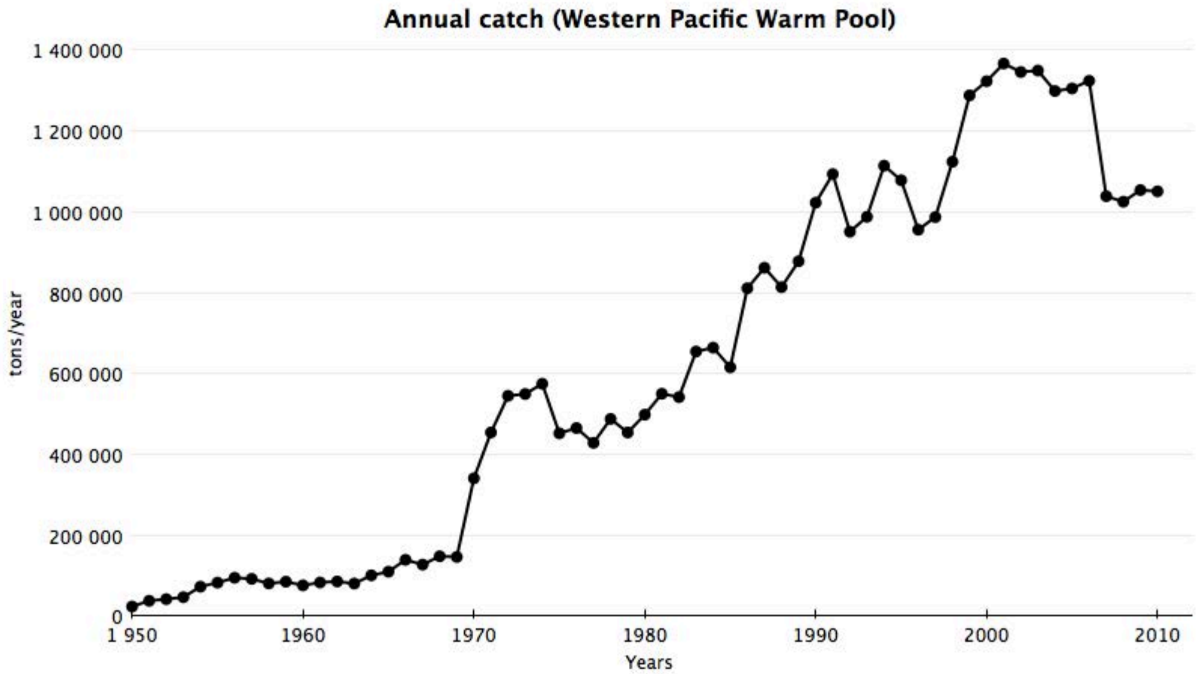


Fish and Fisheries

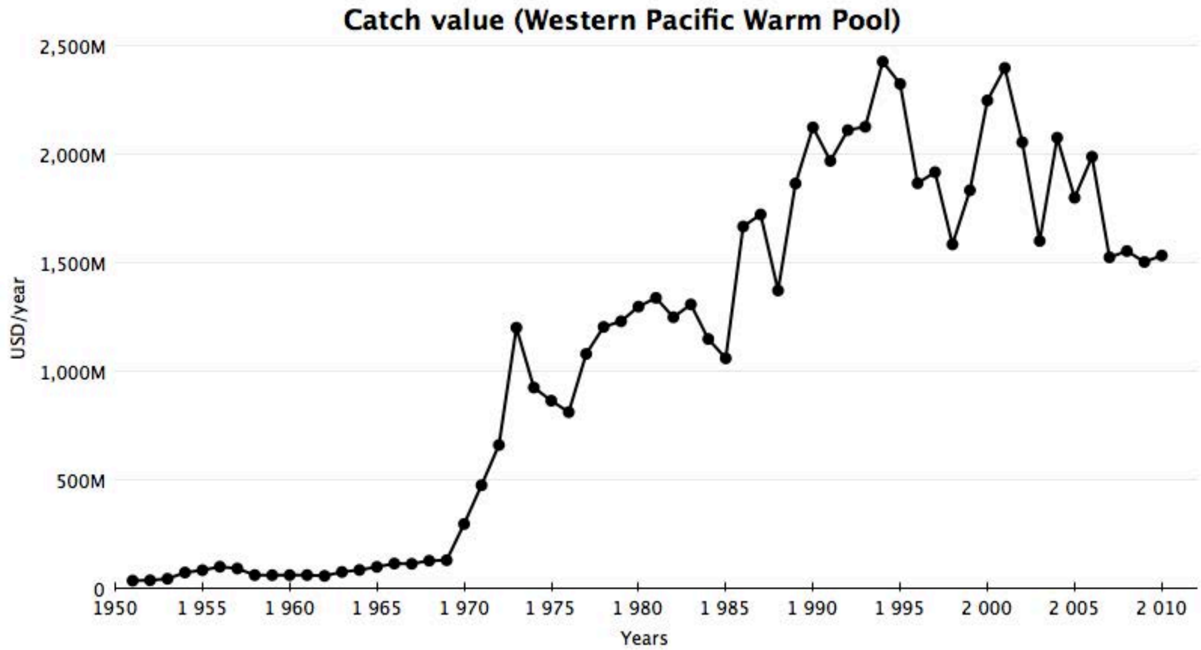
The Western Pacific Warm Pool (WPWP), which is not a designated LME, covers 13 million km^2 in the Central Western Pacific.

Annual Catch

As the WPWP is in effect, a vast expanse of deep tropical waters studded with small volcanic islands or atolls, the bulk of the fisheries catches consists of tunas and other large pelagic fishes caught in open waters (more than 50%), and smaller reef-associated fishes and invertebrates. In absolute terms, this amounted to an average of 130,000 t per year in the 1950s and 1960s, to between 1.0 – 1.4 million t since 1990. The catch of the WPWP from bottom-impacting gear went from a few hundred tonnes in 1950 to about 40,000 tonnes in 2010, which is currently about 4 % of the total catch, but as much as 20% of the non-tuna catch.

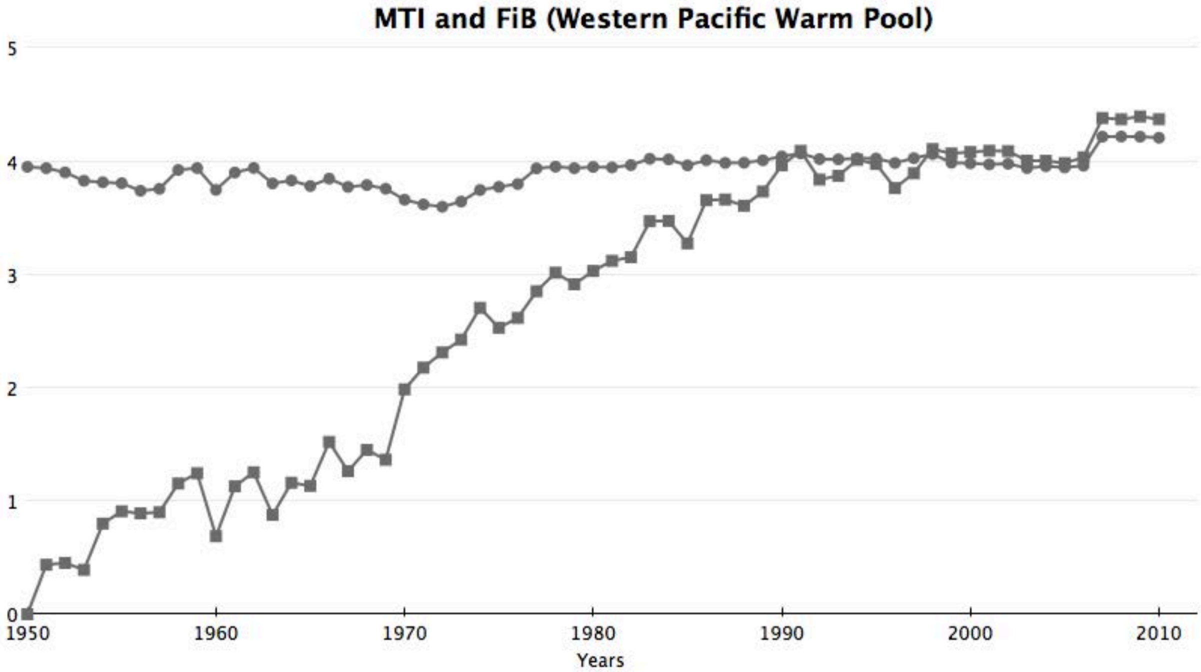


Catch lue



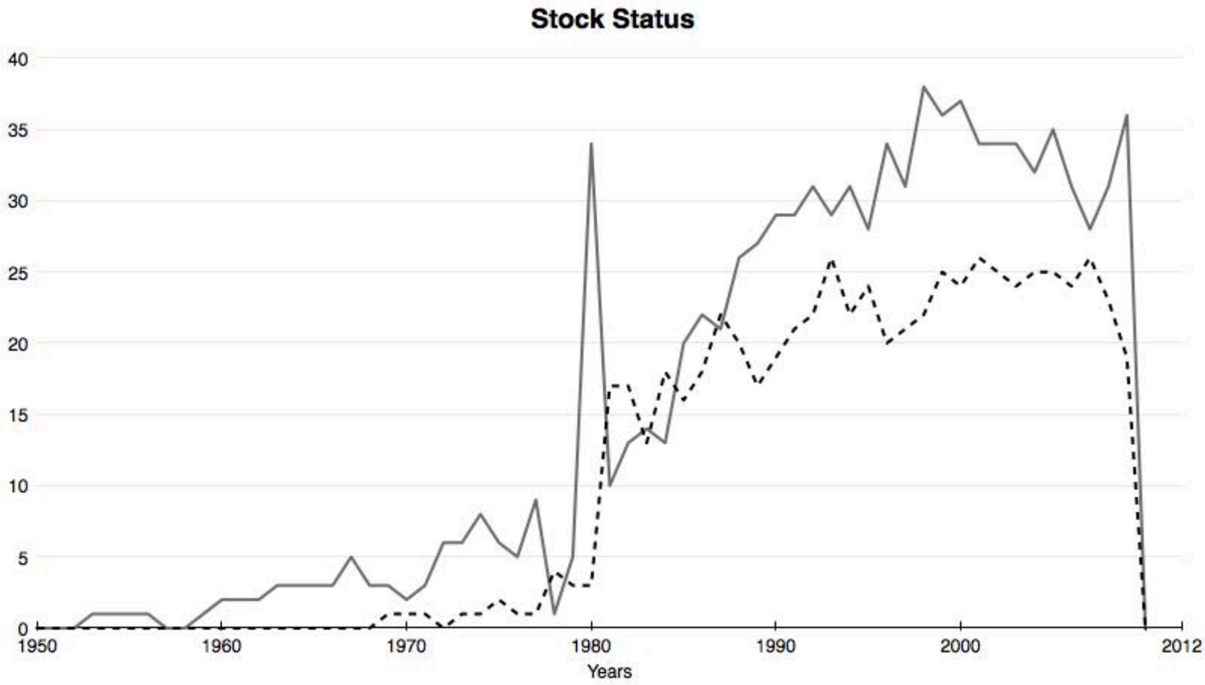
Marine Trophic Index and Fishing in Balance index

The primary production required (PPR) to sustain the reported landings in the WPWP grew slowly from less that 1% in the early 1950 to about 2% in 1970, but it increased rapidly to a plateau of about 20 % in the mid-1990s, around which it now oscillates. Related to this, the MTI decreased from 1950 to the early 1970s, but picked up and plateaued from 1990 on as tuna and other high-trophic level pelagic fishes increased, the post-2006 increase being an artefact of the time series extension. The trend in the FiB index confirms this, and illustrates how the pelagic fisheries expanded their areas of operations.



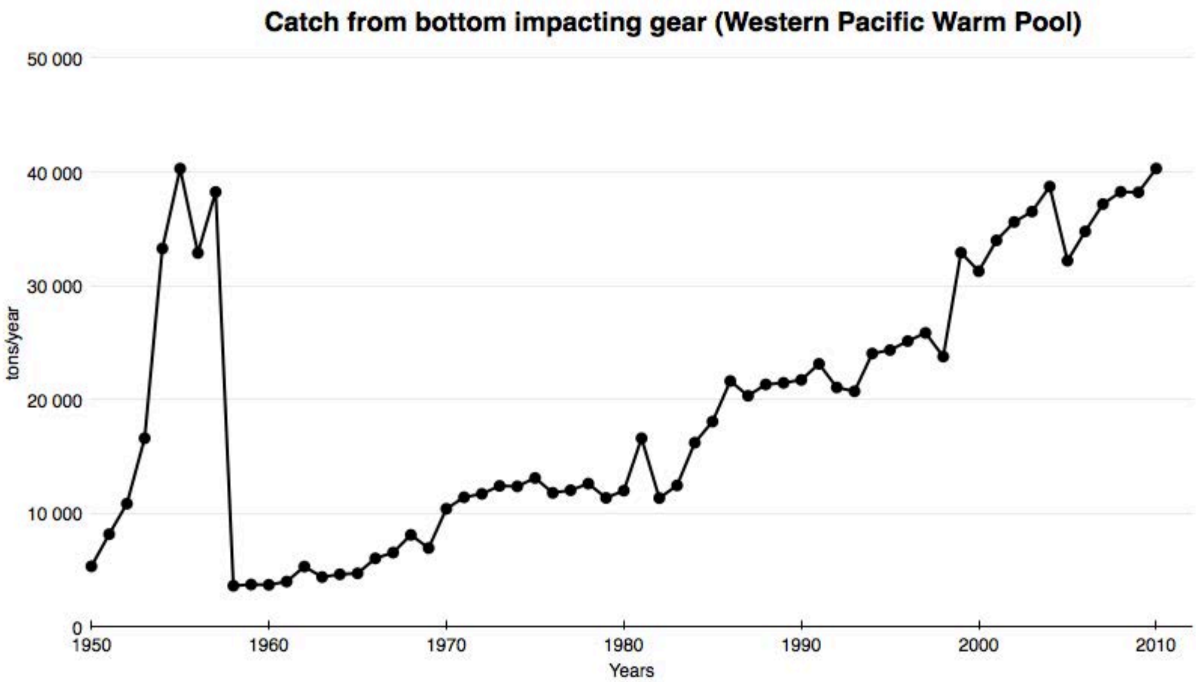
Stock status

The Stock-Catch Status Plots indicate that about 90 % of the catch of commercially exploited stocks in the WPWP are fully exploited, while stocks in the developing stage, estimated to be nearly 100% in the 1970s, has shrunk to 10%.



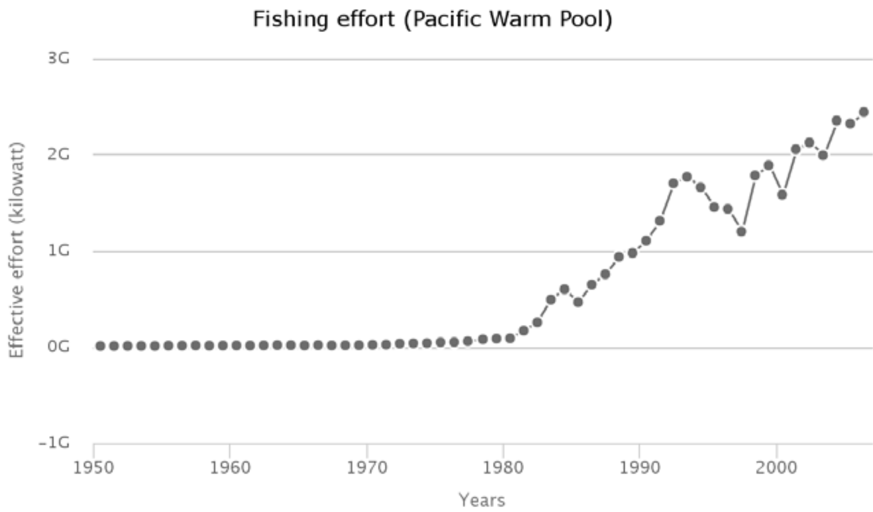
Catch from ottom mpacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 1 and 6% from 1950 to 2010. This percentage fluctuated around 3% in the recent decade.



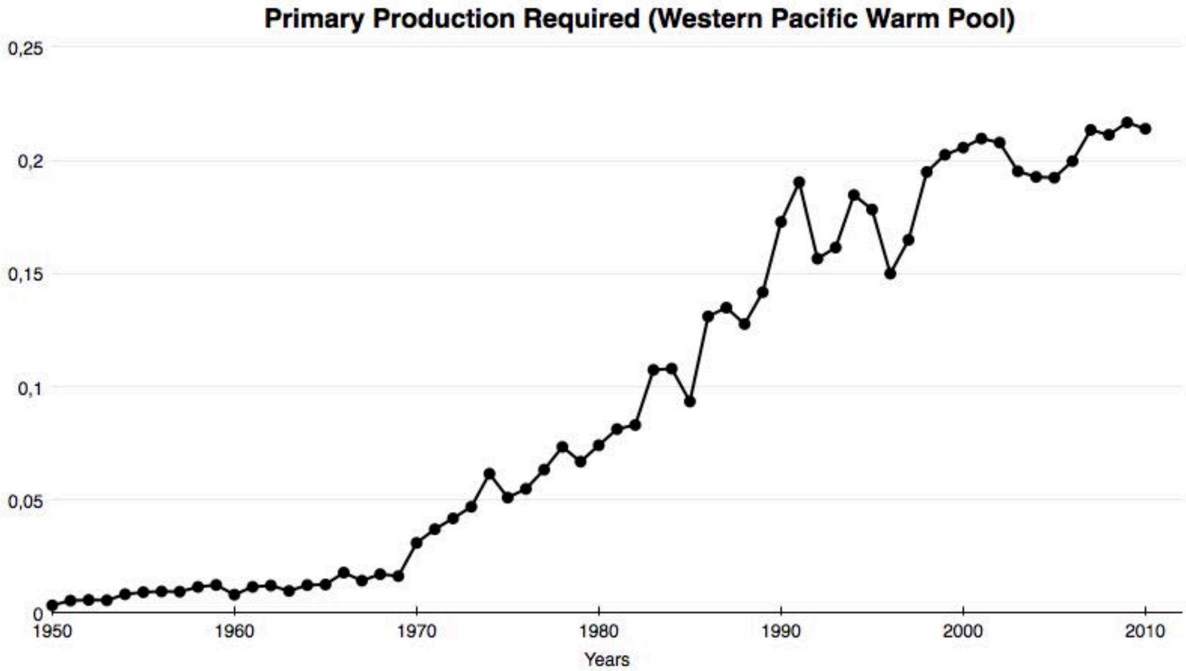
Fishing effort

The total effective effort continuously increased from around 8 million kW in the 1950s to its peak around 2.4 billion kW in 2006.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in the WPWP grew slowly from less that 1% in the early 1950 to about 2% in 1970, but it increased rapidly to a plateau of about 20 % in the mid-1990s, around which it now oscillates.



Pollution and Ecosystem Health

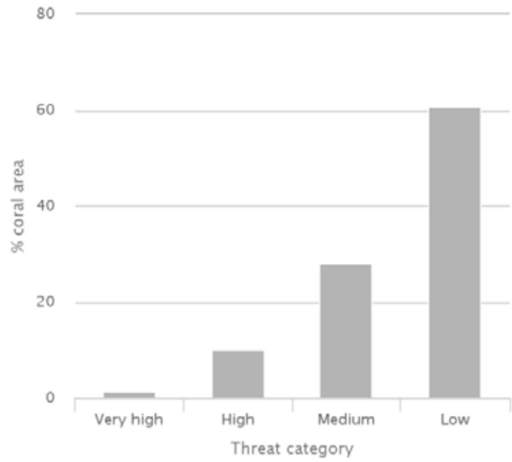
Ecosystem Health

Mangrove and coral cover

0.003% of the Western Pacific Warm Pool is covered by mangroves (US Geological Survey, 2011) and 0.15 by coral reef (Global Distribution of Coral Reefs, 2010).

Reefs at risk

The Western Pacific Warm Pool (WPWP) has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 142. 1.44% of coral reefs cover is under very high threat, and 10% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 6.55% and 19.85% for very high and high threat categories, respectively. By year 2030, 11.44% of coral cover in the WPWP is predicted to be under very high to critical level of threat from warming and acidification; this proportion remains unchanged in 2050.



Marine Protected Area change

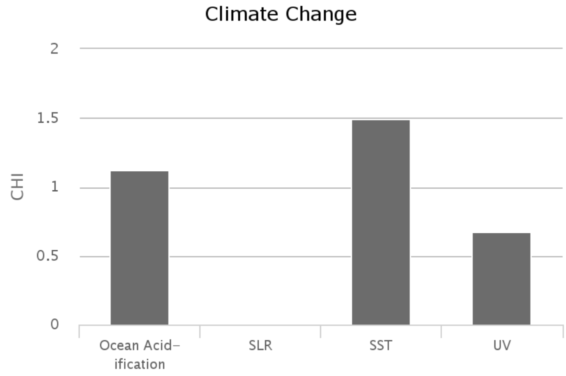
The Western Pacific Warm Pool experienced an increase in MPA coverage from 3,367 km^2 prior to 1983 to 114,485 km^2 by 2014. This represents an increase of 3,300%, within the medium category of MPA change.

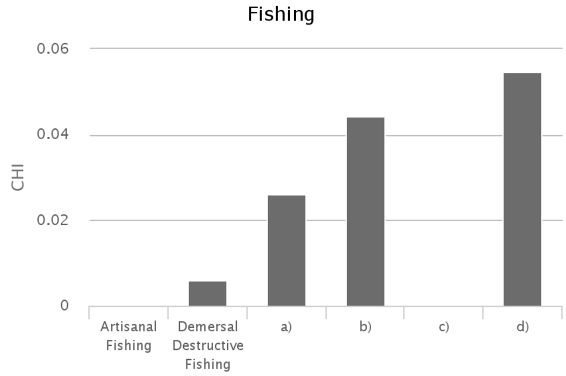
Socio-economics

The Western Pacific Warm Pool is a thermally dynamic region defined by the annual average sea surface temperature isotherm 28°C and above. Within this shifting region are 14 oceanic island states that receive support from the Global Environment Facility: the Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga-Tokelau, Tuvalu and Vanuatu. Though not an LME, the WPWP states are included in this assessment because they are inhabited coastal areas. With the limited data available for island states in general, only five countries - Fiji, Samoa, Solomon Islands, Tonga and Vanuatu -- are assessed. The normalization process allows for comparisons among these five nations.

The populations of the five island states together account for 85% of the aggregate estimate for the 14 GEF beneficiary states in 2010. Close to 90% of the population are rural, and with relatively high rates of poverty, regionally referred as hardship. National poverty headcount ratios are highest for Vanuatu at 40%; Fiji, at 31%; 23% for Solomons; and 20% in the case of Samoa. The range of present day Human Development Index (HDI) values among these five island countries cuts across the three lower HDI classification groups with Fiji at the top have a medium ranked 2013 HDI score (0.724) and Solomon Islands Having a score in the lowest category (0.491).

Cumulative human impact





a) Demersal Non-destructive High Bycatch Fishing
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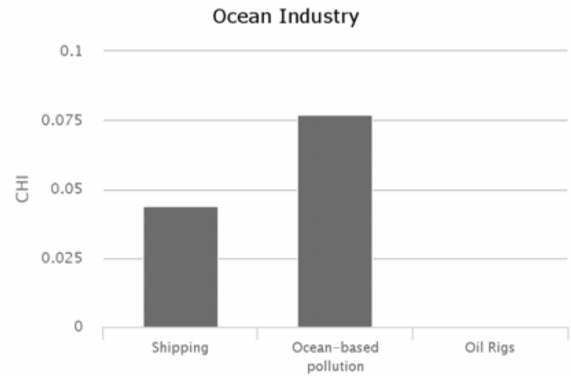
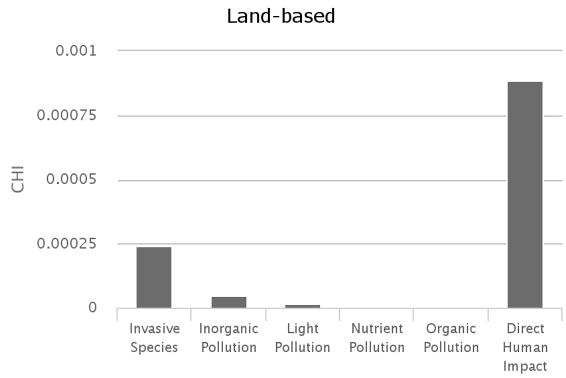
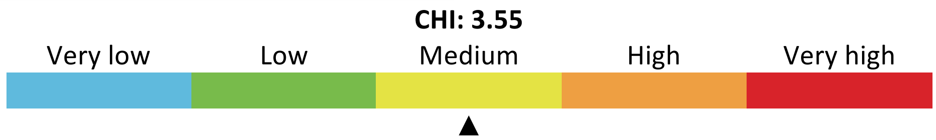






Pacific Warm Pool Island State	2010 Population	2013 HDI	Present day Climate Threat Index	Sea level rise RCP 8.5 2100 (m)	SSP1 2100			SSP3 2100		
					Population	HDI	Sea level rise Threat Index	Population	HDI	Sea Level rise Threat Index
Fiji	854,098	0.724	0.5196	0.7923	600,167	0.849	0.3804	600,167	0.4733	0.4761
Samoa	183,081	0.694	0.3104	0.7828	102,000	0.869	0.1113	102,000	0.5383	0.1265
Solomon Isla	535,699	0.491	0.5597	0.7911	796,833	0.721	0.6549	796,833	0.3539	0.6549
Tonga	104,260	0.705	0.2395	0.8097	67,500	0.869	0.2108	67,500	0.5497	0.2080
Vanuatu	245,786	0.616	0.2292	0.7931	369,333	0.852	0.3252	369,333	0.3899	0.5090

The Present-day Climate-related Extreme Events Threat Index is highest for Solomon Islands because of that island state's low HDI (high HDI Gap). Fiji has the next highest threat level because it has the highest cyclone-related annual mortality rate and highest annual property losses incurred during the period 1994 to 2013. The differences between SSP1 and SSP3 scores of the Sea-level Rise Threat Index is related to the differences in projected HDI scores, since sea-level rise and population estimates are the same for both scenarios. Solomon Islands is the most vulnerable of the five oceanic states in both scenarios, and Samoa the least. Projected RCP 8.5 sea-level rises reach about 0.81 m in 2100. As indicated for LME coastal countries, investing in education offers a strategic and long-term approach to reducing human vulnerability. It is particularly important for the Solomon Islands where education metrics such as mean years in school and the female tertiary educational attainment for present and projected scenarios are at the low end of the range. A long-term mitigation plan that answers to issues of habitability within the projected sea-level rise scenarios is needed.

Governance

Governance Architecture

The three transboundary arrangements for pollution and biodiversity that fall under the Noumea Convention are integrated under SPREP although there is a deficiency of protocols to give effect to the intent of the convention. The Pacific Islands Region has a well-structured mechanism for policy coordination and integration across all issues in the form of the Pacific Islands Forum. It is not clear that integration at the technical level is as well-structured, although there are many linkages and interaction among the relevant processes in this region, several of the supported by MOUs between agencies. The Western Pacific Warm Pool (WPWP) has been assigned an overall integration score of 1.0 due to the presence of the Pacific Islands Forum (PIF) with its ability to function as an overall policy coordinating organization for the key transboundary issues within the WPWP.
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
57	**51**	**1**

Legend:

Very low	Low	Medium	High	Very high

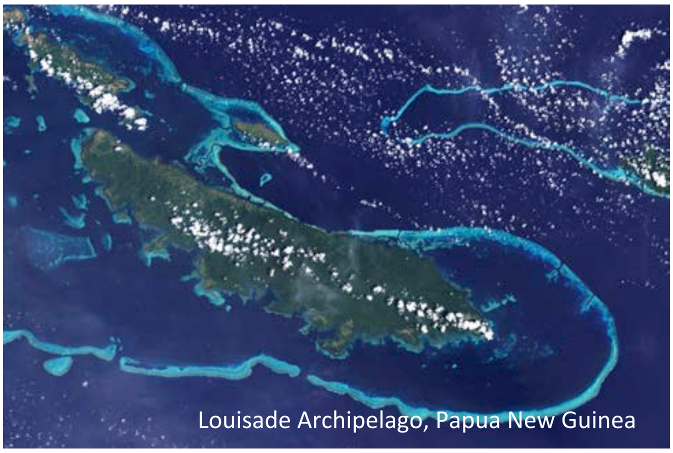
NASA

NASA

NASA Earth Observatory

NASA

NASA NLT Landsat 7



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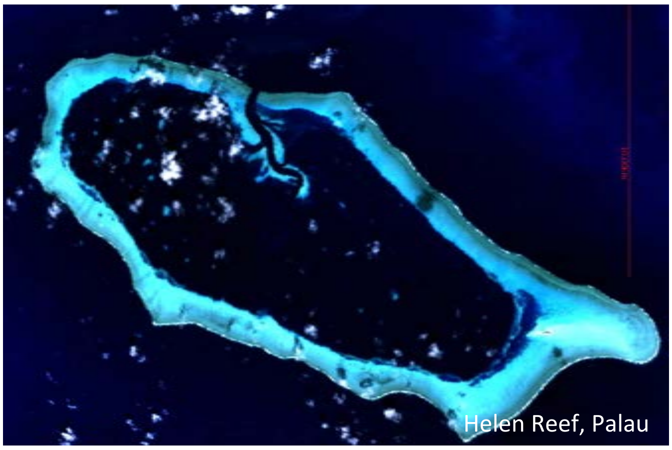
NASA Earth Observatory

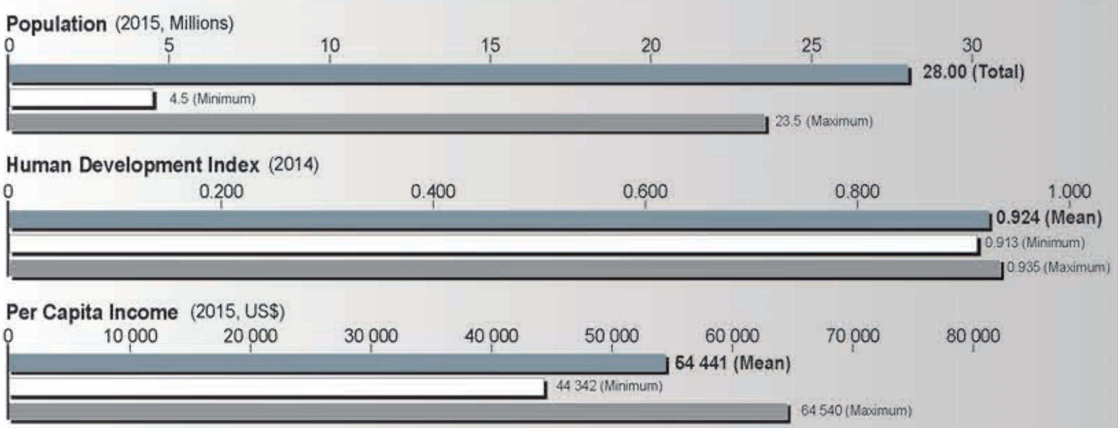


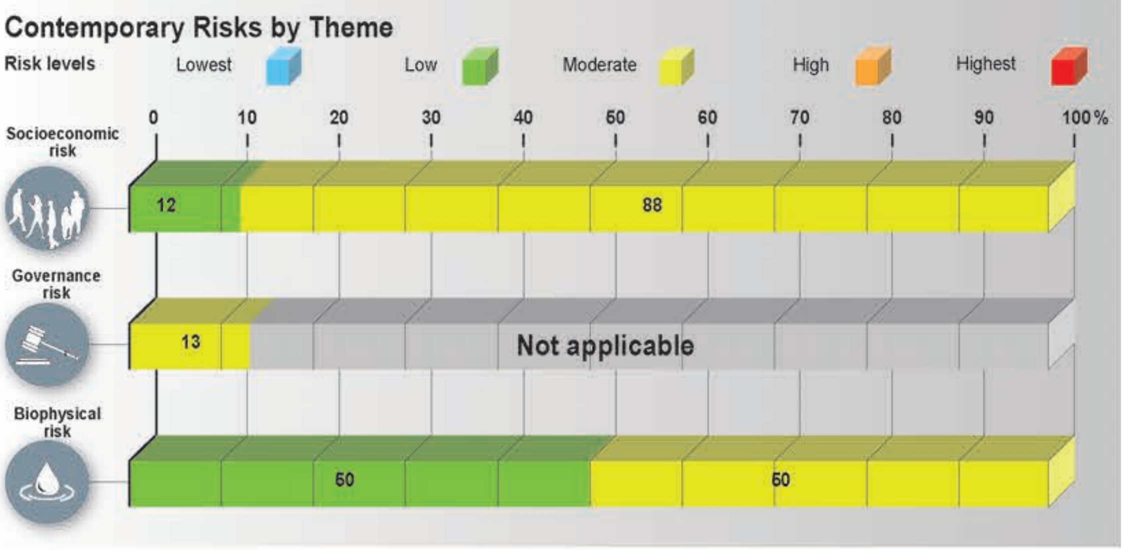
NASA

Note: Because of lack of data, these GEF- eligible island states were not included in the socio-economic assessment of the Western Pacific Warm Pool.

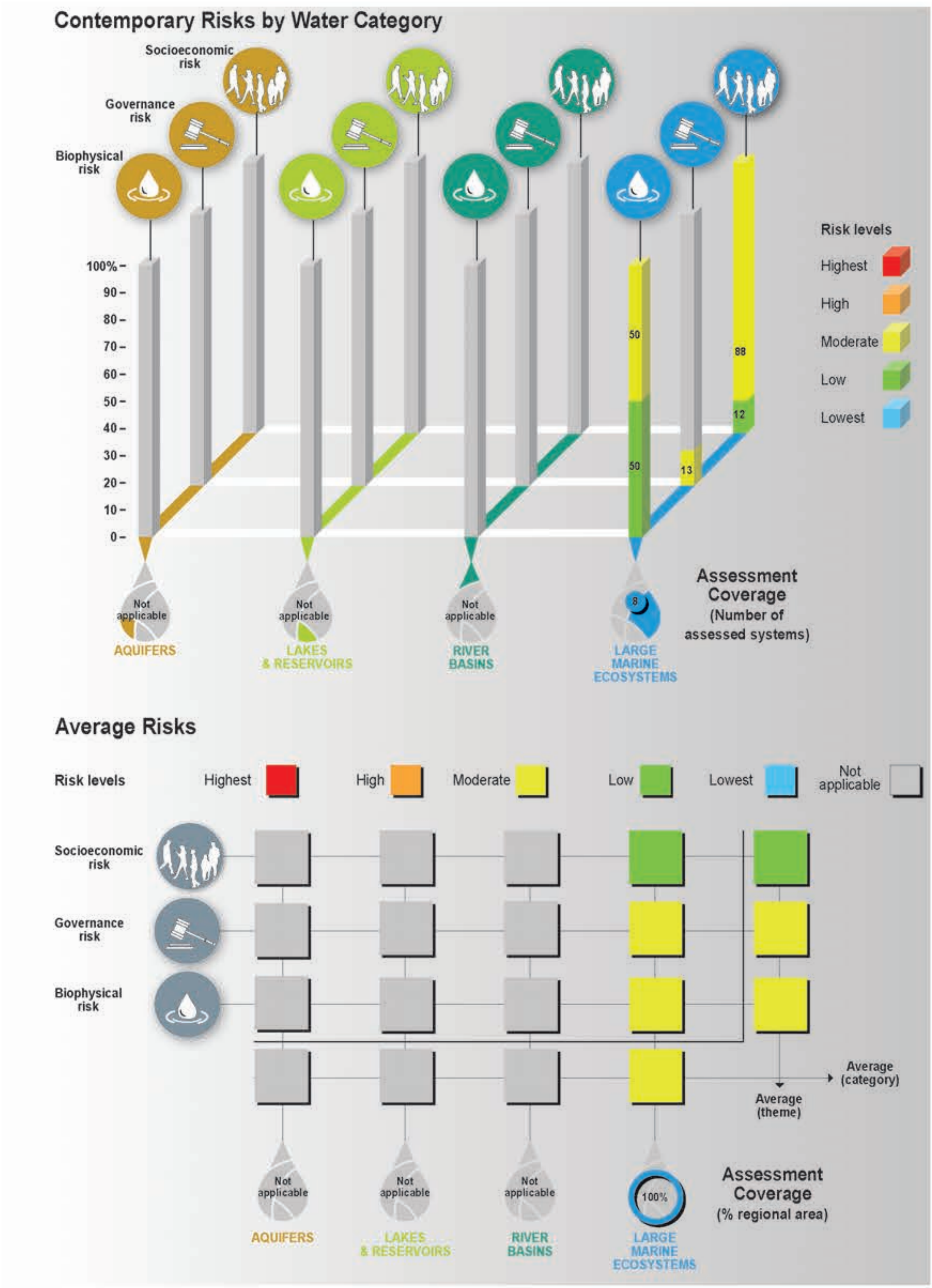
TRANSBOUNDARY WATERS: AUSTRALIA & NEW ZEALAND

The region composed of these two countries exhibits the highest HDI at an average of 0.924, and has an aggregate population of 28 million. Contemporary risks of water systems by water category and theme expressed as percentages are shown at top right. Of the eight LMEs in the region (bottom left), 88% are at moderate socioeconomic risk, one (13%) was assessed for governance and is at moderate risk, and 50% each are at low and moderate biophysical risk. On average (bottom right), the eight LMEs are subject to low socioeconomic risk, and moderate governance and biophysical risk. All eight LMEs are at moderate risk, averaging across the three risk themes.





Regional Risks by Water Category

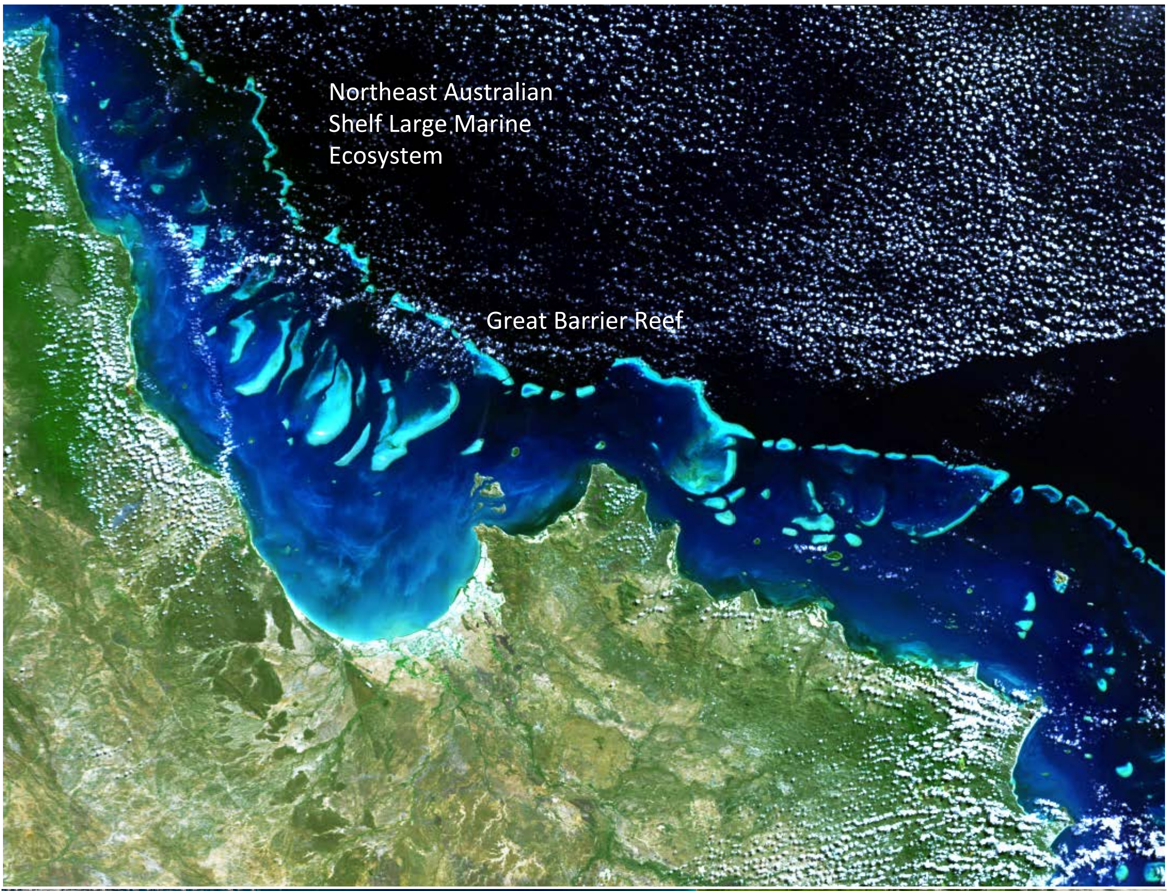


UNEP gef United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission

Large Marine Ecosystems Of Australia – New Zealand

1. LME 39 – North Australian Shelf
2. LME 40 – Northeast Australian Shelf
3. LME 41 – East Central Australian Shelf
4. LME 42 – Southeast Australian Shelf
5. LME 43 – Southwest Australian Shelf
6. LME 44 – West Central Australian Shelf
7. LME 45 – Northwest Australian Shelf
8. LME 46 – New Zealand Shelf

Center for Marine Assessment and Planning, UCSB



ESA

Norman Kuring, Ocean Color Team, NASA

LME 39 – North Australian Shelf

Bordering country: Australia.
LME Total area: 772,214 km^2

List of indicators

LME overall risk

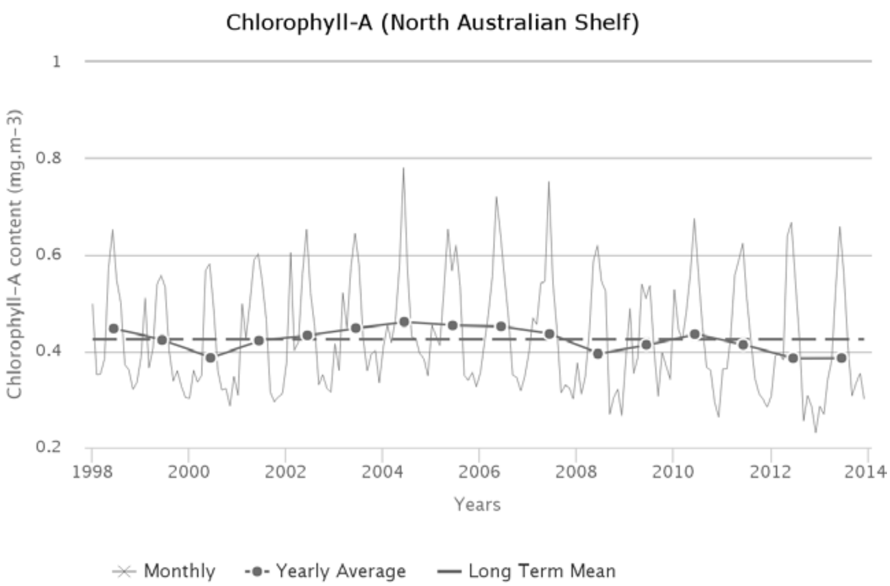
This LME falls in the cluster of LMEs that exhibit high rates of increase in MPA coverage.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low.

Very low | Low | Medium | High | Very high

Productivity

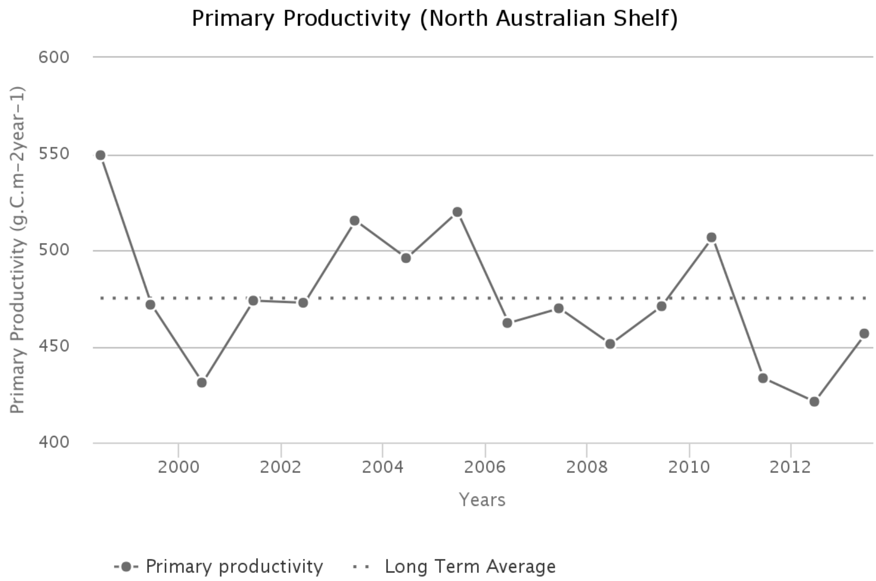
Chlorophyll-A

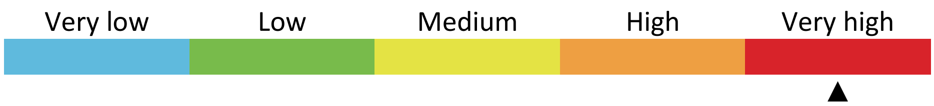
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.638 mg.m^{-3}) in June and a minimum (0.318 mg.m^{-3}) during December. The average CHL is 0.424 mg.m^{-3}. Maximum primary productivity (549 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (421 g.C.m^{-2}.y^{-1}) during 2012. There is a statistically insignificant decreasing trend in Chlorophyll of -2.28 % from 2003 through 2013. The average primary productivity is 475 g.C.m^{-2}.y^{-1}, which places this LME in Group 5 of 5 categories (with 1 = lowest and 5= highest).



Very low | Low | Medium | High | Very high

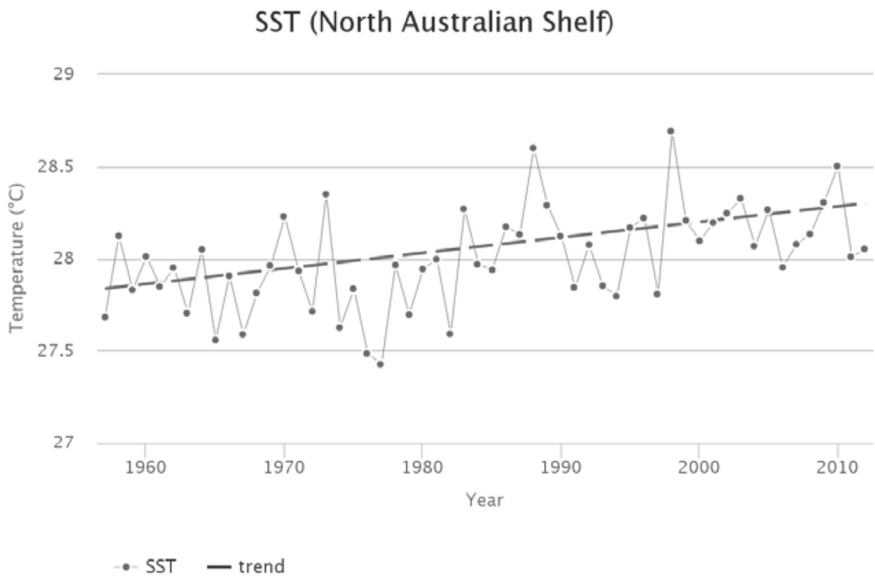
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the North Australian Shelf LME #39 has warmed by 0.44°C, thus belonging to Category 3 (moderate warming LME). Like the adjacent Indonesian Sea LME #38, the North Australian Shelf LME #39 underwent a cooling that lasted through 1977, when SST fell to 27.4°C, after which SST rose steadily. The observed similarity of thermal histories of these LMEs is expected since the North Australian Shelf is oceanographically connected to the Indonesian Sea by the Indonesian Throughflow. The all-time minimum of 1977 is not evident elsewhere. The all-time maximum of 1998 was likely caused by the El Niño 1997-98. The warm event of 1988 occurred simultaneously in the Sulu-Celebes Sea LME #37, Northeast Australian Shelf LME #40, East-Central Australian Shelf LME #41, and only a year later in the Southeast Australian Shelf LME #42. The twin peaks of 1970-1973 occurred simultaneously in the adjacent Northeast Australian Shelf LME #40 and the East-Central Australian Shelf LME #41, especially the warm event of 1973.

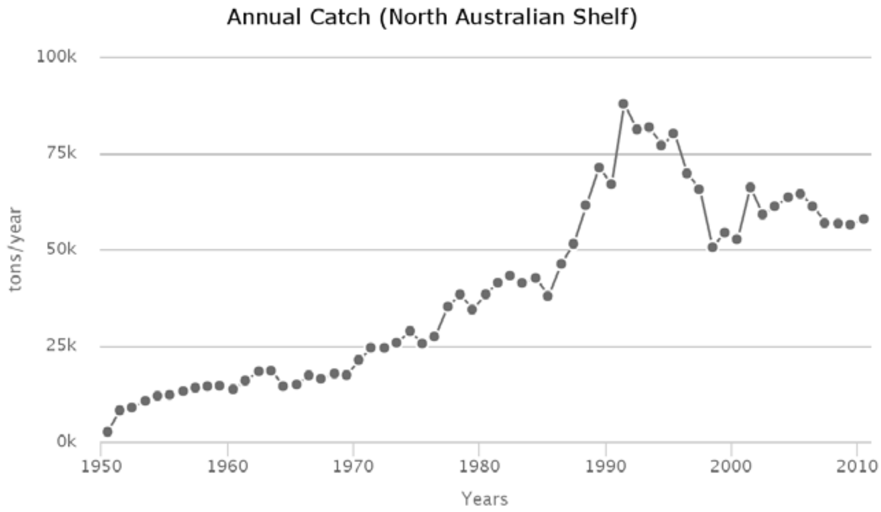


Fish and Fisheries

Fish stocks in the North Australian Shelf LME are small, but diverse. The level of endemism in the LME is low, with most species distributed widely in the Indo-West Pacific region. Commercially fished species in the LME include northern prawn (Arafura Sea), threadfin bream, skipjack tuna, Indo-Pacific anchovies, mud crab, barramundi, salmon, shark, Spanish mackerel, as well as snappers and reef fish.

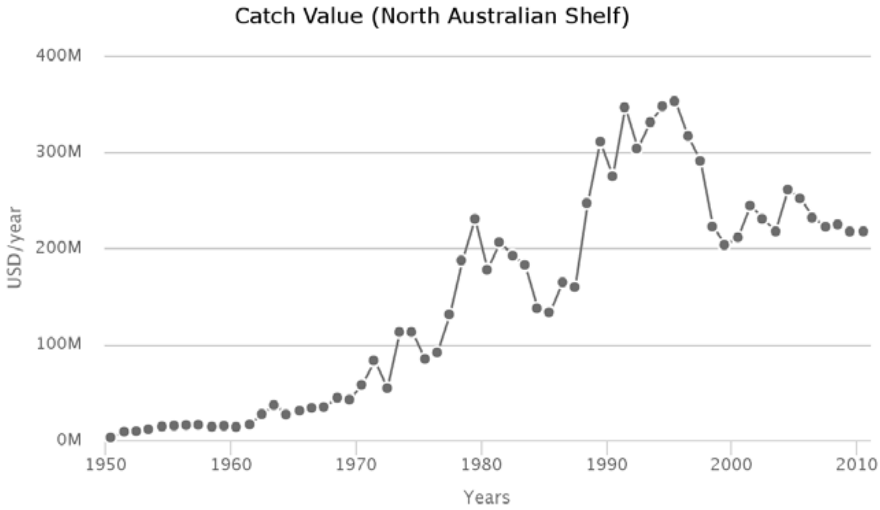
Annual Catch

About half of the reported landings consist of mixed species. Total reported landings grew steadily to around 87,000 t in 1991.



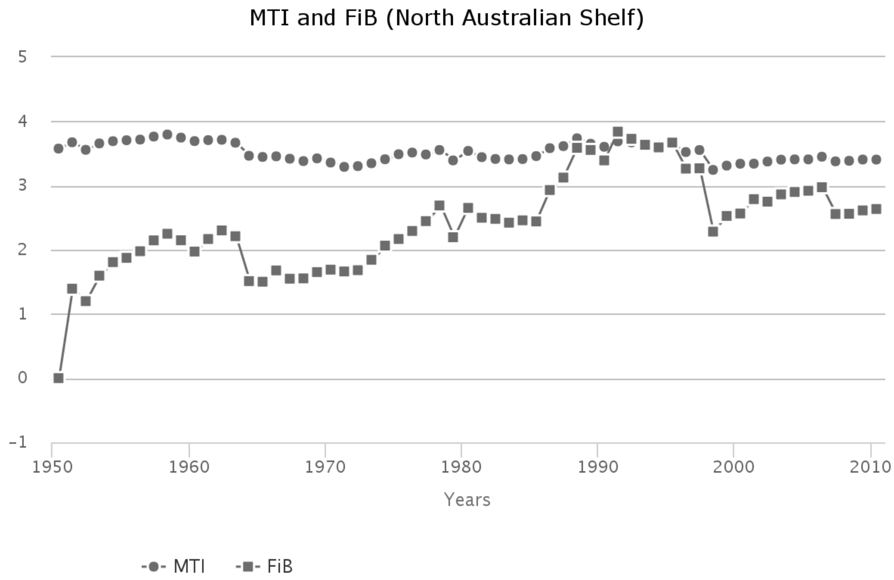
Catch value

The value of the reported landings showed a general increase, with a maximum value of just under 350 million US$ (in 2005 real US$) in 1995. Penaeid shrimps and tuna are the two most important groups in terms of value.



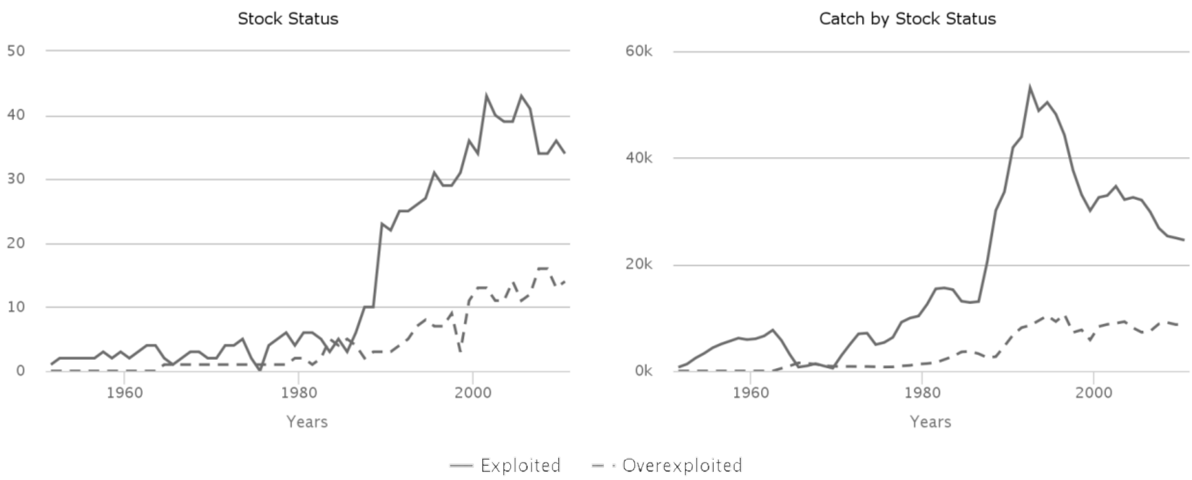
Marine Trophic Index and Fishing-in-Balance index

The MTI declined from 1950 to the mid-1980s, indicating a "fishing down" of the food web, followed by an increase, which coincides with the increased landings of tuna and other large pelagic species. This is confirmed by the FiB index, which also suggests a steady geographic expansion of the fisheries.



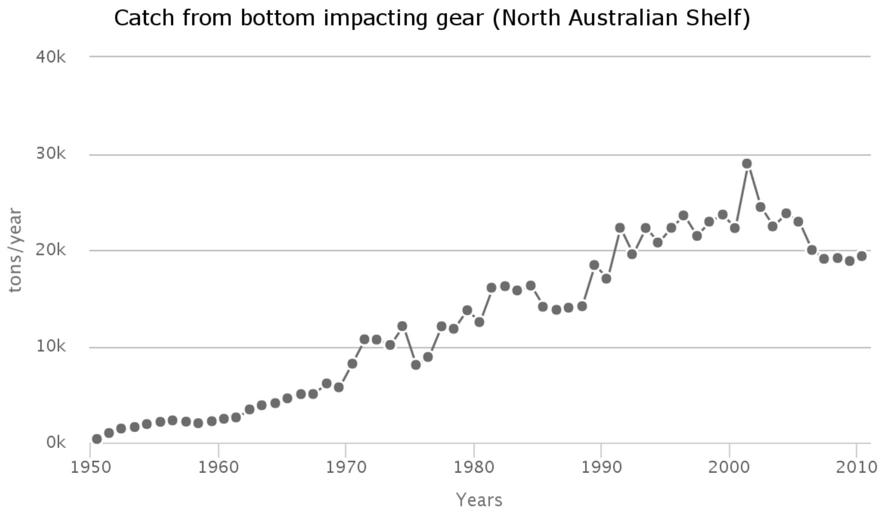
Stock status

The Stock-Catch Status Plots indicate that about 35% of the exploited stocks can be considered collapsed or overexploited. The majority of the reported landings come from fully exploited stocks.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 12 and 45% from 1950 to 2010. This percentage fluctuated around 36% in the recent decade.

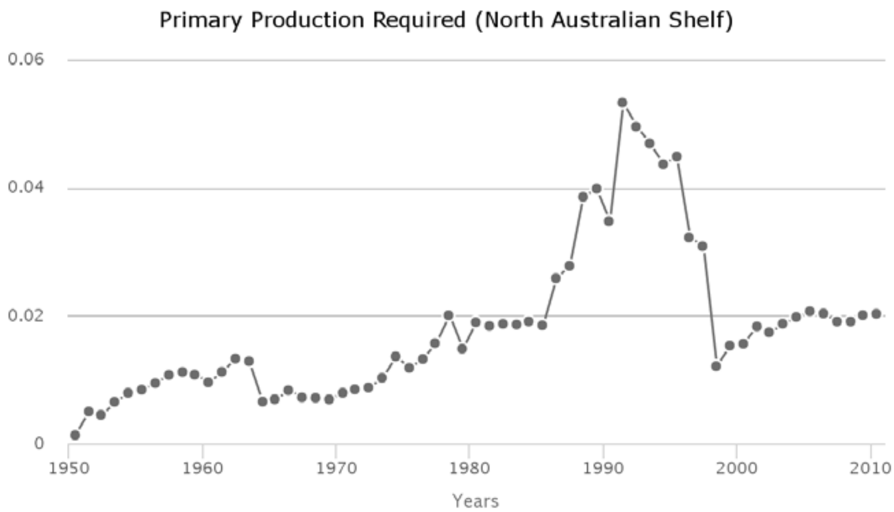


Fishing effort

The total effective effort continuously increased from around 2.5 million kW in the early 1950s to its peak at 9 million kW in 1999.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME is below 2%, which is much lower than other comparable LMEs.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.
An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	2	1	1	2	1	1	2	1

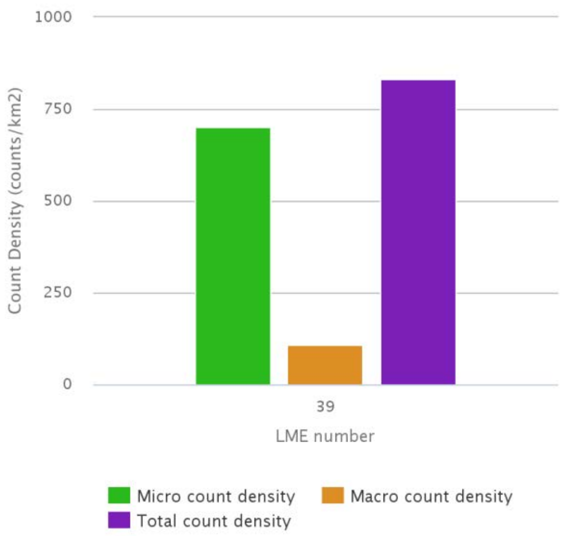
Legend: Very low; Low; Medium; High; Very high

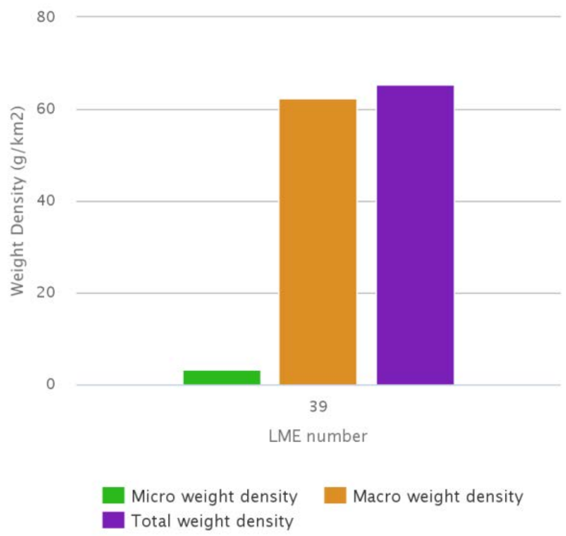
POPs

No pellet samples were obtained from this LME

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively low levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the relative remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be on average over 40 times lower that those LMEs with the highest values. There is moderate evidence from sea-based direct observations and towed nets to support this conclusion.





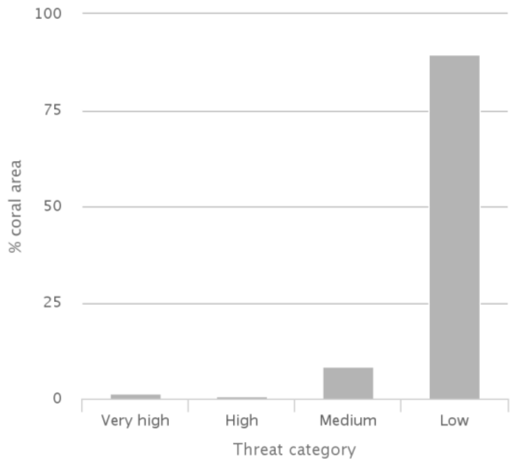
Ecosystem Health

Mangrove and coral cover

Not 0.65% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.24% by coral reefs (Global Distribution of Coral Reefs, 2010).

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 114. 1.4% of coral reefs cover is under very high threat, and 0.8% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values are 1.4% and 1.2% for very high and high threat categories respectively. By year 2030, 6% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification; this proportion increases to 10% by 2050.

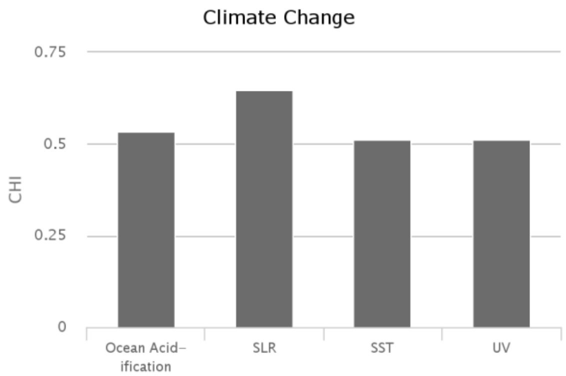


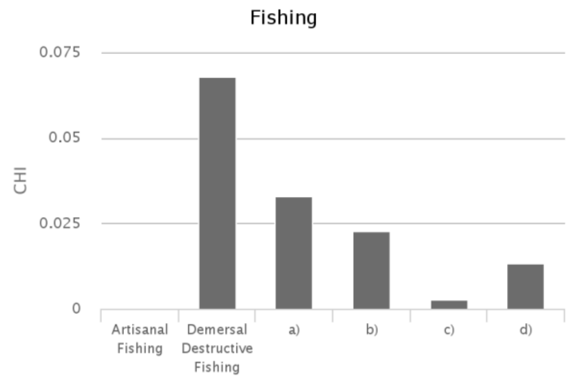
Marine Protected Area change

The North Australian Shelf LME experienced an increase in MPA coverage from 531 km^2 prior to 1983 to 153,288 km^2 by 2014. This represents an increase of 28,788%, within the high category of MPA change.

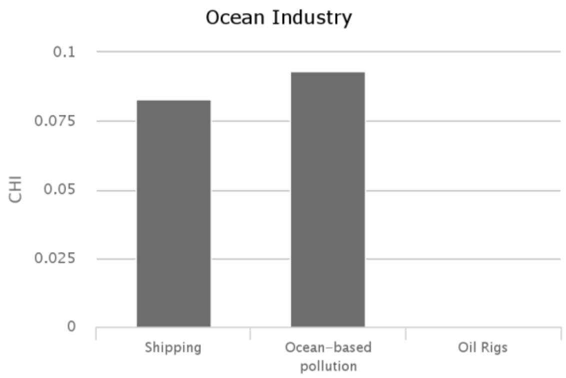
Cumulative Human Impact

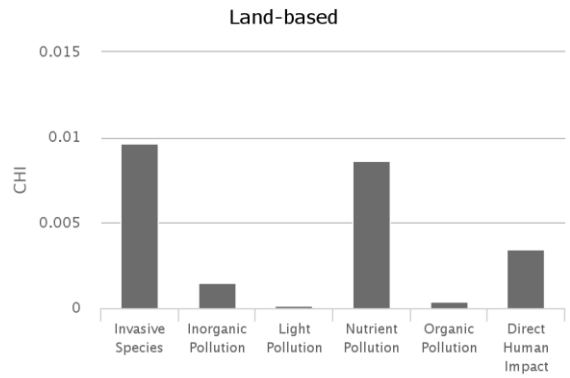
The North Australian Shelf LME experienced an increase in MPA coverage from 531 km^2 prior to 1983 to 153,288 km^2 by 2014. This represents an increase of 28,788%, within the high category of MPA change.

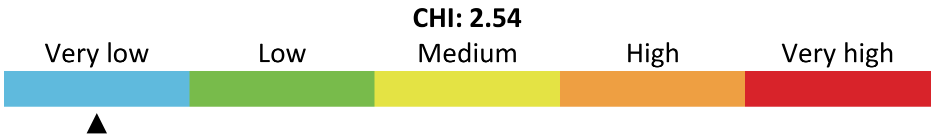




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

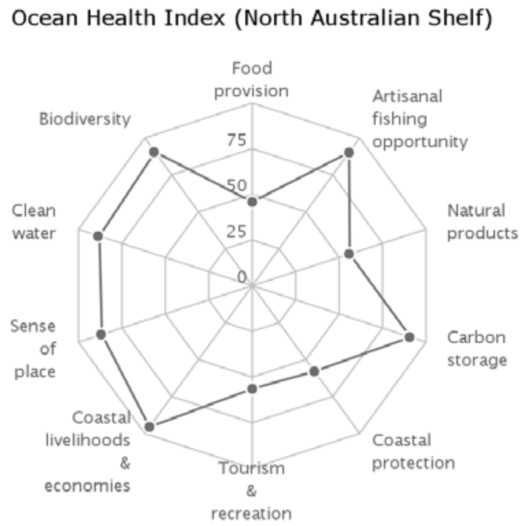






Ocean Health Index

The North Australian Shelf LME scores above average on the Ocean Health Index compared to other LMEs (score 79 out of 100; range for other LMEs was 57 to 82), but still relatively low. This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the score for natural products. This LME scores lowest on food provision and coastal protection goals and highest on artisanal fishing opportunities, carbon storage, coastal livelihoods & economies, lasting special places, clean waters and habitat biodiversity goals. It falls in risk category 1 of the five risk categories, which is the lowest level of risk (1 = lowest risk; 5 = highest risk).



OHI: 75.82

Very low	Low	Medium	High	Very high
				▲

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 372,349 km^2. A current population of 151 thousand in 2010 is projected to decrease to 40 thousand in 2100, with a density of 4 persons per 10 km^2 in 2010 decreasing to 1 per 10 km^2 by 2100. About 30% of coastal population lives in rural areas, and is projected to increase in share to 69% in 2100.

Total population		Rural population	
2010	2100	2010	2100
151,278	40,318	44,947	27,927

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the very low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
21,625

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $275 million for the period 2001-2010. Fish protein accounts for 8% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $33 729 million places it in the high-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
275,433,812	8.3	33,728,586,210	11.7	0.7033

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.942, this LME has an HDI Gap of 0.058, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9423	0.9820	0.7225

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the very low-risk (very low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and remains very low even under a fragmented world development pathway.

2010		2100	
Climate Threat	Contemporary Threat	SSP1	SSP3
0.2302	0.2062	0.1796	0.4378

Legend:

Very low | Low | Medium | High | Very high

Governance

Governance architecture

This area is larger than the original NAS LME and includes the ATSEA Project area. In this LME, the only integration seen across issues is among the pollution and biodiversity under COBSEA. No body or agency with a mandate to provide policy integration across these issues could be found. The ATSEA project may be fulfilling this role to some extent, but it has a limited life-span.

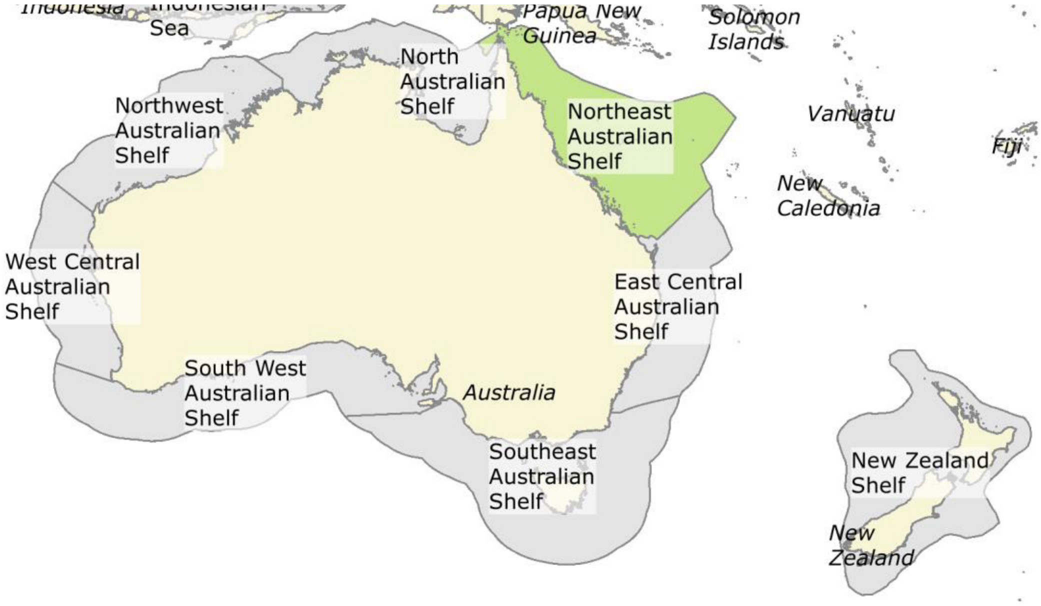
The overall scores for ranking of risk were:

Engagement	Completeness	Integration
80	51	0.1

Legend:

Very low | Low | Medium | High | Very high

LME 40 – Northeast Australian Shelf



Bordering countries: Australia, Papua New Guinea
LME Total area: 1,299,112 km^2

List of indicators

LME overall risk

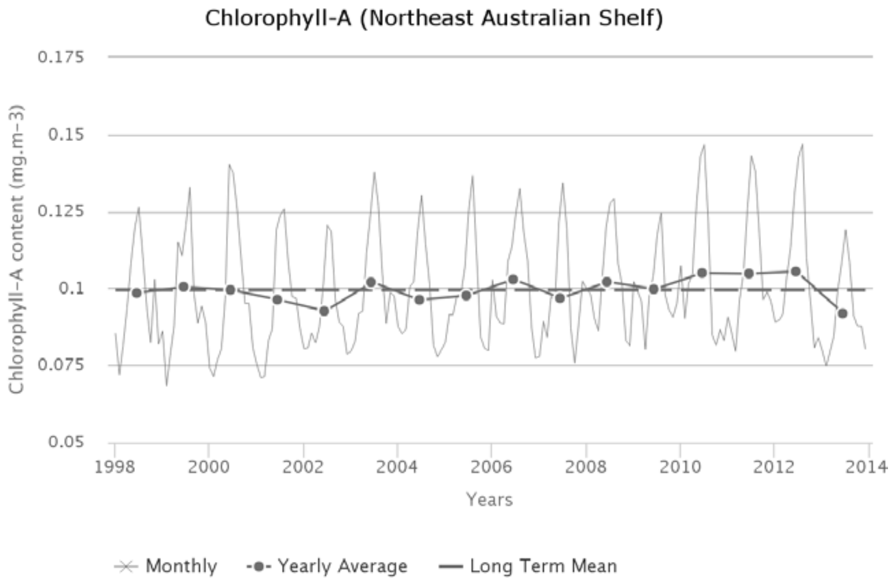
This LME falls in the cluster of LMEs that exhibit low to medium levels of economic development (based on the night light development index) and medium levels of collapsed and overexploited fish stocks.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is low.

Very low | Low | Medium | High | Very high

Productivity

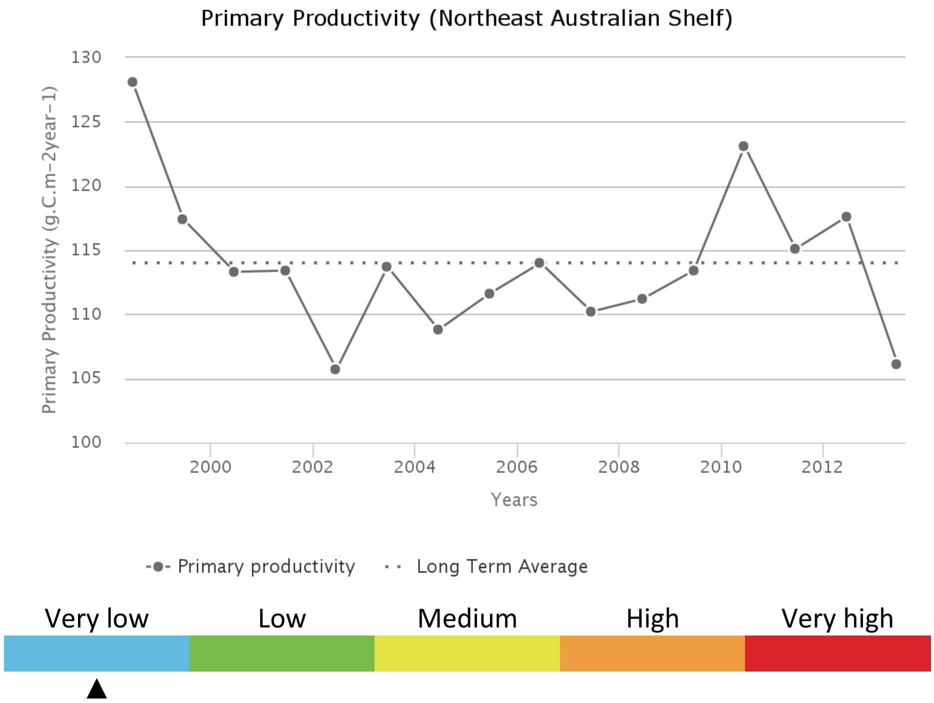
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.131 mg.m^{-3}) in July and a minimum (0.0839 mg.m^{-3}) during December. The average CHL is 0.0995 mg.m^{-3}. Maximum primary productivity (128 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (106 g.C.m^{-2}.y^{-1}) during 2002. There is a statistically insignificant increasing trend in Chlorophyll of 8.22 % from 2003 through 2013. The average primary productivity is 114 g.C.m^{-2}.y^{-1}, which places this LME in Group 1 of 5 categories (with 1 = lowest and 5= highest).



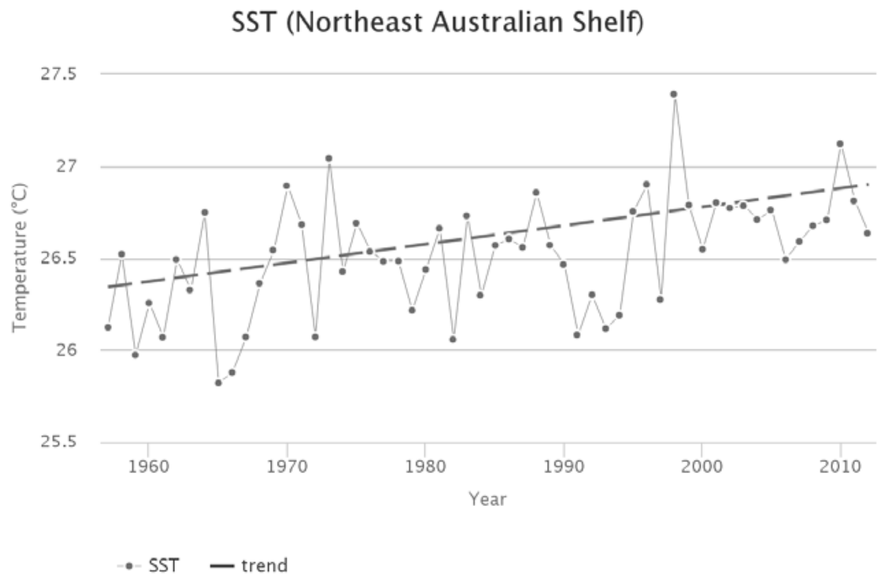
Very low | Low | Medium | High | Very high

Primary productivity



Sea Surface Temperature

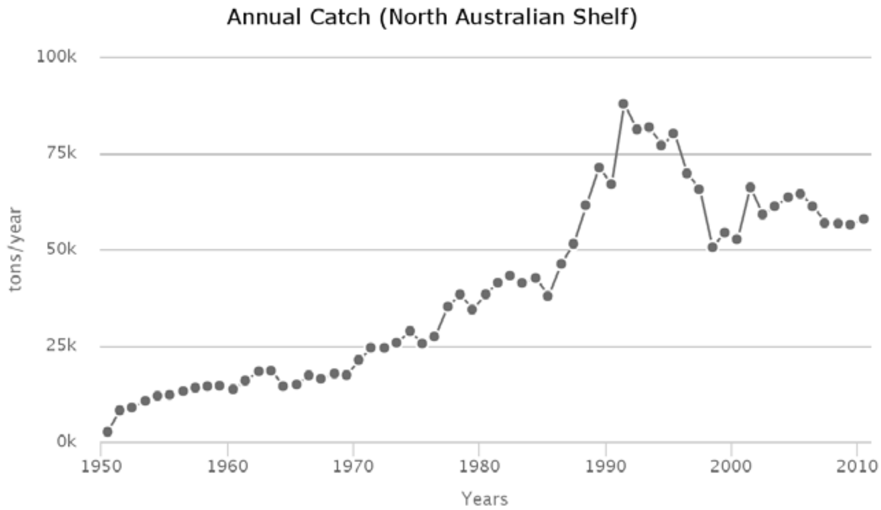
From 1957 to 2012, the Northeast Australian Shelf LME #40 has warmed by 0.53°C, thus belonging to Category 3 (moderate warming LME). Thermal history of this LME correlates with those of adjacent LMEs. The 1965-1966 all-time minimum of 25.8°C occurred almost simultaneously in the Southeast Australian Shelf LME #42. This cold anomaly probably originated in the South Equatorial Current. The 1970-1973 twin warm events occurred in sync with the North Australian Shelf LME #39. The 1982 minimum occurred here simultaneously with the Indonesian Sea LME #38 and Australian Shelf LME #39. The above-noted synchronism is explained by large-scale atmospheric forcing. The 1998 all-time maximum of 27.4°C was likely linked to the El Niño of 1997-1998.



Fish and Fisheries

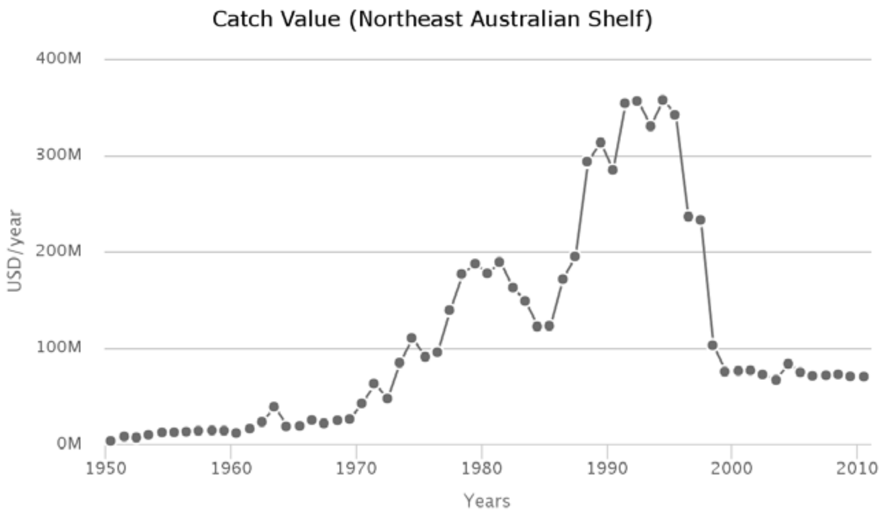
Annual Catch

The relatively nutrient-poor waters of the Northeast Australian Shelf are unable to sustain large fish populations, and total reported landings of the LME comprise mainly tunas (mostly of skipjacks but also yellowfin, bigeye and albacore), shrimps and prawns, and squids (from the late 1980s to early 1990s) and recorded 110,000 t in 1991. The landings have since declined to about one-fifth of the peak landings.



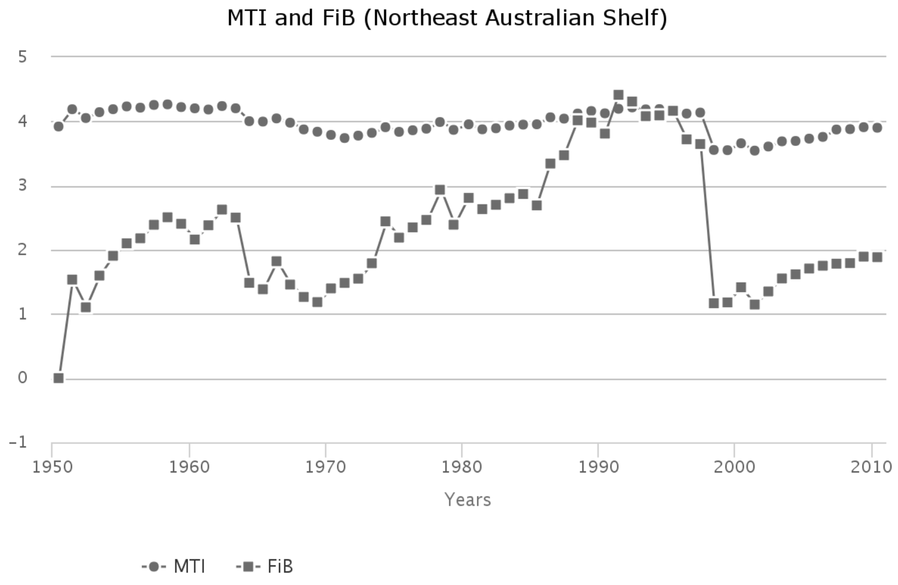
Catch value

The trend in the value reflected that of the landings, rising to about 360 million US$ (in 2005 real US$) in 1994.



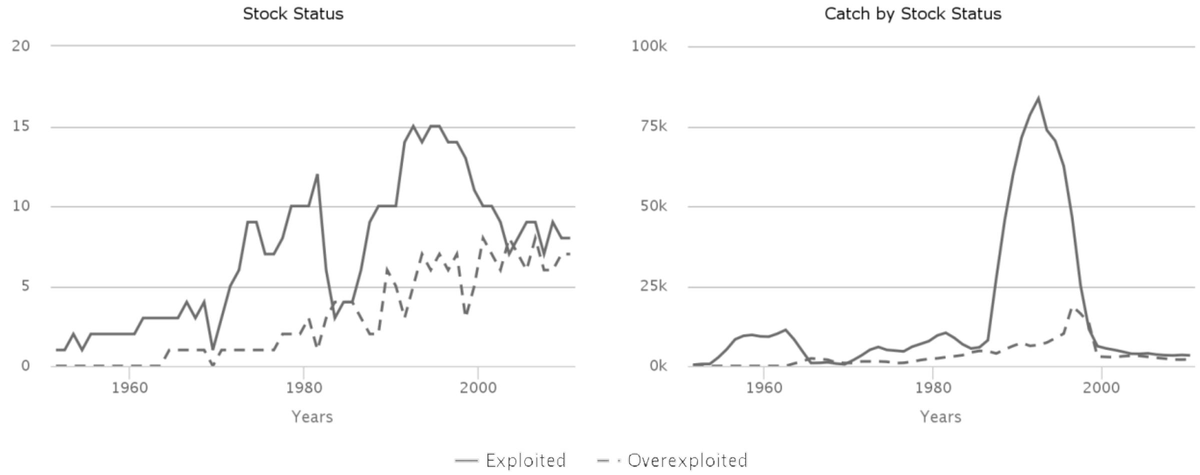
Marine Trophic Index and Fishing-in-Balance index

The MTI in this LME, overall, is still high, while the FiB index has been stable following an increase from 1950 to the mid-1990s with a slight drop during the mid-1970s. These trends imply a growth of fisheries in the region with no clear signs of a 'fishing down'. Since 1997, there is a sharp decline in the FiB index and this indicates that the ecosystem functioning is impaired.



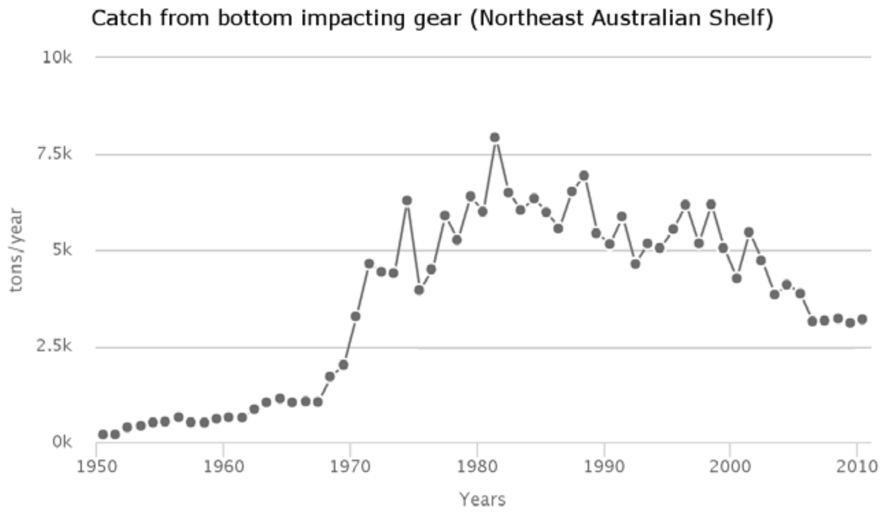
Stock status

The Stock-Catch Status Plots indicate that more than half of the stocks in the region are currently either overexploited or have collapsed and that about half of the reported landings is supplied by such stocks.



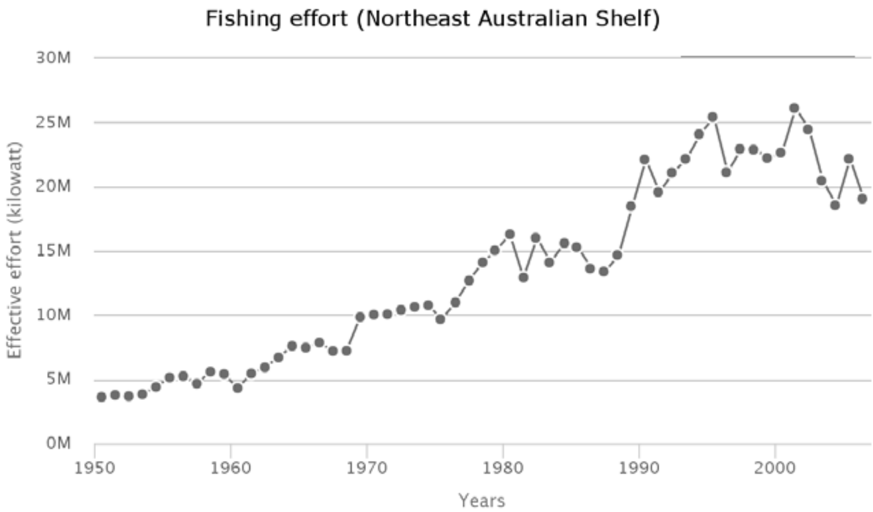
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 3 and 32% from 1950 to 2010. This percentage fluctuated around 20% in the recent decade.



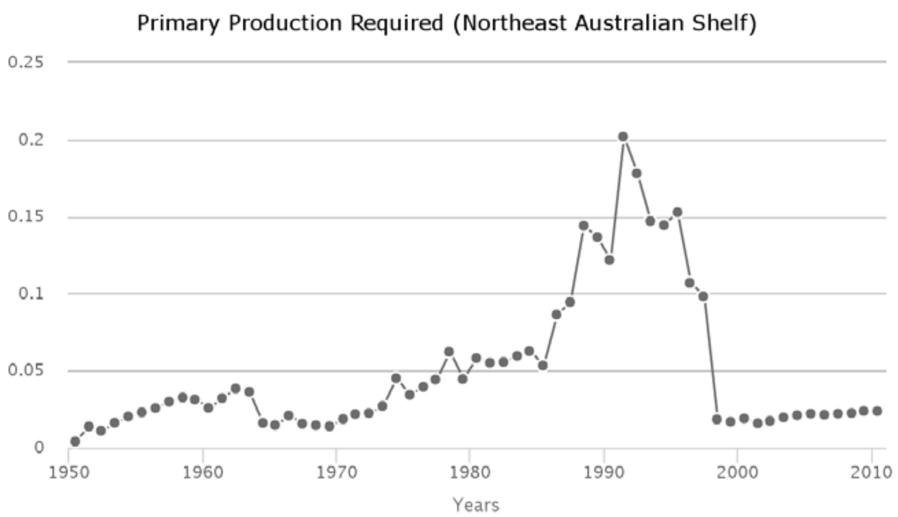
Fishing effort

The total effective effort continuously increased from around 4 million kW in the early 1950s to its peak at 26 million kW in 2001.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME reached 5% of the observed primary production in the late 1980s, but is still relatively low, considering the high proportion of high-trophic level pelagic species in the landings.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	3	1	1	3	1	1	3	1

Legend:

Very low · Low · Medium · High · Very high

POPs

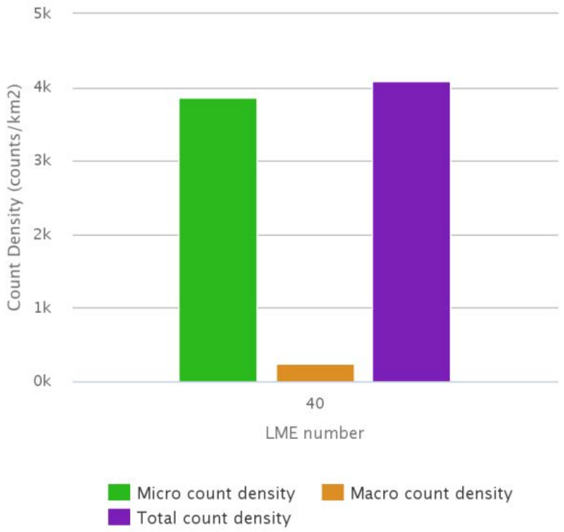
Three samples at three locations are available from the Northeast Australian Shelf LME. They show minimal concentrations (ng.g^{-1} of pellets) for all the POPs (PCBs ranging from 0.1 to 1, DDTs from 0.1 to 1, HCHs from not detected to 0.2) indicators, corresponding to risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This is probably due to minimal anthropogenic activities involving the use of POPs (PCBs in industries and DDT and HCH pesticides in agriculture).

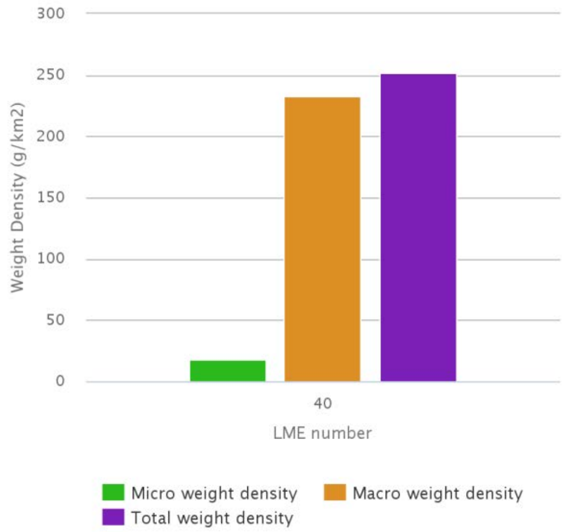
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
3	0	**1**	1	**1**	0.1	**1**

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively moderate levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 12 times lower that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





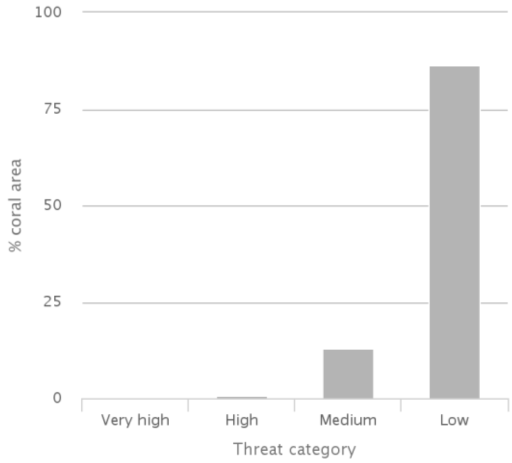
Ecosystem Health

Mangrove and coral cover

0.18% of this LME is covered by mangroves (US Geological Survey, 2011) and 2.83% by coral reefs (Global Distribution of Coral Reefs, 2010), the highest coral coverage of any LME.

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 115. 0.2% of coral reefs cover is under very high threat, and 0.8% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 0.9% and 5.9% for very high and high threat categories respectively. By year 2030, 5% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification; this proportion increases to 12% by 2050.

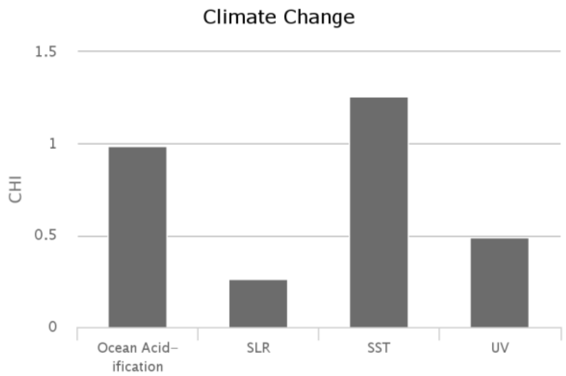


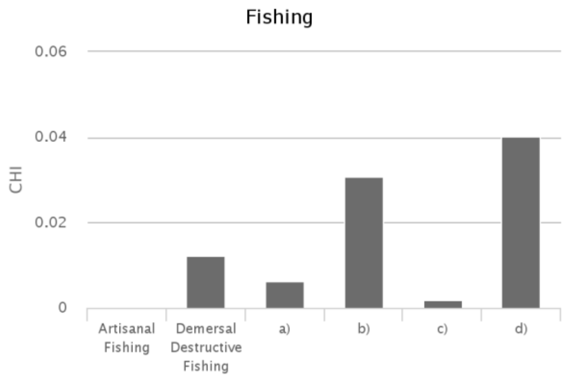
Marine Protected Area change

The Northeast Australian Shelf LME experienced an increase in MPA coverage from 17,653 km^2 prior to 1983 to 1,240,238 km^2 by 2014. This represents an increase of 6,926%, within the medium category of MPA change.

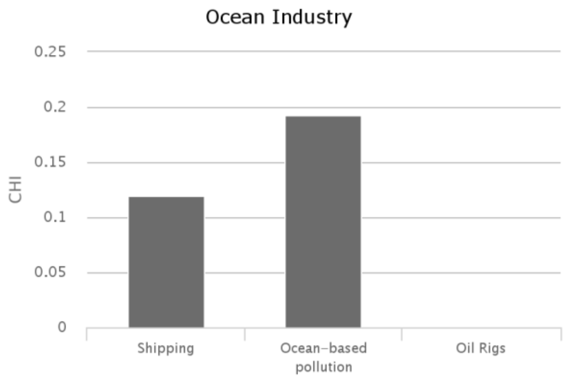
Cumulative Human Impact

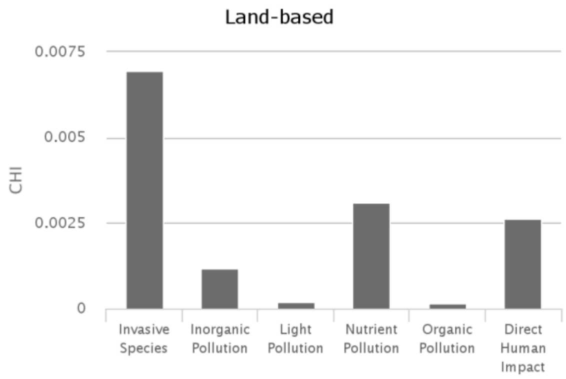
The Northeast Australian Shelf LME experiences average overall cumulative human impact (score 3.41; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 2 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.99; maximum in other LMEs was 1.20), UV radiation (0.49; maximum in other LMEs was 0.76), sea level rise (0.26; maximum in other LMEs was 0.71), and sea surface temperature (1.26; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, ocean based pollution, and pelagic low-bycatch commercial fishing.

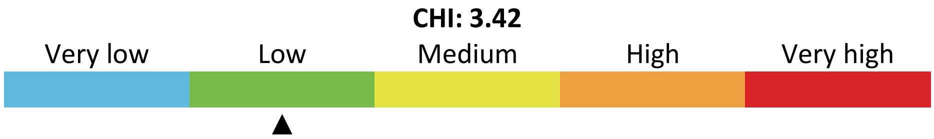




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing



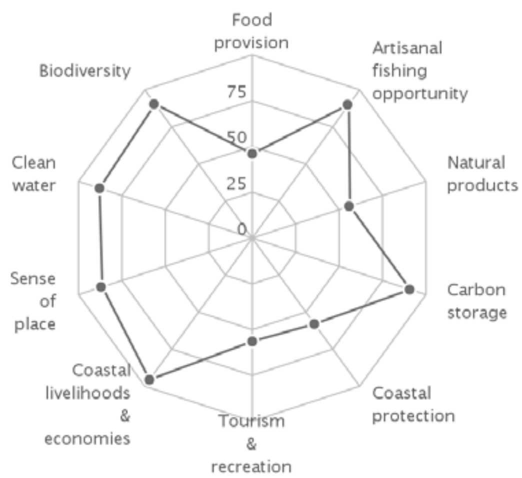




Ocean Health Index

The Northeast Australian Shelf LME scores above average on the Ocean Health Index compared to other LMEs (score 79 out of 100; range for other LMEs was 57 to 82), but still relatively low. This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the score for natural products. This LME scores lowest on food provision and coastal protection goals and highest on artisanal fishing opportunities, coastal livelihoods & economies, lasting special places, clean water and habitat biodiversity goals. It falls in risk category 1 of the five risk categories, which is the lowest level of risk (1 = lowest risk; 5 = highest risk).

Ocean Health Index (Northeast Australian Shelf)



OHI: 75.79

Very low	Low	Medium	High	Very high
				▲

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 233,329 km^2. A current population of 864 thousand in 2010 is projected to decrease to 340 thousand in 2100, with a density of 4 persons per km^2 in 2010 decreasing to 2 per km^2 by 2100. About 32% of coastal population lives in rural areas, and is projected to increase in share to 42% in 2100.

Total population		Rural population	
2010	2100	2010	2100
864,131	399,548	274,961	169,187

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 16% of the LME's coastal dwellers. This LME places in the medium-risk category based on percentage and in the low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
136,524

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $86 million for the period 2001-2010. Fish protein accounts for 9% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$32 443 million places it in the medium-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with medium risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
86,133,841	8.6	32,442,754,171	11.7	0.7340

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.920, this LME has an HDI Gap of 0.080, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a high-risk category (low HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9202	0.9604	0.6695

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

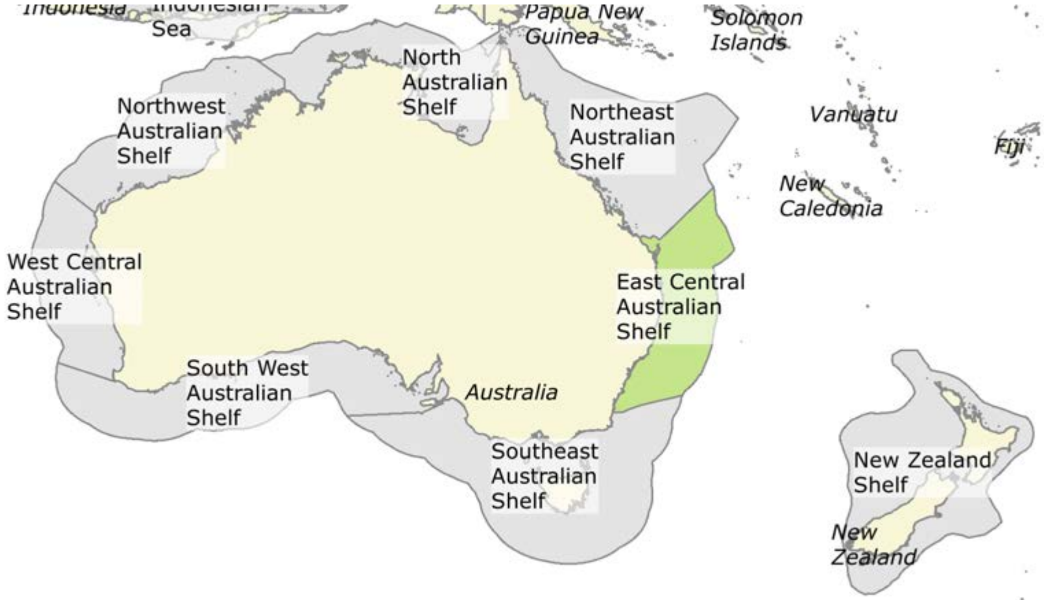
The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the low-risk (low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to medium under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.3569	0.2508	0.2699	0.5514

Legend: Very low, Low, Medium, High, Very high

LME 41 – East Central Australian Shelf



Bordering country: Australia.
LME Total area: 660,679 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit high rates of increase in MPA coverage.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low.

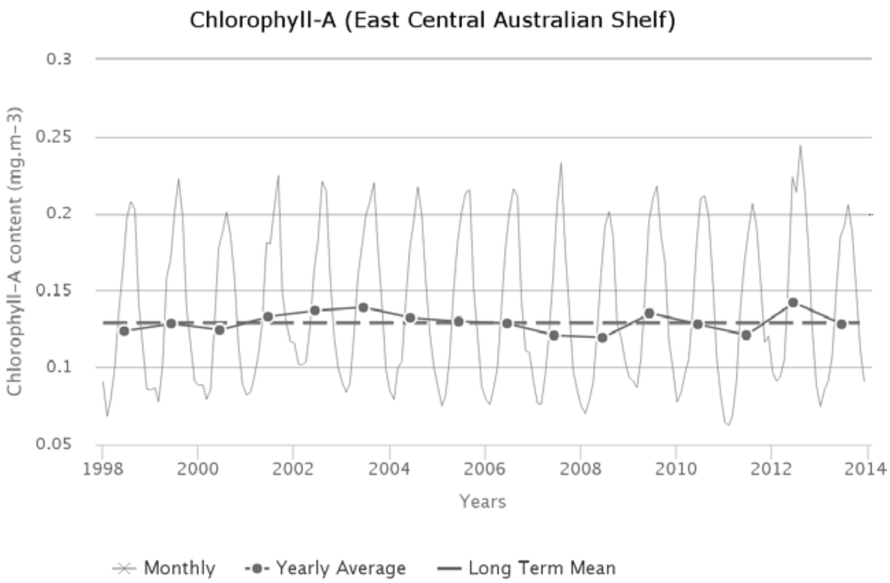
Very low | Low | Medium | High | Very high

▲

Productivity

Chlorophyll A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.214 $mg.m^{-3}$) in August and a minimum (0.0801 $mg.m^{-3}$) during February. The average CHL is 0.129 $mg.m^{-3}$. Maximum primary productivity (139 $g.C.m^{-2}.y^{-1}$) occurred during 1998 and minimum primary productivity (115 $g.C.m^{-2}.y^{-1}$) during 2008. There is a statistically insignificant increasing trend in Chlorophyll of 2.26 % from 2003 through 2013. The average primary productivity is 130 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 1 of 5 categories (with 1 = lowest and 5= highest).



Very low | Low | Medium | High | Very high

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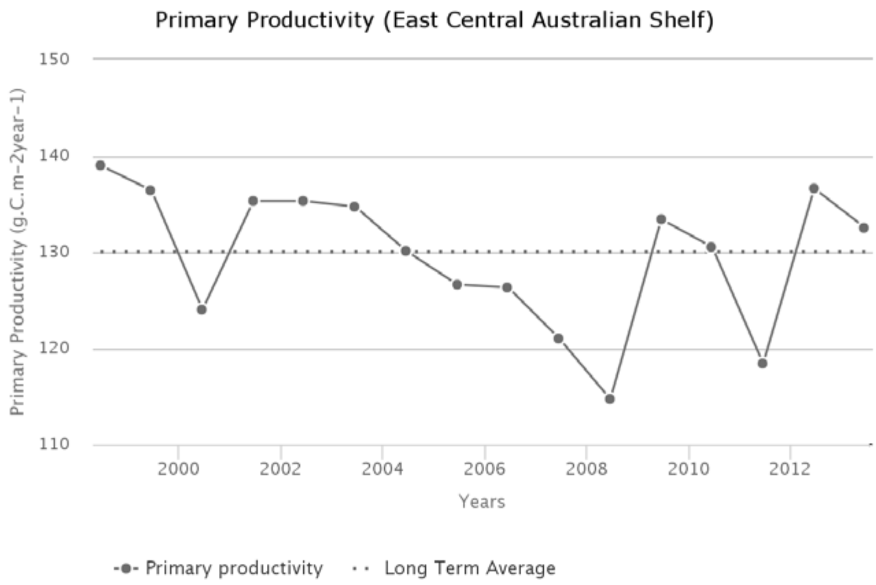
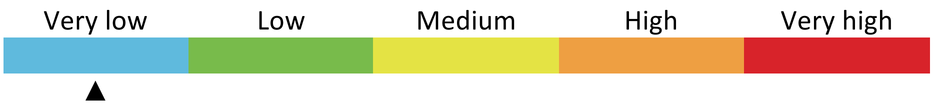
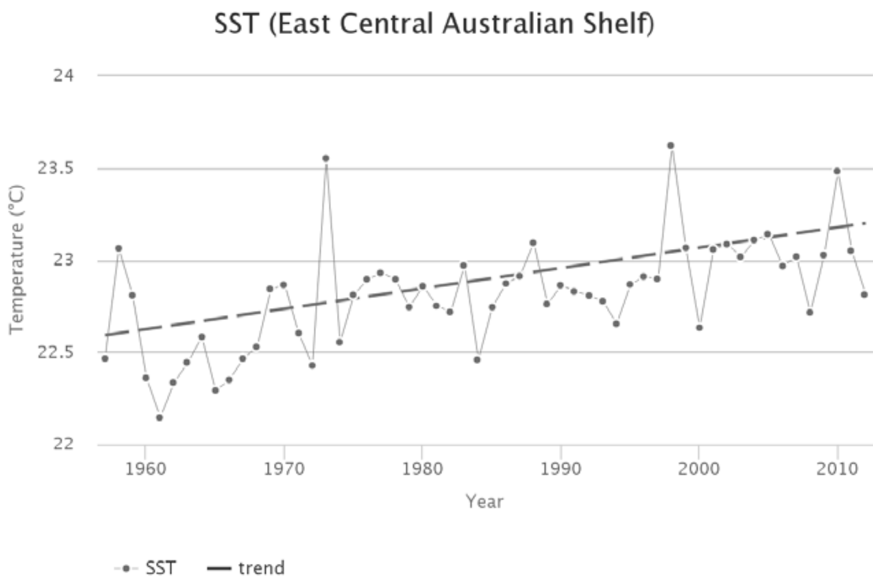
Primary roductivity





Sea Surface mperature

From 1957 to 2012, the East-Central Australian Shelf LME #41 has warmed by 0.58°C, thus belonging to Category 3 (moderate warming LME). The steady warming of the East-Central Australian Shelf was punctuated by two warm events, in 1973 and 1998. The 1973 peak was a large-scale event that occurred simultaneously in the Indonesian Sea LME #38, North Australian Shelf LME #39, and Northwest Australian Shelf LME #45. The above-noted synchronism can only be explained by large-scale atmospheric forcing. Indeed, oceanic advection by currents must be ruled out because the entire Northeast and East Australian coastal and offshore region (basically, most of the Coral Sea and northern part of the Tasman Sea) is dominated by the South Equatorial Current and its extension, East Australian Current; whereas the Indian Ocean inflow via Torres Strait is negligible. The 1998 all-time maximum of 23.6°C was a manifestation of the 1997-1998 El Niño. Otherwise, the interannual variability of this ecosystem was rather small, with year-to-year variations less than 0.5°C.

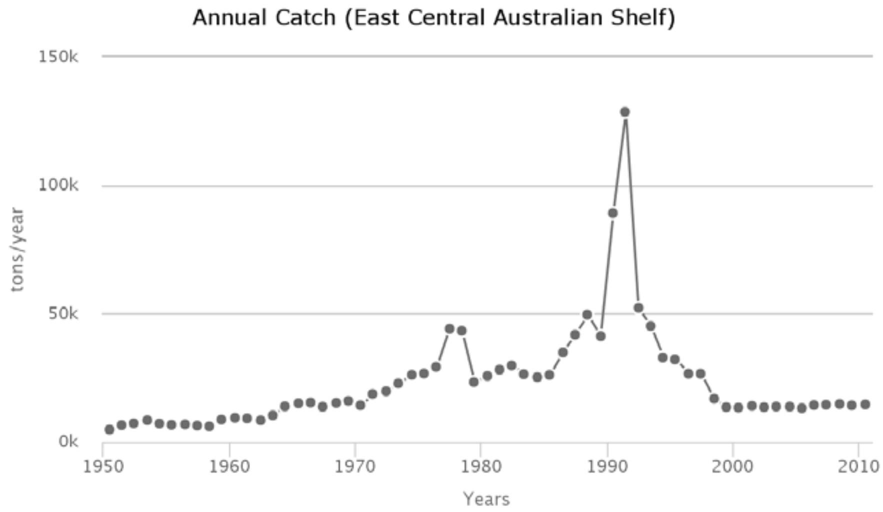


Fish and Fisheries

Australian waters are relatively nutrient-poor and unable to sustain large fish populations. Production in the East-Central Australian Shelf LME is limited by nutrient runoff and low levels of nutrient-rich upwellings. Some fish species are endemic to Australia. Two of the more significant commercial fisheries are the estuarine prawn trawl fishery, squid and the East coast tuna fishery.

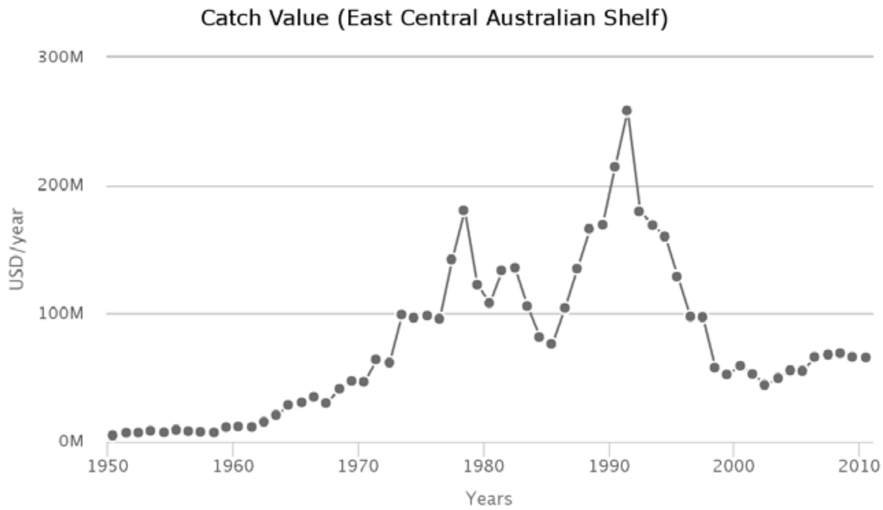
Annual Catch

Reported landings in the LME include mullet, shrimps and prawns, butterfishes and tunas (skipjack, yellowfin and bluefin) and have fluctuated over the last 60 years with a peak in 1991 at about 130,000 t. Then, the catch declined from the 1990s to recent years. From 1999 to 2010, the reported landings fluctuated around 13,000 to 15,000 t.



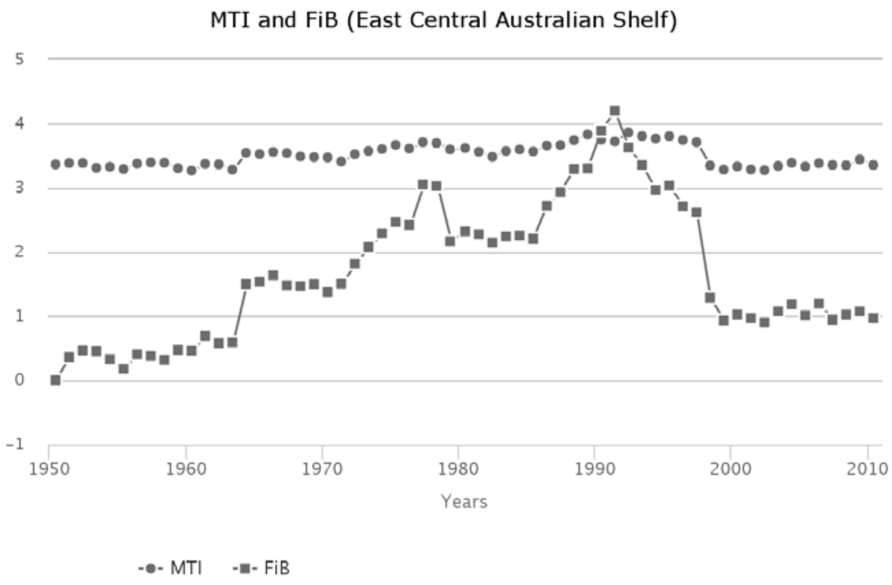
Catch lue

The value of the reported landings reached nearly 260 million US$ (in 2005 real US$) in the 1991 and declined to around 67 million US$ in recent years.



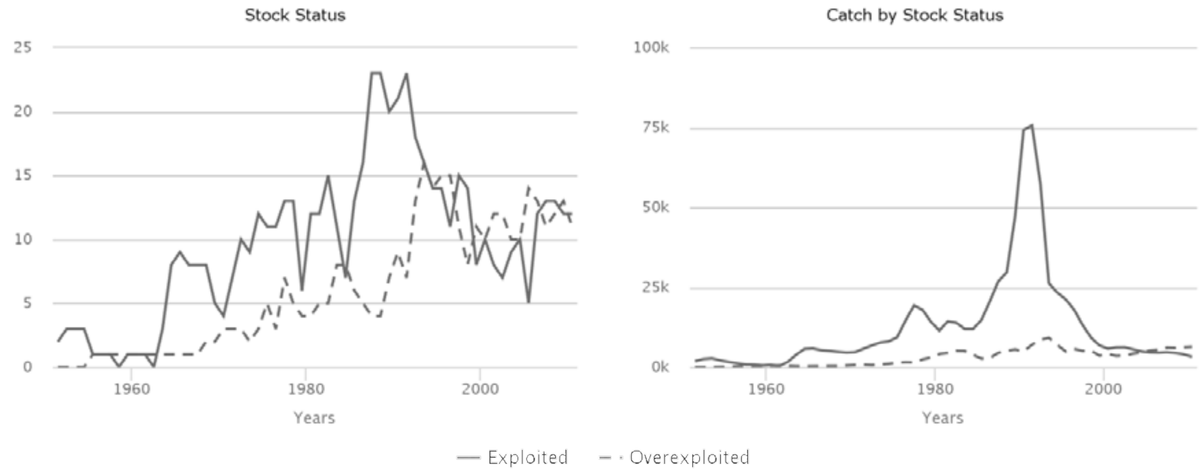
Marine Trophic Index and Fishing in Balance index

Both the MTI and the FiB index vary widely and no clear interpretation on the state of the LME or its fisheries can be made based on these indices. It is likely that such variation in the two indices is due to the low level of exploitation in the region.



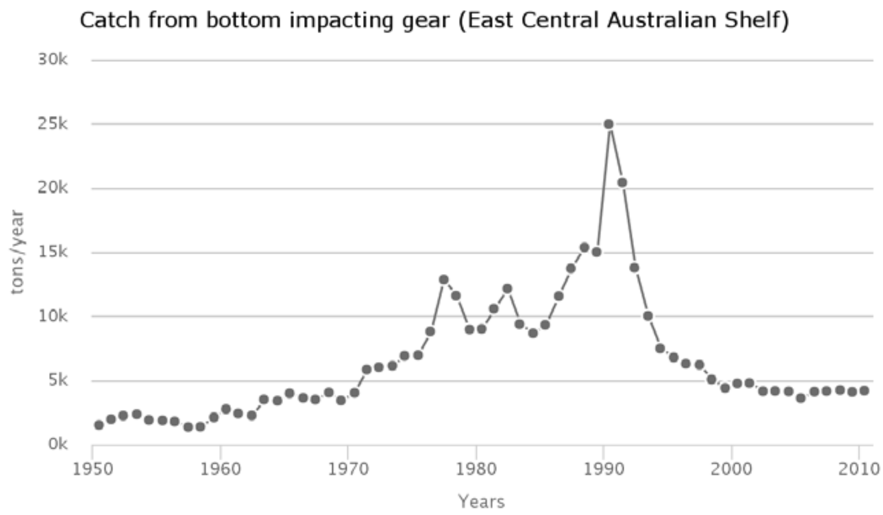
Stock status

The fluctuations in the reported landings make interpretation of the Stock-Catch Status Plots difficult. Whilst these plots imply that approximately 30% and 25% of stocks are collapsed and overexploited, respectively, whether such interpretation is a true reflection of the ecosystem depends on the cause for the fluctuations in the landings, i.e., whether they are induced by the fisheries or not.



Catch from ottom mpacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 16 and 40% from 1950 to 2010. This percentage fluctuated around 30% in the recent decade.

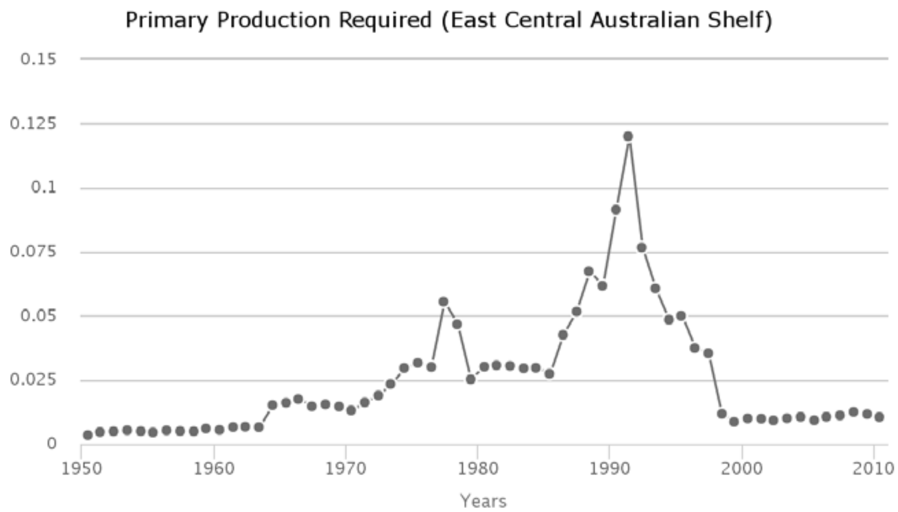


Fishing effort

The total effective effort continuously fluctuated between 0.6% and 3.6% from 1950 to 1991 and then it increased to its first peak at 15 million kW in 1993.

Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME is currently below 4%.



Pollution and Ecosystem Health

Pollution

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An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient atio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was low (2). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	2	1	1	2	1	1	2	1

Legend:

Very low Low Medium High Very high

POPs

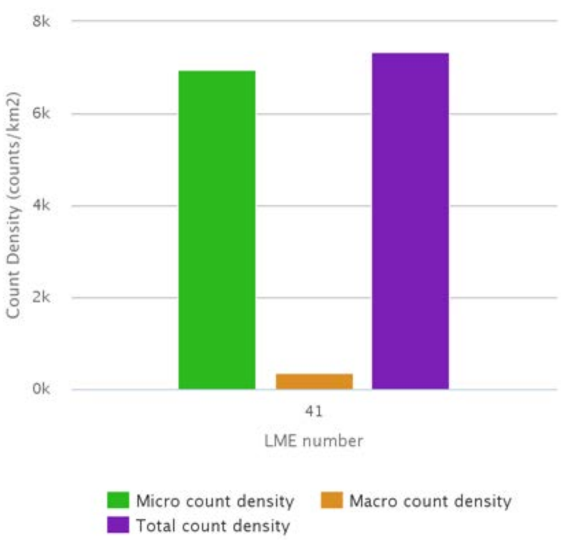
This LME includes Sydney and the vicinities. Seven samples from 7 locations are available. This LME shows moderate average concentration ($ng.g^{-1}$ of pellets) of 149 (range 18-294) for PCBs and high average concentration of 107 (range 7-326) for DDTs, corresponding to category 3 and 4, respectively, of the five risk categories (1 = lowest risk; 5 = highest risk). Minimal concentration ($ng.g^{-1}$ of pellets) was observed for HCHs (0.6, range from not detected to 1.1), corresponding to risk category 1. High concentrations of PCBs were recorded in Sydney Harbor (up to 294 $ng.g^{-1}$), which can be attributed to legacy pollution. Higher levels of PCBs were observed even for the more recent sample. Continuous monitoring is recommended. High levels of DDTs were observed widely in this LME. Dominance of DDT over the degradation products was observed, suggesting current inputs of DDTs. Agricultural application and/or antifouling paint may explain the high level of DDTs. Source identification is necessary.

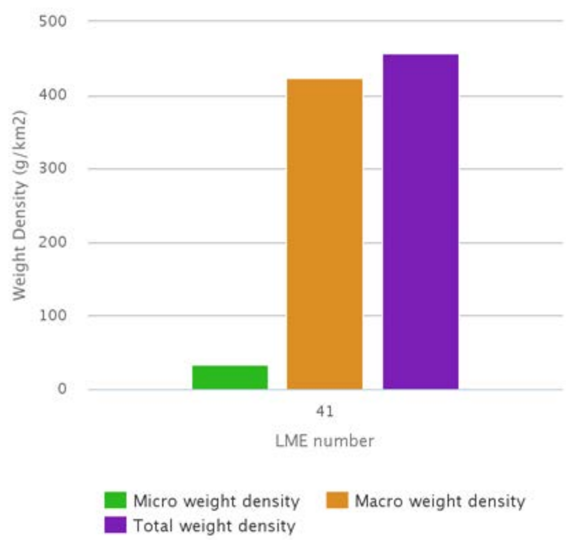
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
7	149	**3**	107	**4**	0.6	**1**

Legend: Very low, Low, Medium, High, Very high

Plastic ebris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively moderate levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 12 times lower that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





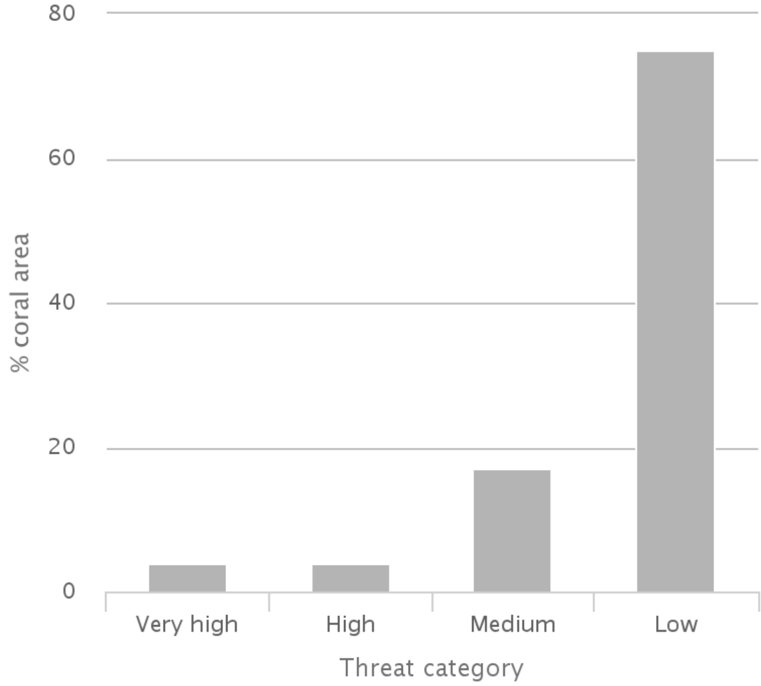
Ecosystem Health

Mangrove and coral cover

0.06% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.02% by coral reefs (Global Distribution of Coral Reefs, 2010).

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 137. 4% of coral reefs cover is under very high threat, and 4% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 8% and 7% for very high and high threat categories respectively. By year 2030, 4% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification; this proportion increases to 5% by 2050.

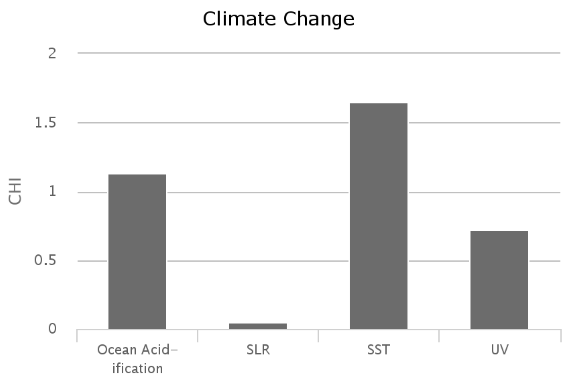


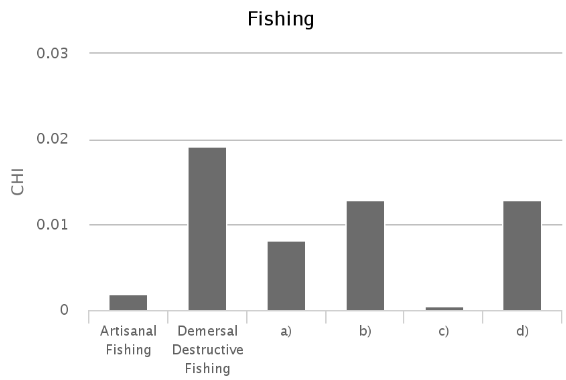
Marine Protected Area change

The East Central Australian Shelf LME experienced an increase in MPA coverage from 285 km^2 prior to 1983 to 197,860 km^2 by 2014. This represents an increase of 69,294%, within the highest category of MPA change.

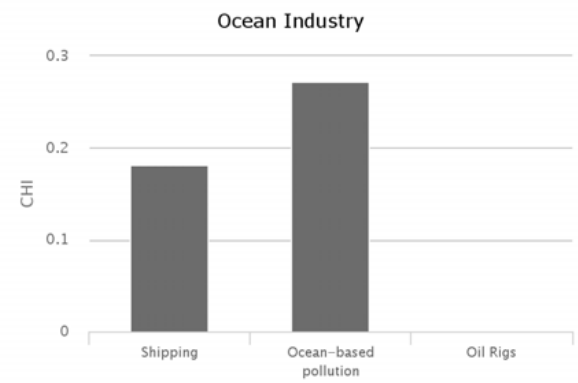
Cumulative man mpact

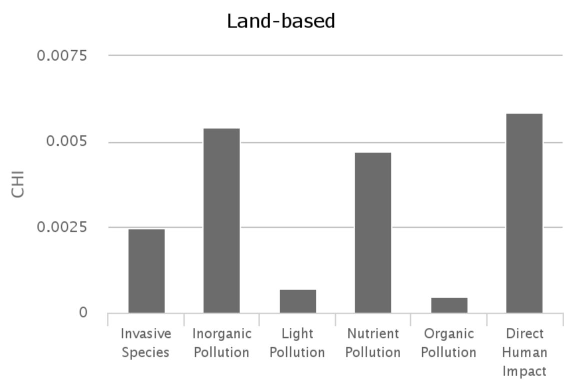
The East Central Australian Shelf LME experiences above average overall cumulative human impact (score 4.08; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (1.13; maximum in other LMEs was 1.20), UV radiation (0.72; maximum in other LMEs was 0.76), and sea surface temperature (1.65; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, and ocean based pollution.





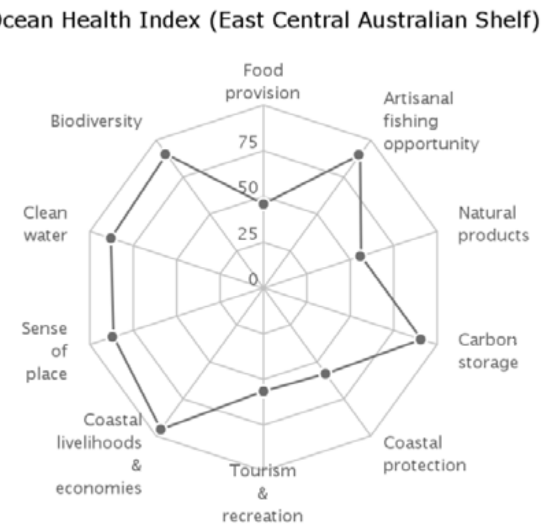
a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing





Ocean Health ndex

The East Central Australian SLME scores above average on the Ocean Health Index compared to other (score 79 out of 100; range for other LMEs was 57 to 82), but still relatively low. This score indicates that the LME is below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the scores for natural products and coastal livelihoods. This LME scores lowest on food provision and coastal protection goals and highest on artisanal fishing opportunities, carbon storage, coastal livelihoods & economies, clean water and habitat biodiversity goals. It falls in risk category 1 of the five risk categories, which is the lowest level of risk (1 = lowest risk; 5 = highest risk).



OHI: 75.81

Very low	Low	Medium	High	Very high
				▲

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 148,428 km^2. A current population of 9 125 thousand in 2010 is projected to increase to 12 883 thousand in 2100, with a density of 61 persons per km^2 in 2010 increasing to 87 per km^2 by 2100. About 18% of coastal population lives in rural areas, and is projected to increase in share to 26% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
9,124,731	12,883,190	1,688,447	3,329,357

Legend: Very low · Low · Medium · High · Very high

Coastal oor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the medium-risk category based on percentage and in the medium-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
1,304,359

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $70 million for the period 2001-2010. Fish protein accounts for 8% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$50 719 million places it in the high-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with very low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
70,474,497	8.3	50,718,787,520	11.7	0.6148

Legend: Very low, Low, Medium, High, Very high

Human evelopment Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.942, this LME has an HDI Gap of 0.058, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and increasing population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9423	0.9820	0.7225

Legend: Very low, Low, Medium, High, Very high

Climate Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

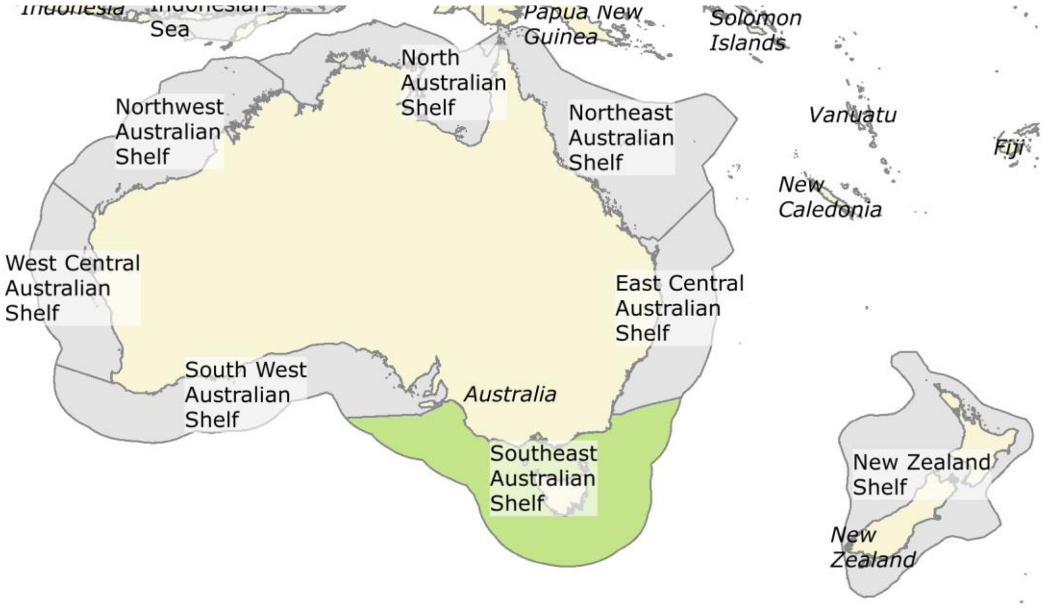
Present day climate threat index of this LME is within the very low-risk (very low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to medium under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.2574	0.2212	0.2249	0.5456

Legend:

Very low | Low | Medium | High | Very high

LME 42 – Southest Australian Shelf



Bordering country: Australia
LME Total area: 1,199,787 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit high rates of increase in MPA coverage.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low.

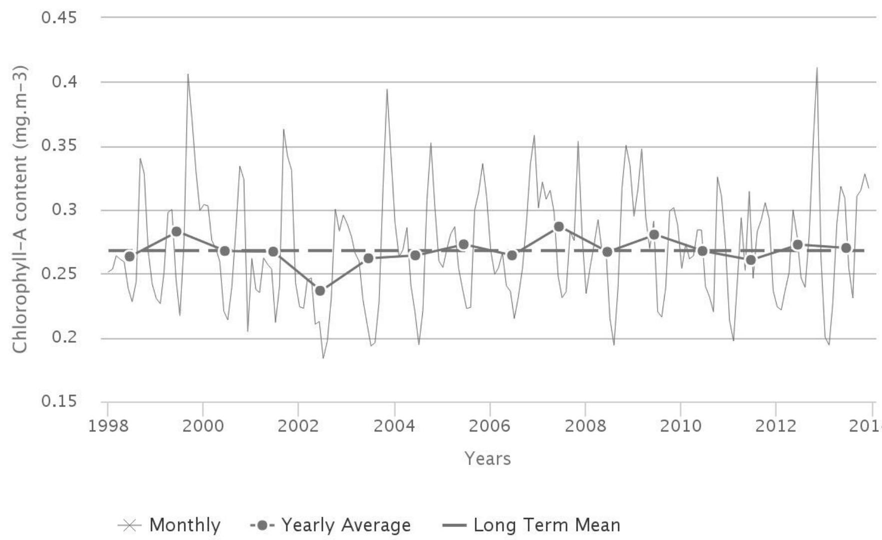
Very low Low Medium High Very high

Productivity

Chlorophyll-A

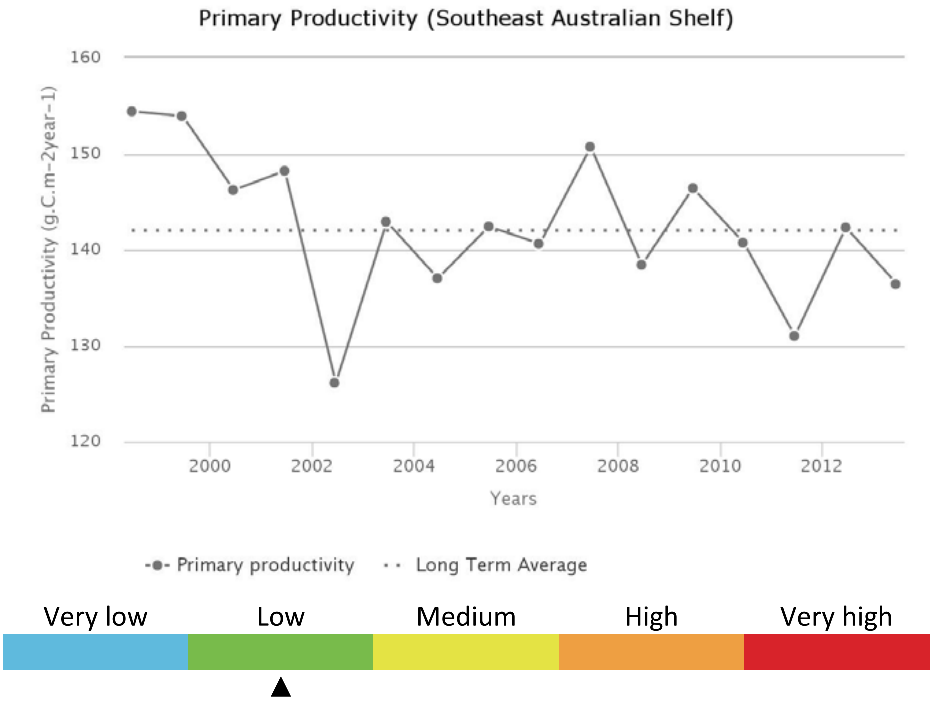
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.325 mg.m^{-3}) in October and a minimum (0.216 mg.m^{-3}) during July. The average CHL is 0.268 mg.m^{-3}. Maximum primary productivity (154 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (126 g.C.m^{-2}.y^{-1}) during 2002. There is a statistically significant increasing trend in Chlorophyll of 0.870 % from 2003 through 2013. The average primary productivity is 142 g.C.m^{-2}.y^{-1}, which places this LME in Group 2 of 5 categories (with 1 = lowest and 5= highest).

Chlorophyll-A (Southeast Australian Shelf)



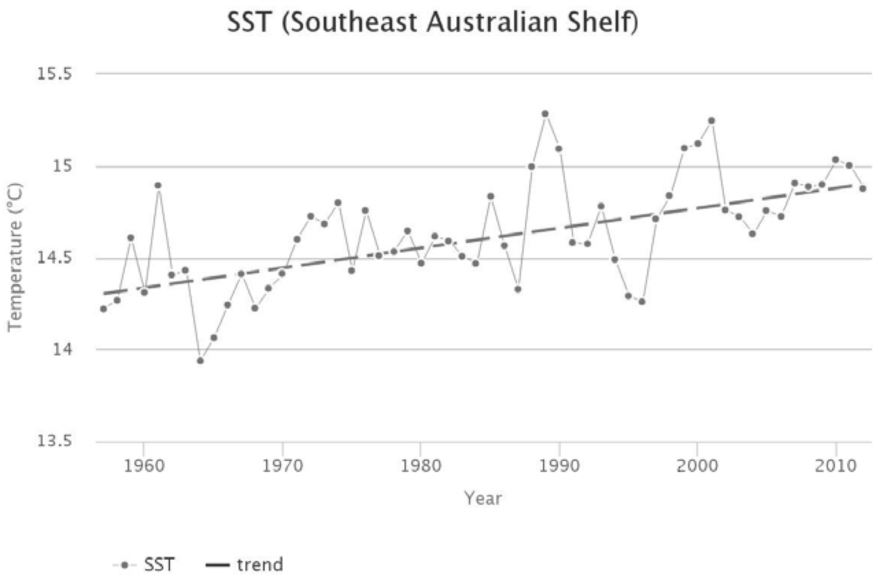
Very low Low Medium High Very high

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the Southeast Australian Shelf LME #42 has warmed by 0.61°C, thus belonging to Category 3 (moderate warming LME). The thermal history of this LME features a long-term ascending trend, although this warming was quite erratic, including major reversals. Some peculiarities of this LME's thermal history are likely caused by its location as the southernmost Australian LME. Therefore, this LME is strongly affected by the Subantarctic and Antarctic. The most striking difference between this LME and other Australian LMEs is the absence of a major peak in 1998 linked to the 1997-98 El Niño. Instead, SST peaked in 2001. A similar warm event peaked in 2000 in the adjacent Southwest Australian Shelf LME #43. The all-time maximum of 1989 correlates with the peak of 1988 in the Sulu-Celebes Sea LME #37, North Australian Shelf LME #39, West-Central Australian Shelf LME #44, and lesser peaks of 1989 in the Southwest Australian Shelf LME #43 and of 1988 in the Northwest Australian Shelf LME #45. The peak of 1961 occurred simultaneously in the adjacent Southwest Australian Shelf LME #43..

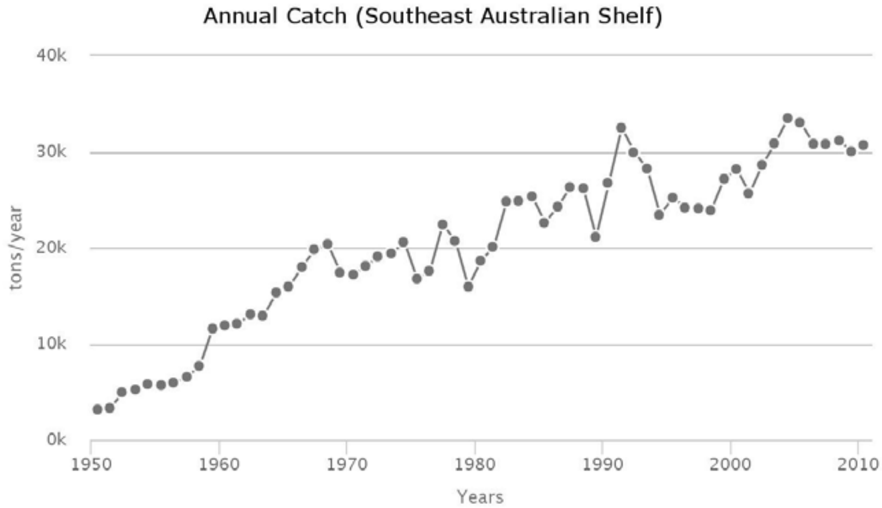


Fish and Fisheries

Among the groups fished in this LME are scallop, rock lobster, abalone, tuna, piked dogfish and blue grenadier.

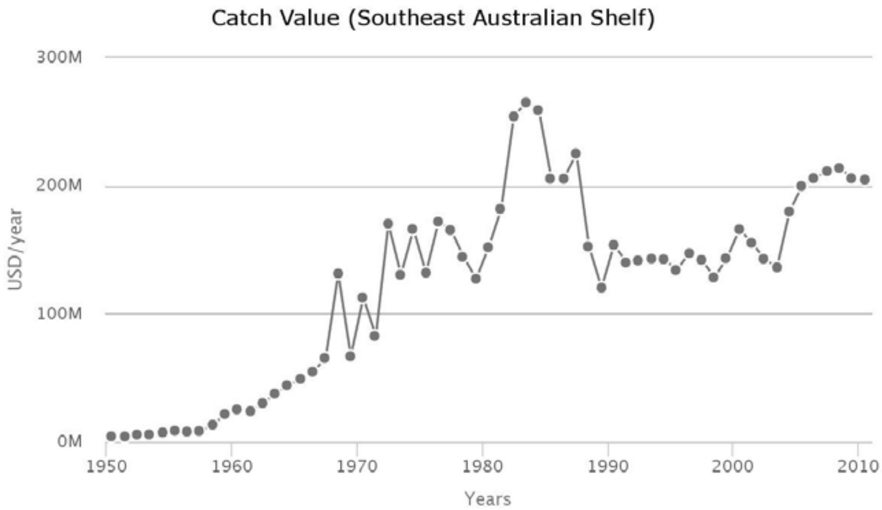
Annual Catch

Total reported landings from the LME have been on the rise, recording 33,000 t in 2004, with a notable increase in the landings of blue grenadier over the last ten years.



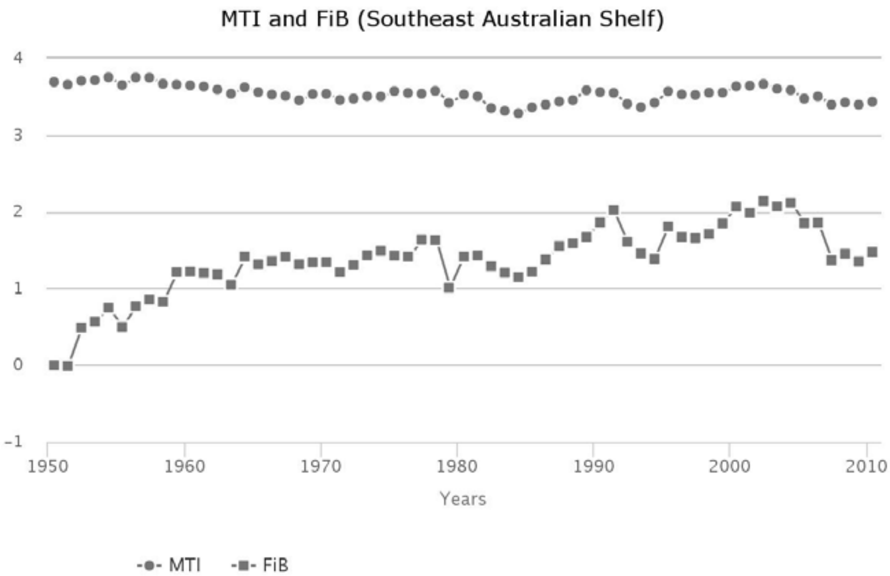
Catch value

As a result of the increased catches of southern bluefin tuna in the 1960s and 1970s, the annual reported landings attained high values of over 170 million US$ (in 2005 real US$) during this period.



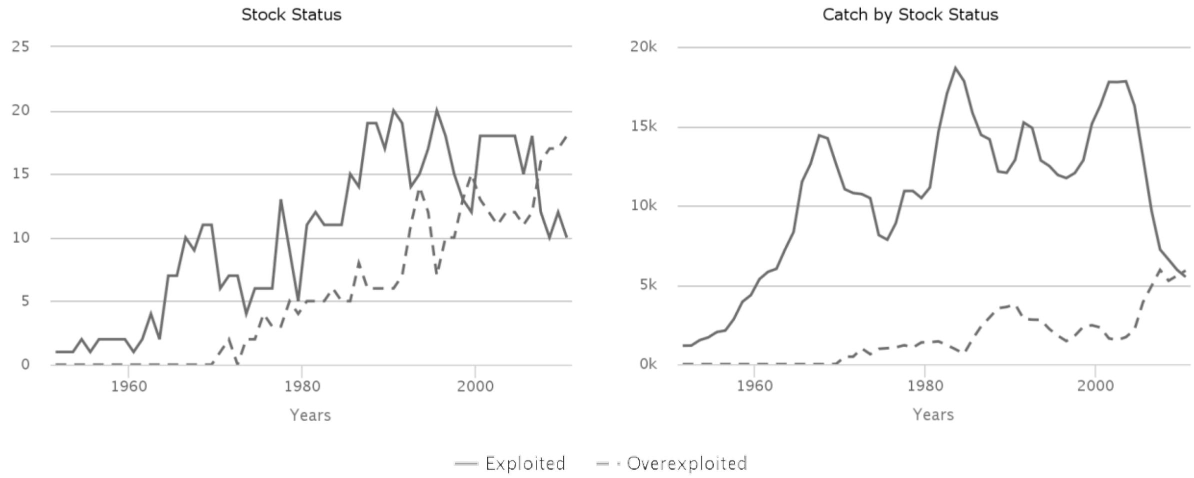
Marine Trophic Index and Fishing-in-Balance index

From early 1990s to 2004, both the MTI and the FiB indexes have increased in the LME, indicating a development of new offshore fisheries in this period. Since then, both indexes have declined indicating 'fishing down' of the food web.



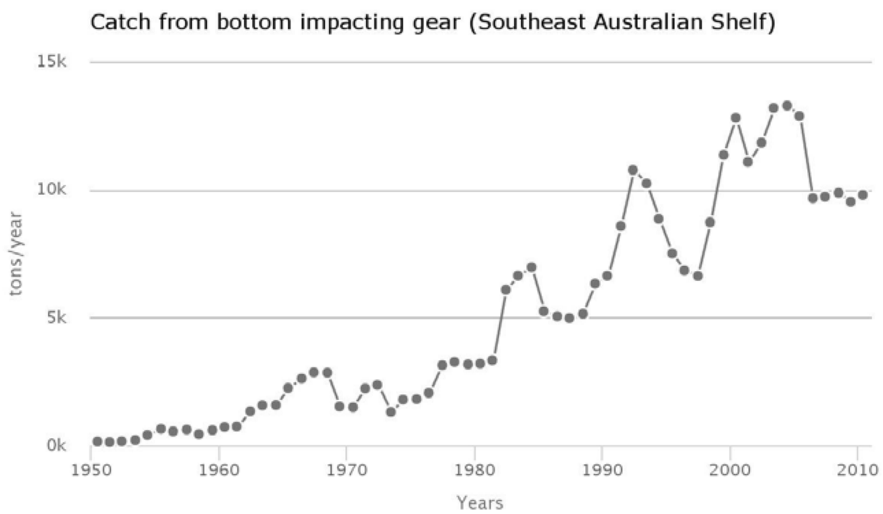
Stock status

The Stock-Catch Status Plots indicate that more than half of the stocks in the LME are currently either overexploited or have collapsed, but only about 25% of the catch biomass is from such stocks.



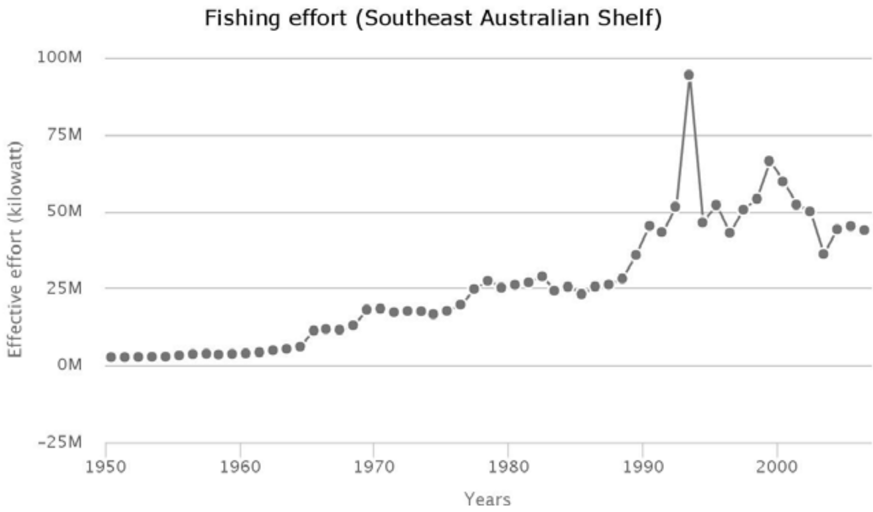
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch increased from 6% in the 1950s to its first peak at around 45% in 1999. Then, this percentage kept decreasing and fluctuated between 30% and 45% in the recent decade.



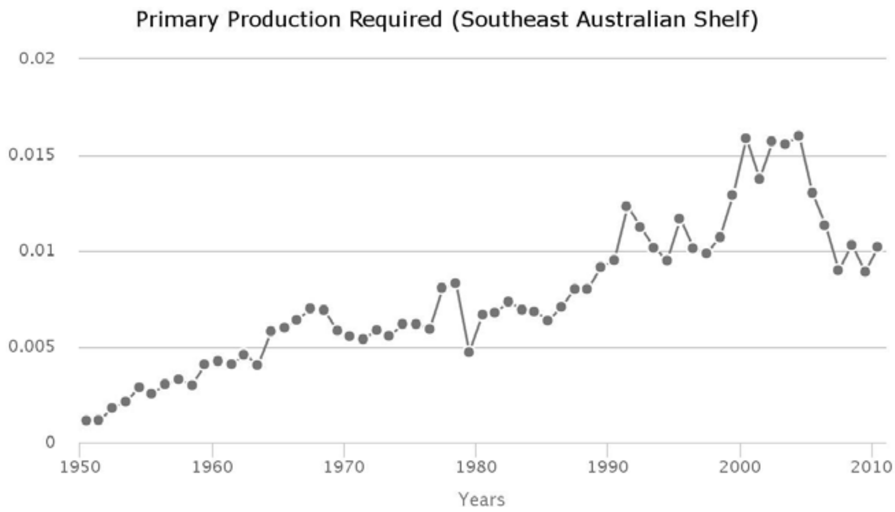
Fishing effort

The total effective effort continuously increased from around 3 million kW in the 1950s to its peak around 94 million kW in 1993.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME is currently below 2.5%.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	3	1	1	3	1	1	3	1

Legend: Very low, Low, Medium, High, Very high

POPs

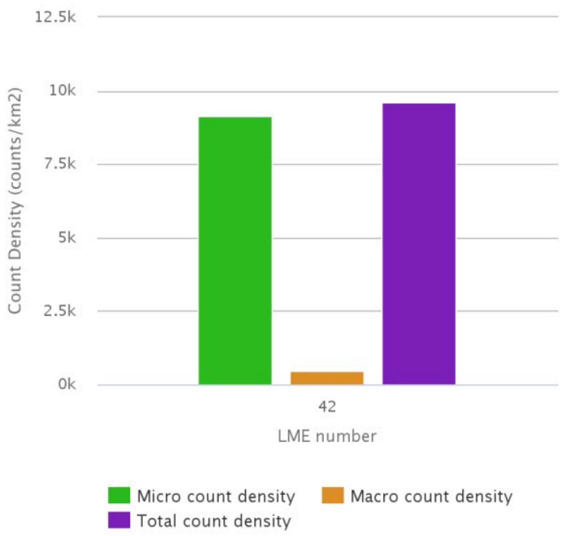
This LME includes Melbourne and the vicinities. Three samples from 3 locations are available. It shows average concentrations (ng.g^{-1} of pellets) of 134 (range 70 -223) for PCBs, 58 (range 24-77) for DDTs, and 11.1 (range from not detected to 20.7) for HCHs. All the averages correspond to risk category 3 of the five risk categories (1 = lowest risk; 5 = highest risk). A high concentration of PCBs (223 ng.g^{-1}) was recorded in a sample from Melbourne, and can be explained by legacy pollution. Moderate levels of DDTs pollution were observed in this LME. Dominance of DDT over the degradation products was observed, suggesting current inputs of DDTs. Agricultural application and/or antifouling paint may explain the moderate level of DDTs. Extremely high concentration of HCHs (20.7 ng.g^{-1}) was detected at one location (Queenscliff). The collection was made in 2010 after the onset of regulation by the Stockholm Convention. Illegal usage is suspected. Source identification of HCHs and DDT is necessary.

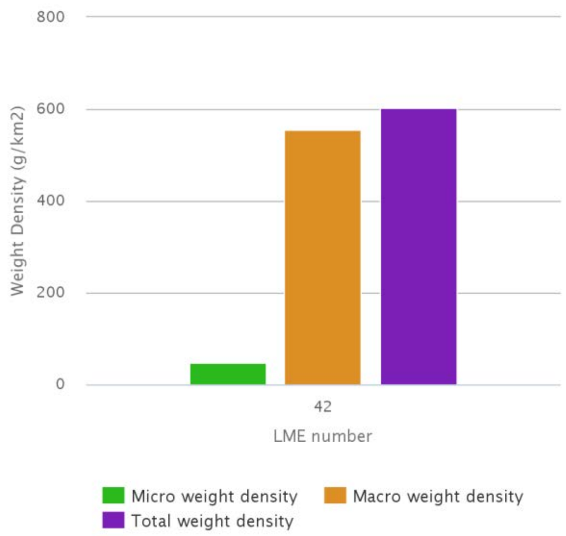
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
3	134	3	58	3	11.1	3

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively high levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 100 times higher that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

0.003% of this LME is covered by mangroves (US Geological Survey, 2011).

Reefs at risk

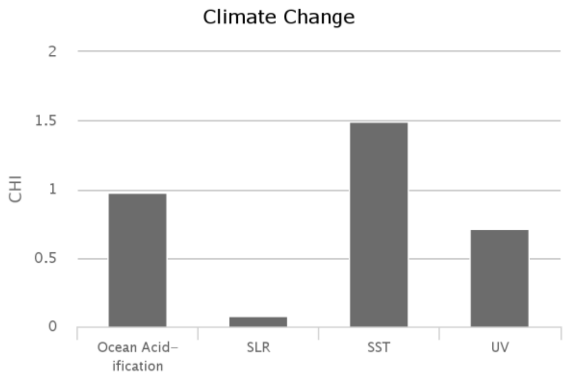
Not applicable.

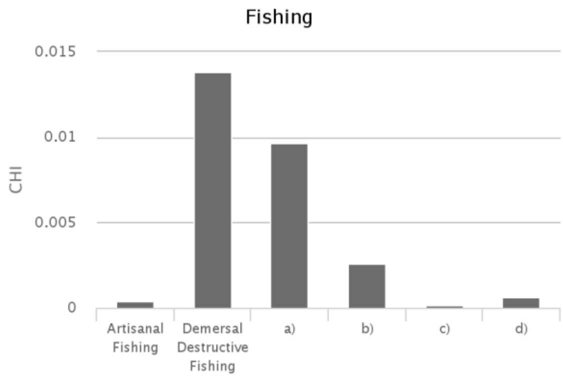
Marine Protected Area change

The Southeast Australian Shelf LME experienced an increase in MPA coverage from 961 km^2 prior to 1983 to 248,316 km^2 by 2014. This represents an increase of 25,735%, within the high category of MPA change.

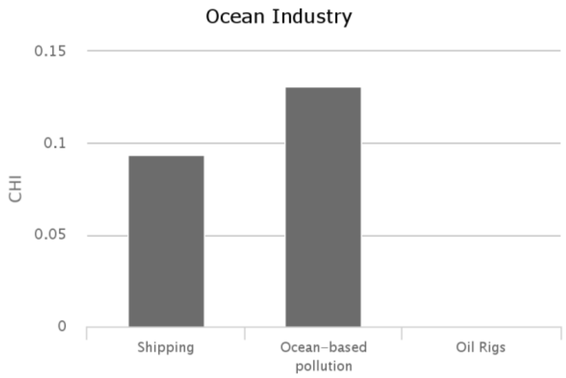
Cumulative Human Impact

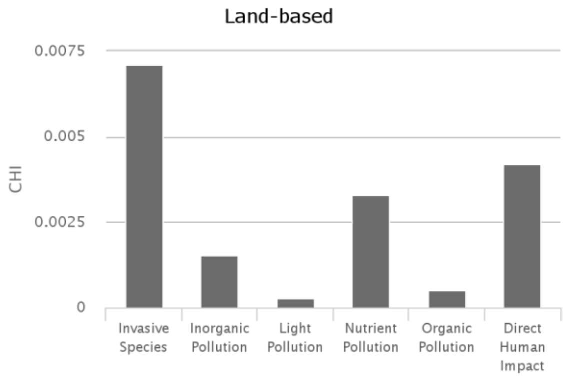
The Southeast Australian Shelf LME experiences an average overall cumulative human impact (score 3.53; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 3 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.98; maximum in other LMEs was 1.20), UV radiation (0.72; maximum in other LMEs was 0.76), and sea surface temperature (1.49; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, and ocean based pollution.

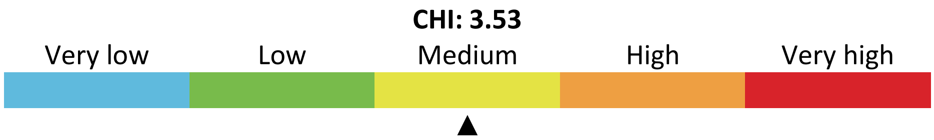




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

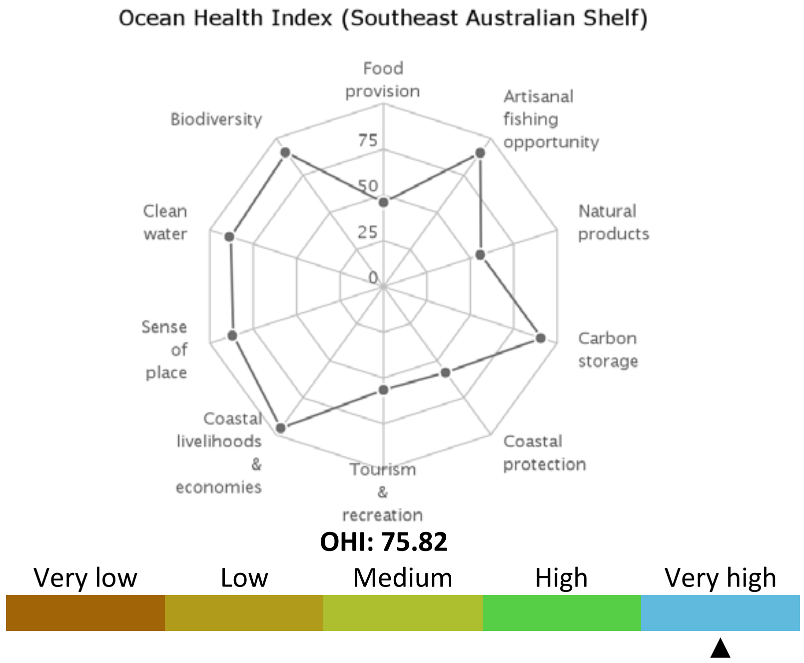






Ocean Health Index

The Southeast Australian Shelf LME scores above average on the Ocean Health Index compared to other LMEs (score 79 out of 100; range for other LMEs was 57 to 82 but still relatively low. This score indicates that the LME is below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the scores for natural products and coastal livelihoods. This LME scores lowest on food provision and coastal protection goals and highest on artisanal fishing opportunities, carbon storage, coastal livelihoods & economies, clean water and habitat biodiversity goals. It falls in risk category 1 of the five risk categories, which is the lowest level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 214,240 km^2. A current population of 6 706 thousand in 2010 is projected to increase to 8 158 thousand in 2100, with a density of 31 persons per km^2 in 2010 increasing to 38 per km2 by 2100. About 17% of coastal population lives in rural areas, and is projected to increase in share to 29% in 2100.

Total population		Rural population	
2010	2100	2010	2100
6,705,856	8,158,529	1,144,108	2,367,813

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the medium-risk category based on percentage and in the medium-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
958,586

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $221million for the period 2001-2010. Fish protein accounts for 8% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013 $38 113 million places it in the high-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with very low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
220,709,711	8.3	38,113,154,290	11.7	0.6481

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.942, this LME has an HDI Gap of 0.058, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and increasing population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9423	0.9820	0.7225

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the very low-risk (very low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to medium under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.2556	0.2232	0.2227	0.5404

Legend: Very low, Low, Medium, High, Very high

LME 43 – Southwest Australian Shelf

Bordering country: Australia
LME Total area: 1,046,368 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit high rates of increase in MPA coverage.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low.

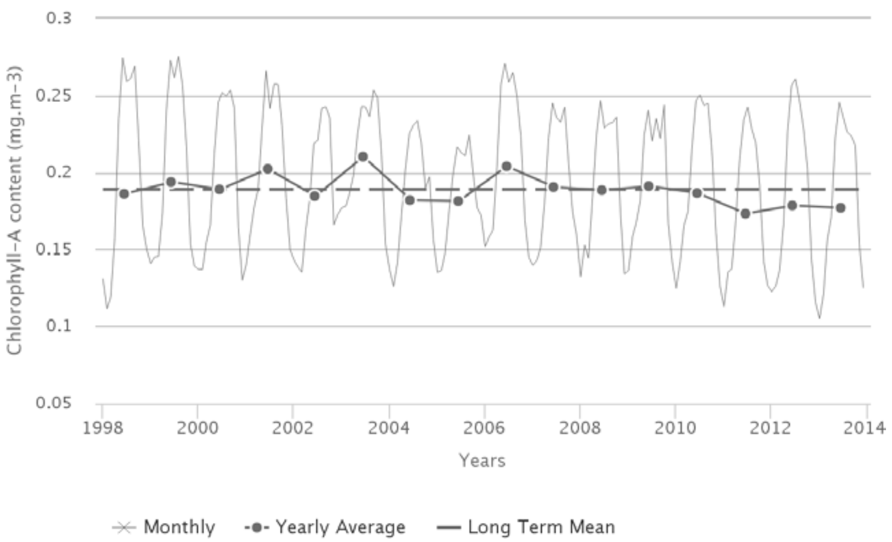
Very low	Low	Medium	High	Very high
▲				

Productivity

Chlorophyll-A

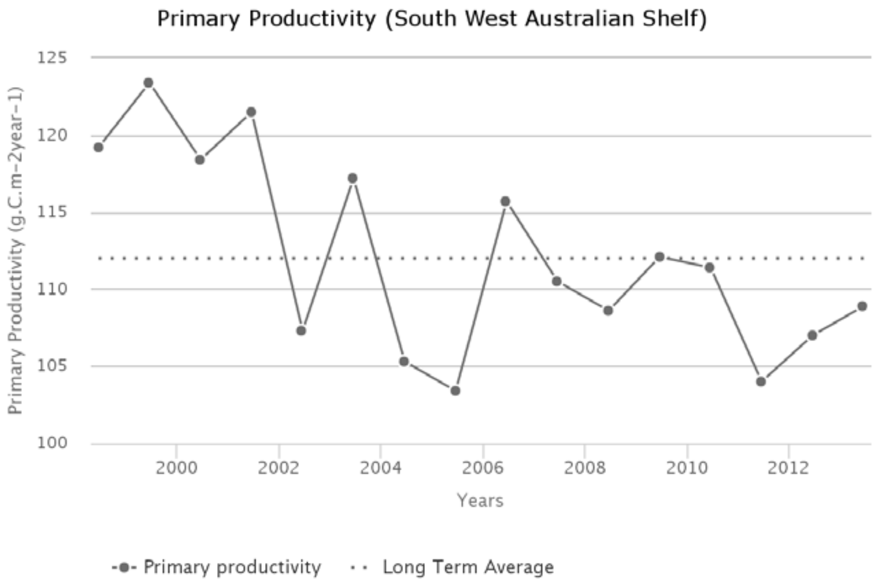
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.247 $mg.m^{-3}$) in June and a minimum (0.135 $mg.m^{-3}$) during January. The average CHL is 0.189 $mg.m^{-3}$. Maximum primary productivity (123 $g.C.m^{-2}.y^{-1}$) occurred during 1999 and minimum primary productivity (103 $g.C.m^{-2}.y^{-1}$) during 2005. There is a statistically insignificant decreasing trend in Chlorophyll of -9.80 % from 2003 through 2013. The average primary productivity is 112 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 1 of 5 categories (with 1 = lowest and 5= highest).

Chlorophyll-A (South West Australian Shelf)



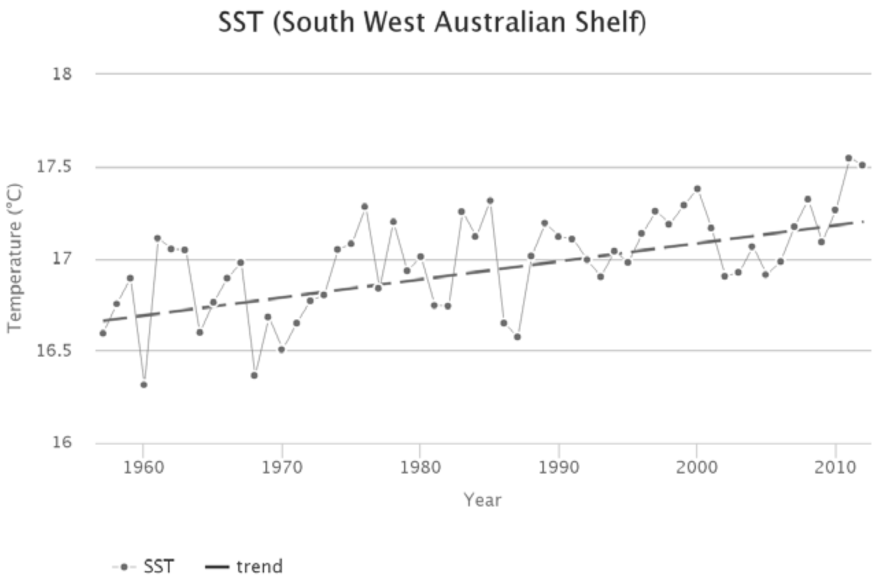
Very low	Low	Medium	High	Very high
▲				

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the Southwest Australian Shelf LME #43 has warmed by 0.54°C, thus belonging to Category 3 (moderate warming LME). The steady warming of the Southwest Australian Shelf was punctuated by several events. Most conspicuous warm events occurred in 1961-63, 1976, 1983-85, and 2000. Three cold events peaked in 1960, 1968, and 1986-87. Most events correlate with similar episodes south and north of Australia. The 2000 warm event can be linked to a similar event of 1999-2001 in the Southeast Australian Shelf LME #42. These two LMEs, ##42 and 43, are the only two areas where the El Niño 1997-98 manifested much later than elsewhere. The warm event of 1983-85 occurred simultaneously in the West-Central Australian Shelf LME #44. The cold event of 1968 also had a counterpart in LME #44 as well as the warm event of 1961-63. The observed synchronism between West-Central, Southwest, and Southeast Australian Shelf LMEs ## 42-44 can be explained by the existence of the Leeuwin Current that carries warm tropical waters from the Southeast Indian Ocean around Cape Leeuwin into the Great Australian Bight and eventually toward Tasmania and into Bass Strait (Ridgway and Condie, 2004).

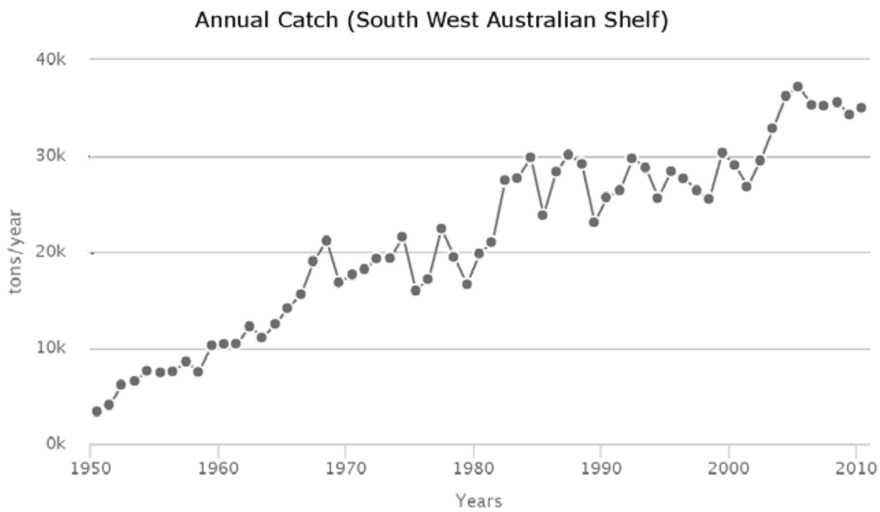


Fish and Fisheries

Australian waters are relatively nutrient-poor and unable to sustain large fish populations. Production is limited by low levels of nutrient-rich upwellings. Many species are endemic to Australia. Among the main species caught are Australian spiny lobster, piked dogfish, scallops and abalone.

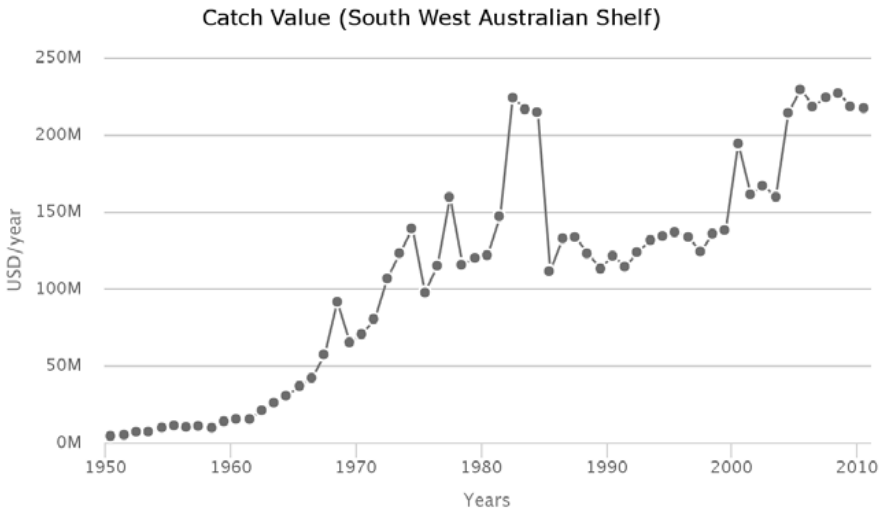
Annual Catch

The total reported landings in the LME are still growing with 37,000 t recorded in 2005. However, there is, presumably, a significant fish bycatch from the shrimp fishery which is not included in the reported landings.



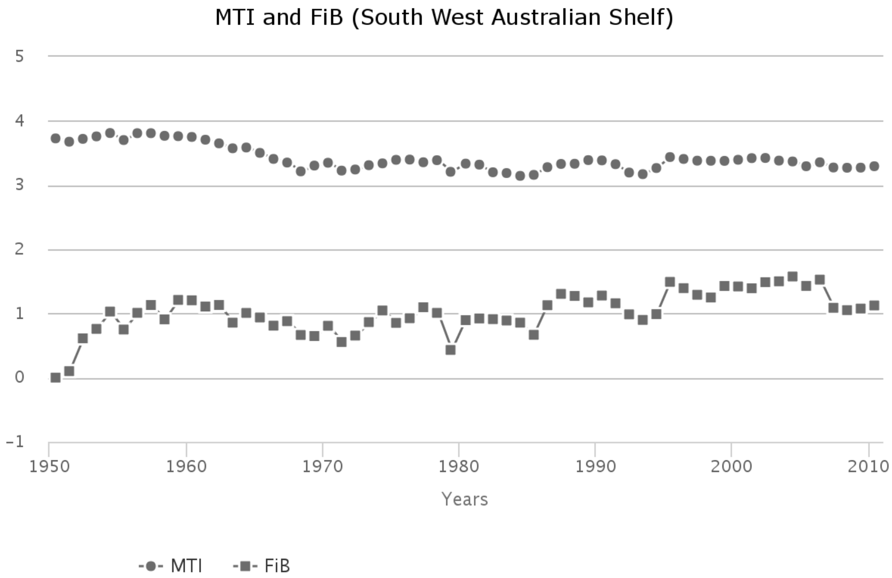
Catch value

The reported landings were valued at 230 million US$ (in 2005 real US$) in 2005, due to the high value commanded by spiny lobsters (crustaceans) and abalone (molluscs).



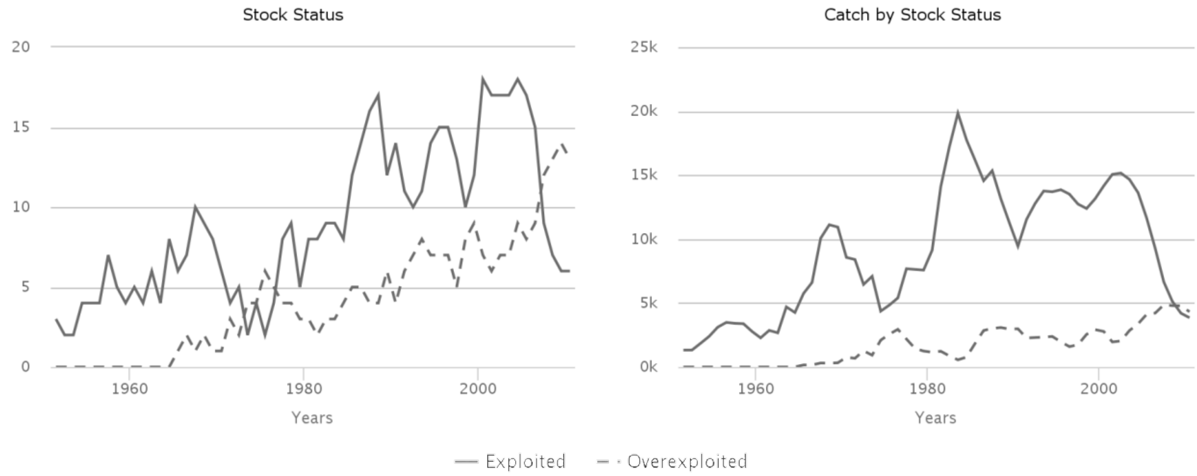
Marine Trophic Index and Fishing-in-Balance index

During the 1950s and the 1960s, the MTI declined steadily, indicating a 'fishing down' of the food web in the LME during this period. The subsequent increase of mean trophic levels, as well as the FiB index, suggests a geographic expansion of the fisheries.



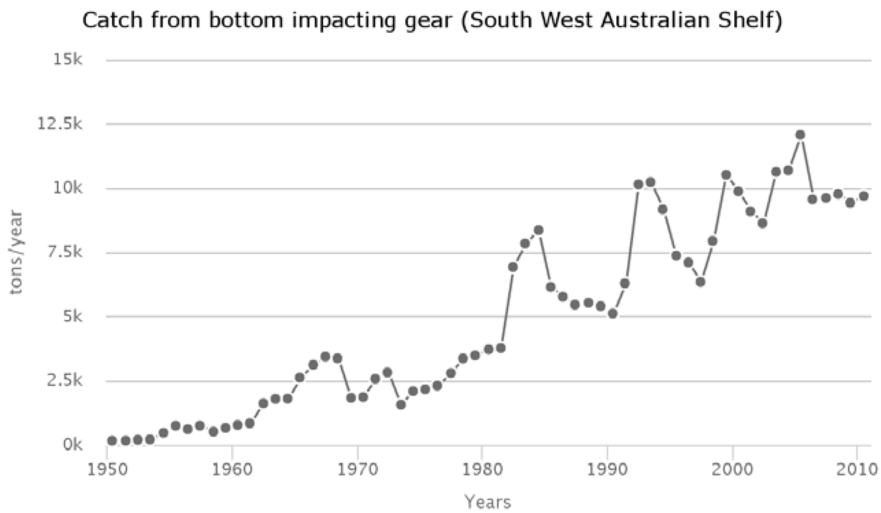
Stock status

The Stock-Catch Status Plots indicate that about 10% of commercially exploited stocks in the LME have collapsed and another 30% are overexploited. About half of the reported landings are supplied by developing stocks.



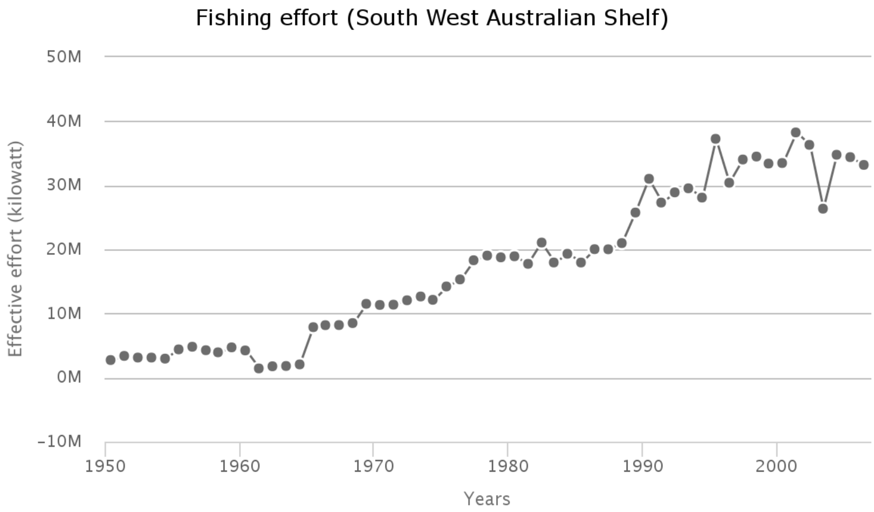
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch increased from 4% in the 1950s to its first peak at around 36% in 1993. Then, this percentage fluctuated between 27% and 34% in recent decade.



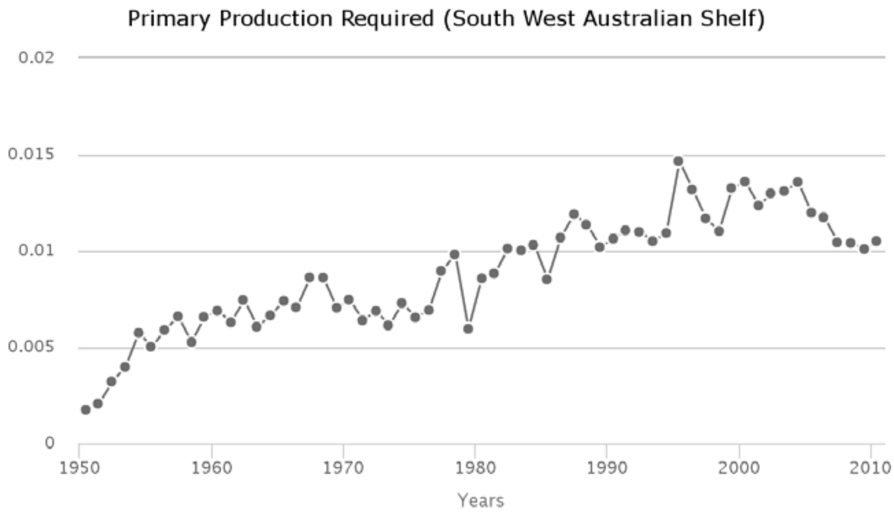
Fishing effort

The total effective effort continuously increased from around 3 million kW in the 1950s to its peak around 38 million kW in 2001.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME has been increasing, but is still below 2% of observed primary production.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			**2030**			**2050**		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	3	1	1	3	1	1	3	1

Legend: Very low, Low, Medium, High, Very high

POPs

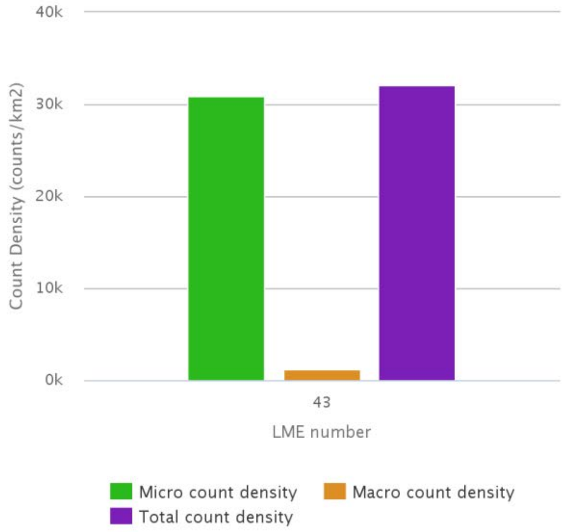
Only one sample from one location is available for the Southwest Australian Shelf LME. The sample shows minimal concentrations for all the POPs (PCBs, DDTs, HCHs) indicators, corresponding to risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This is due to minimal anthropogenic activities involving the use of POPs (PCBs in industries and DDT and HCH pesticides in agriculture).

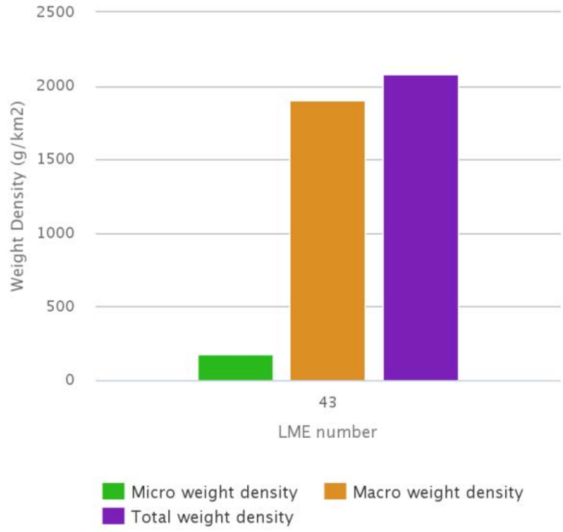
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
1	0	**1**	1	**1**	n.d.	**1**

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the highest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 400 times higher that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

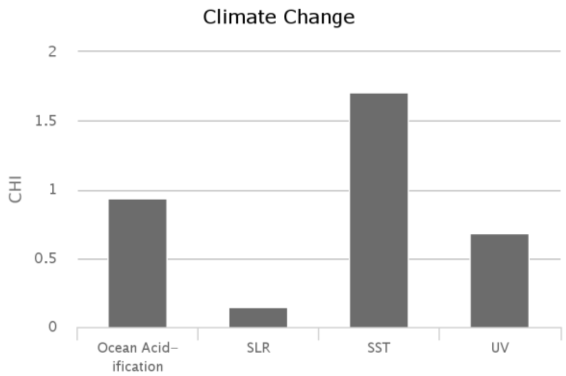
Not applicable.

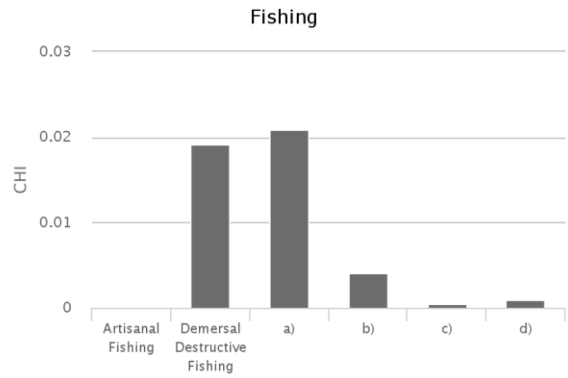
Marine Protected Area change

The Southwest Australian Shelf LME experienced an increase in MPA coverage from 822 km^2 prior to 1983 to 405,892 km^2 by 2014. This represents an increase of 49,306%, within the highest category of MPA change.

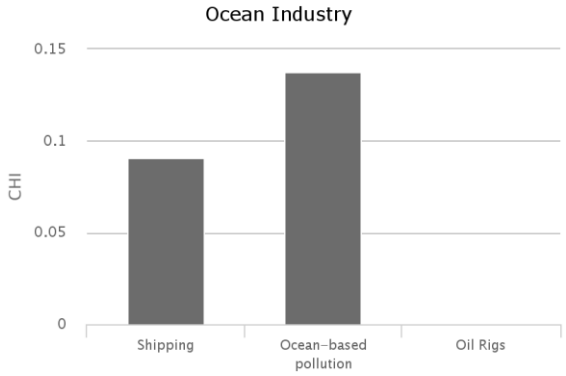
Cumulative Human Impact

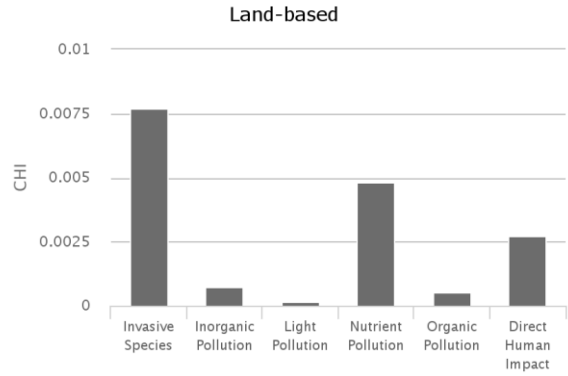
The South West Australian Shelf LME experiences above average overall cumulative human impact (score 3.76; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 3 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.93; maximum in other LMEs was 1.20), UV radiation (0.68; maximum in other LMEs was 0.76), sea level rise (0.15; maximum in other LMEs was 0.71), and sea surface temperature (1.71; maximum in other LMEs was 2.16). Other key stressors include commercial shipping and ocean based pollution.

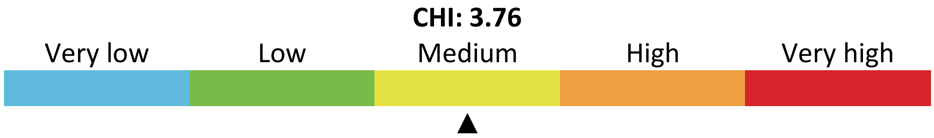




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

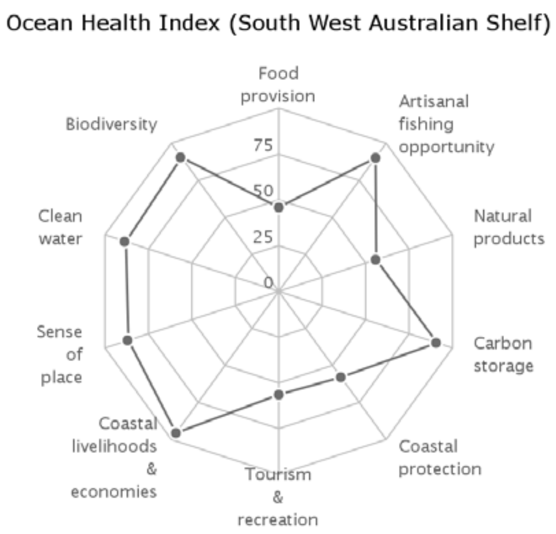






Ocean Health Index

The South West Australian Shelf LME scores above average on the Ocean Health Index compared to other LMEs (score 79 out of 100; range for other LMEs was 57 to 82 but still relatively low. This score indicates that the LME is below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the scores for natural products and coastal livelihoods. This LME scores lowest on food provision and coastal protection goals and highest on artisanal fishing opportunities, carbon storage, coastal livelihoods & economies, clean water and habitat biodiversity goals. It falls in risk category 1 of the five risk categories, which is the lowest level of risk (1 = lowest risk; 5 = highest risk).



OHI: 75.82

Very low | Low | Medium | High | Very high

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 313,831 km^2. A current population of 1 619 thousand in 2010 is projected to increase to 2 067 thousand in 2100, with a density of 5 persons per km^2 in 2010 increasing to 7 per km^2 by 2100. About 20% of coastal population lives in rural areas, and is projected to increase in share to 33% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
1,618,835	2,067,494	331,432	681,326

Legend: Very low | Low | Medium | High | Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the medium-risk category based on percentage and in the low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
231,409

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $242 million for the period 2001-2010. Fish protein accounts for 8% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$21 582 million places it in the medium-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with very low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
242,130,989	8.3	25,581,584,710	11.7	0.6145

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.942, this LME has an HDI Gap of 0.058, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and increasing population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9423	0.9820	0.7225

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the very low-risk (very low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.2470	0.2146	0.2064	0.5012

Legend: Very low, Low, Medium, High, Very high

LME 44 – West Central Australian Shelf

Bordering country: Australia
LME Total area: 543,577 km^2

List of indicators

LME overall risk

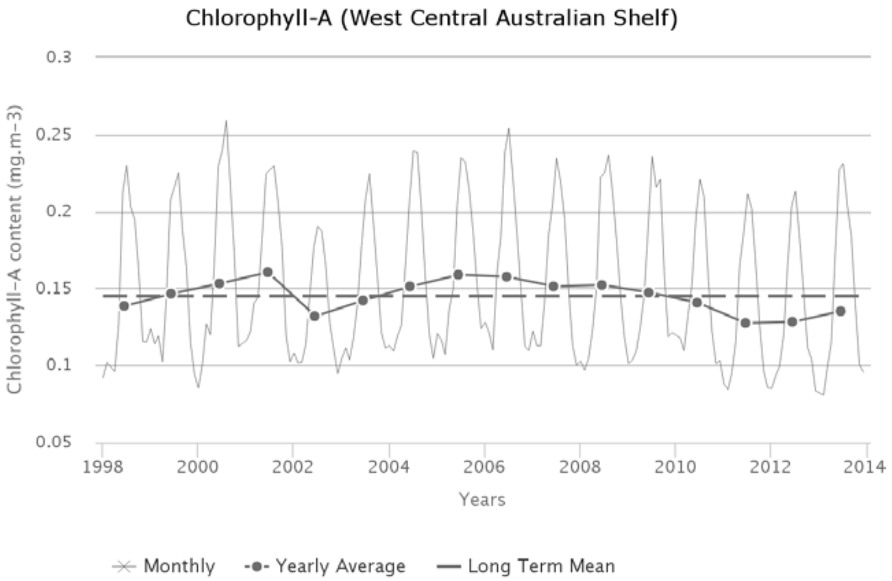
This LME falls in the cluster of LMEs that exhibit high rates of increase in MPA coverage.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low.

Very low	Low	Medium	High	Very high
▲				

Productivity

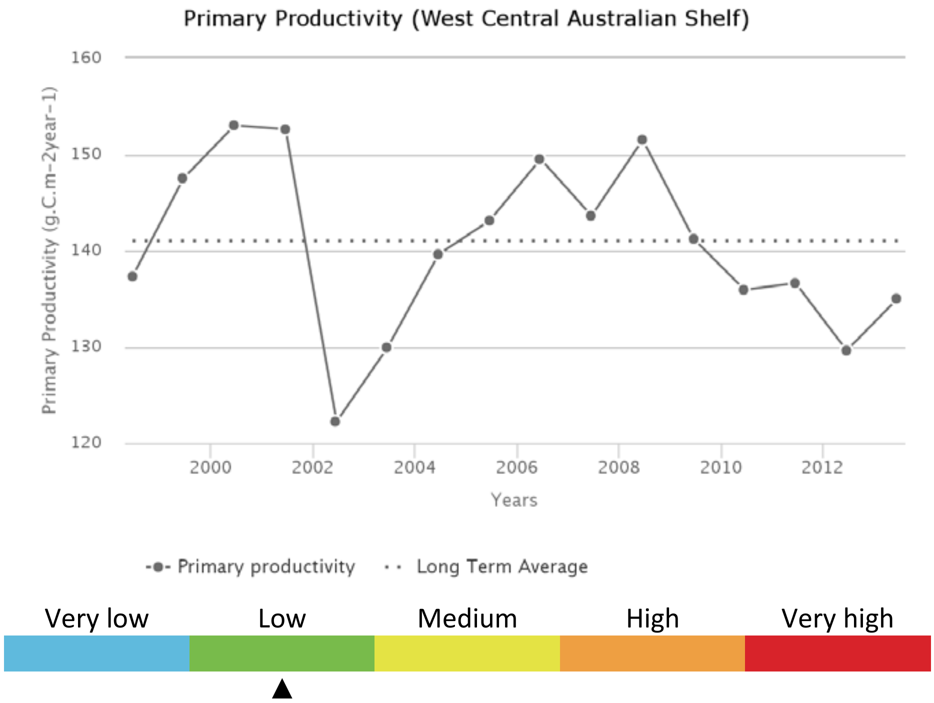
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.226 $mg.m^{-3}$) in July and a minimum (0.105 $mg.m^{-3}$) during December. The average CHL is 0.145 $mg.m^{-3}$. Maximum primary productivity (153 $g.C.m^{-2}.y^{-1}$) occurred during 2000 and minimum primary productivity (122 $g.C.m^{-2}.y^{-1}$) during 2002. There is a statistically insignificant decreasing trend in Chlorophyll of -10.0 % from 2003 through 2013. The average primary productivity is 141 $g.C.m^{-2}.y^{-1}$, which places this LME in Group 2 of 5 categories (with 1 = lowest and 5= highest).



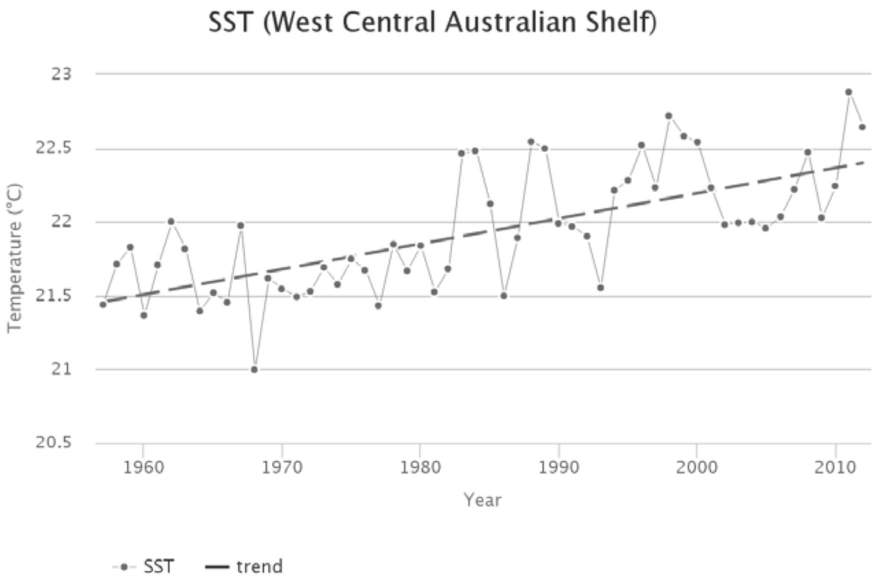
Very low	Low	Medium	High	Very high
	▲			

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the West-Central Australian Shelf LME #44 has warmed by 0.96°C, thus belonging to Category 2 (fast warming LME). The first 25 years since 1957 were rather quiet and relatively cold. The single pronounced cold event of 1968 was also observed in the Sulu-Celebes Sea LME #37 (in 1967), Indonesian Sea LME #38 (in 1967), Northwest Australian Shelf LME #45, and Southwest Australian LME #43. The cold event of 1968 was preceded by the all-time minimum in the Indonesian Sea in 1967 and a minimum of 1967 in the North Australian Shelf LME #39. Therefore, this low-temperature signal was likely transported by the Indonesian Throughflow from the Indonesian Sea onto Western Australia's shelves (LMEs ## 44 and 45), and father south and east, with the Leeuwin Current, onto the Southwest Australian Shelf LME #43. The last three decades featured strong events with peak-to-trough amplitude of 1°C. The two warm events of 1983-84 and 1988-89 were possibly correlated with moderate El Niños. The peak of 1998 was likely linked to the extremely strong El Niño 1997-98.

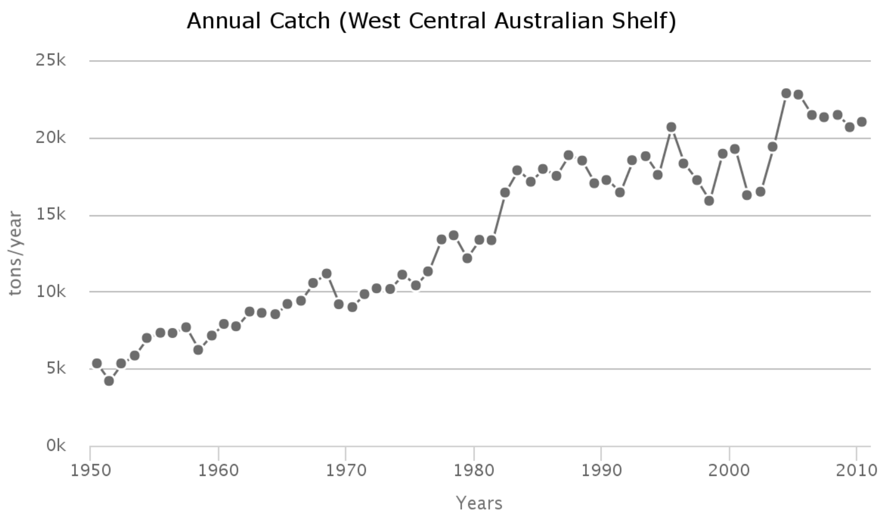


Fish and Fisheries

Production in Australian waters is limited by low levels of nutrients and as a result, fish populations are relatively small. Many species are endemic to Australia. There are commercial fisheries for Australian spiny lobster, abalone, pink snapper, shark, crab, pilchard, prawn and scallop.

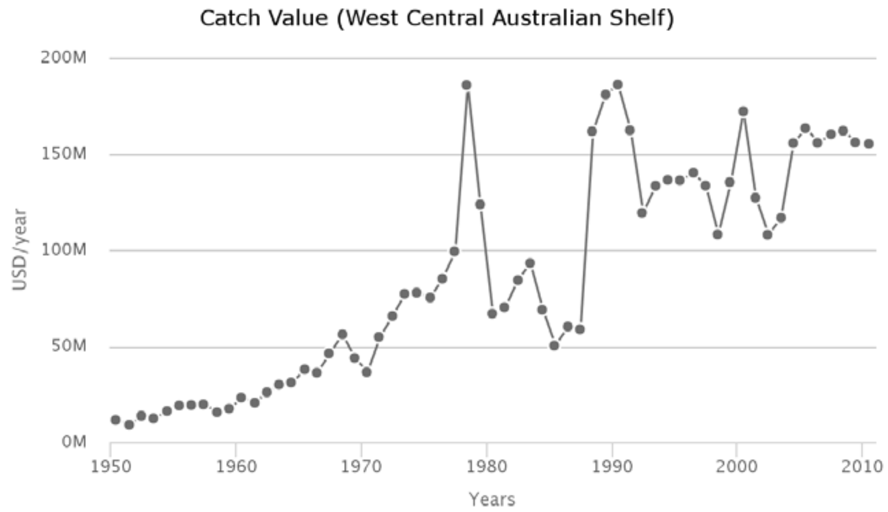
Annual Catch

Total reported landings in the LME peaked at around 23,000 t in 2004. Invertebrates such as Australian spiny lobster, scallops, prawns and shrimps account for the largest share of the landings in the LME.



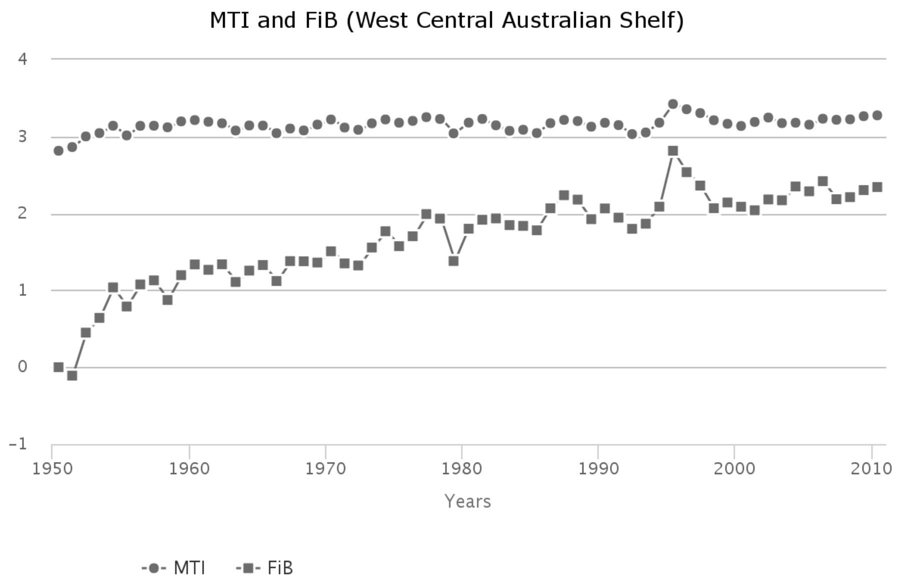
Catch value

The reported landings were worth about 180 million US$ (in 2005 real US$) in 1990.



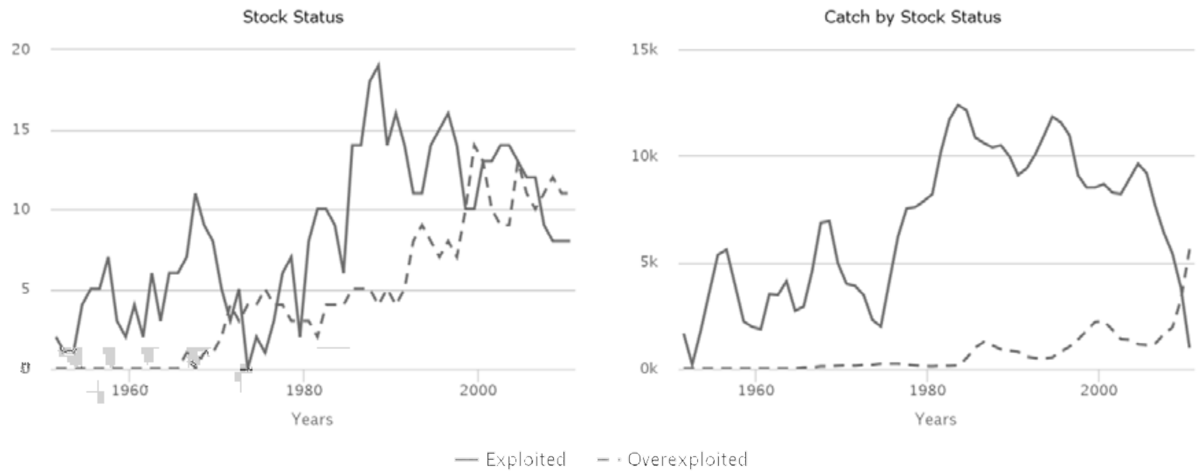
Marine Trophic Index and Fishing-in-Balance index

The MTI in this LME was generally low, due to the low trophic level of Australian spiny lobster which accounts for the largest share of the reported landings. In recent years, however, both MTI and FiB index are on a rise, suggestive of spatial expansion.



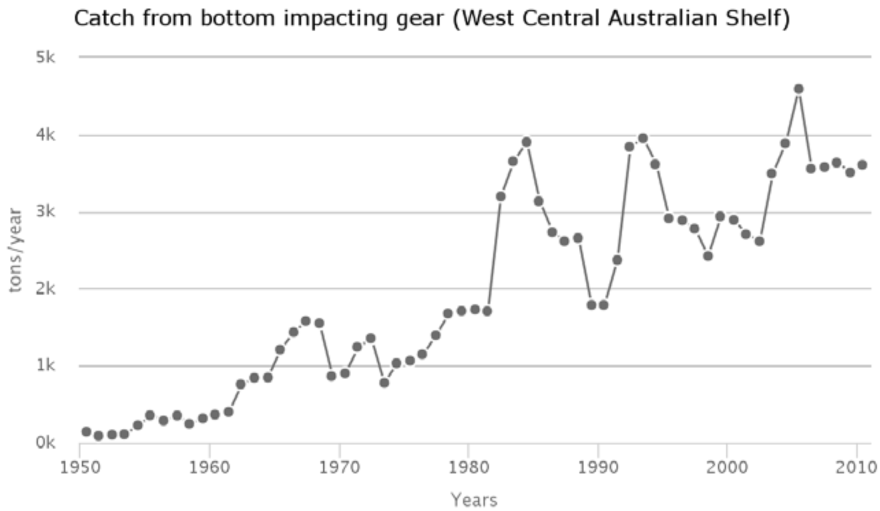
Stock status

The Stock-Catch Status Plots indicate that about 50% of the stocks are deemed as collapsed or overexploited. However, about 50% of the reported landings are supplied by developing stocks.



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch increased from 2% in the early 1950s to its first peak at around 23% in 1983. Then, this percentage fluctuated between 15% and 20% in recent decade.

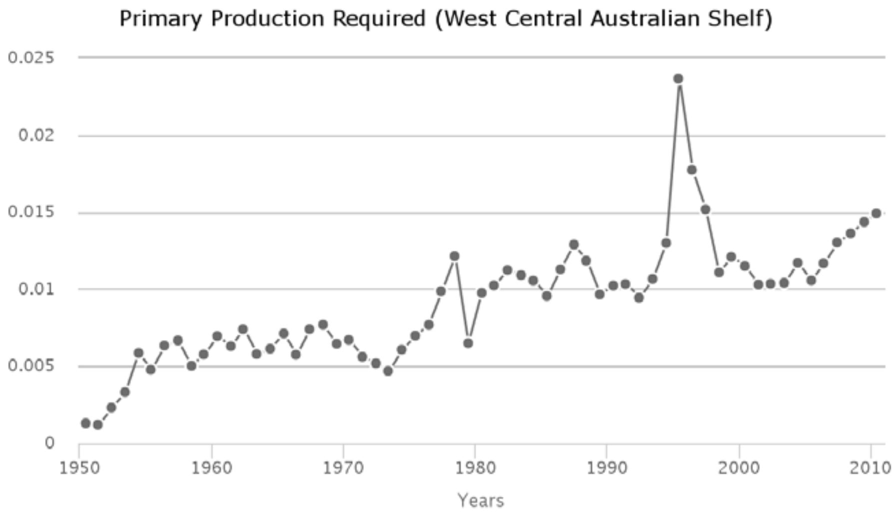


Fishing effort

The total effective effort continuously increased from around 1 million kW in the 1950s to its peak around 36 million kW in 2001.

Primary Production Required

The primary production required (PPR) to sustain the reported landings is very small (less than 1.5%), in line with the low exploitation of the LME.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	3	1	1	3	1	1	3	1

Legend: Very low, Low, Medium, High, Very high

POPs

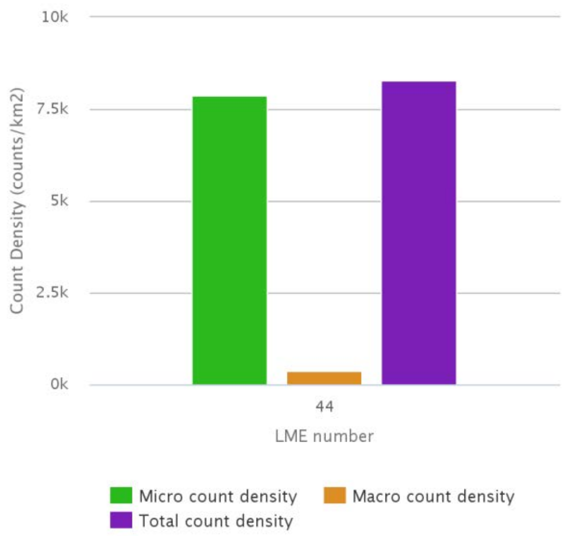
Four samples from 3 locations are available for the West-central Australian Shelf LME. Minimal average concentrations (ng.g^{-1} of pellets) of 6 (range 0.5-13 ng.g^{-1}) were found for PCBs, 3.3 (range 2-7 ng.g^{-1}) for DDTs, and 0.1 (range 0.1- 0.2) for HCHs, all corresponding to risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This is probably due to minimal anthropogenic activities involving the use of POPs (PCBs in industries and DDT and HCH pesticides in agriculture).

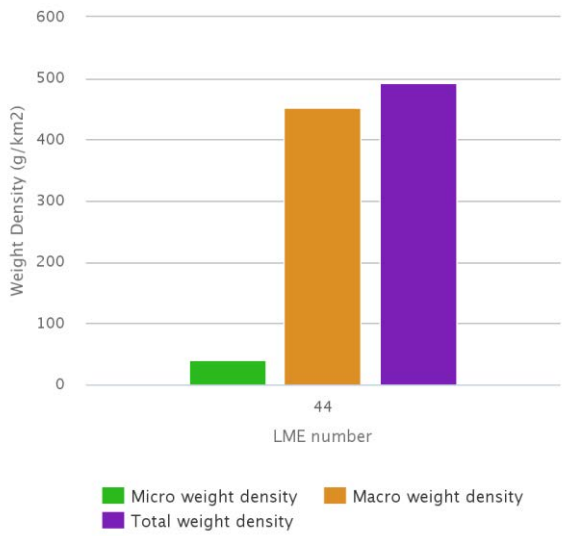
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
4	6	**1**	3	**1**	0.1	**1**

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively high levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 100 times higher that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





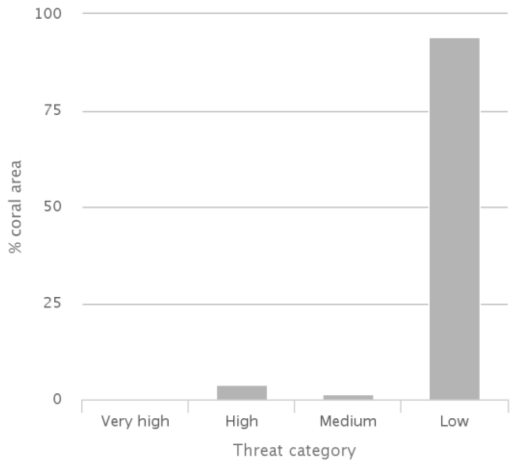
Ecosystem Health

Mangrove and coral cover

0.003% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.15% by coral reefs (Global Distribution of Coral Reefs, 2010).

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 111. 0.4% of coral reefs cover is under very high threat, and 4% under high threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 4% and 1% for very high and high threat categories respectively. By year 2030, 0.9% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification; this proportion increases to 1.4% by 2050.

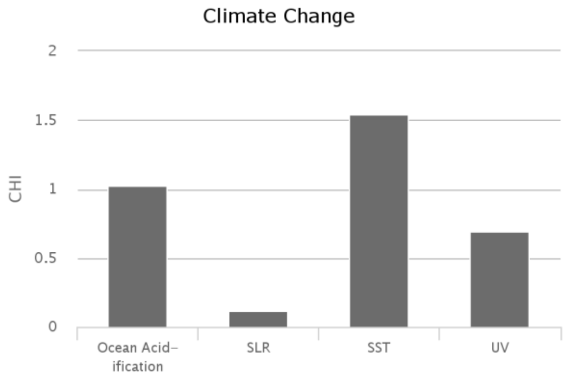


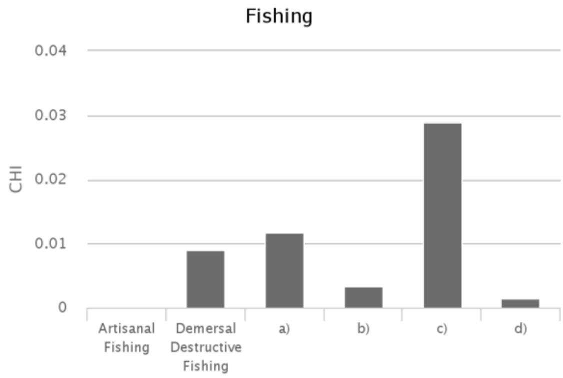
Marine Protected Area change

The West Central Australian Shelf LME experienced an increase in MPA coverage from 0 km2 prior to 1983 to 194,208 km2 by 2014. This represents an increase of 30,000%, within the highest category of MPA change.

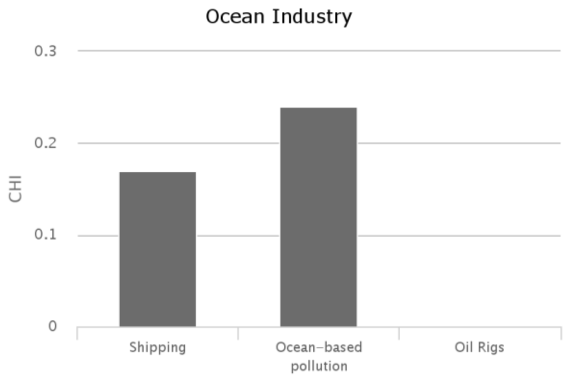
Cumulative Human Impact

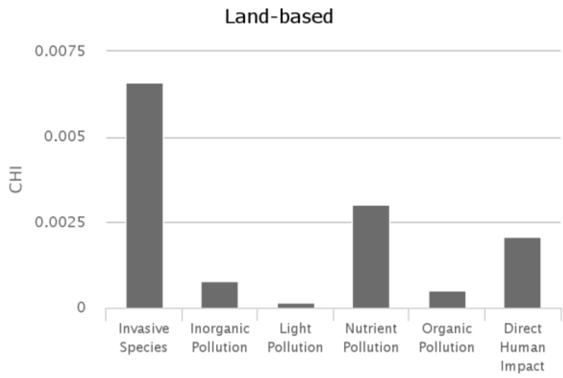
The West Central Australian Shelf LME experiences above average overall cumulative human impact (score 3.87; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 4 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (1.03; maximum in other LMEs was 1.20), UV radiation (0.70; maximum in other LMEs was 0.76), and sea surface temperature (1.55; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, and pelagic high-bycatch commercial fishing.

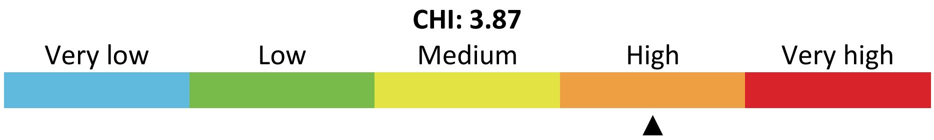




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing



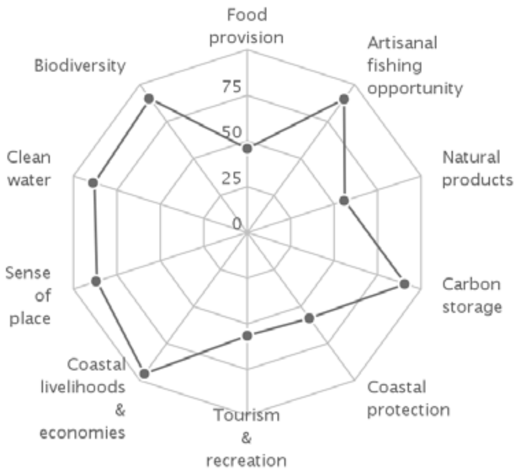




Ocean Health Index

The West Central Australian Shelf LME scores above average on the Ocean Health Index compared to other LMEs (score 79 out of 100; range for other LMEs was 57 to 82 but still relatively low. This score indicates that the LME is below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the scores for natural products and coastal livelihoods. This LME scores lowest on food provision and coastal protection goals and highest on artisanal fishing opportunities, carbon storage, coastal livelihoods & economies, clean water and habitat biodiversity goals. It falls in risk category 1 of the five risk categories, which is the lowest level of risk (1 = lowest risk; 5 = highest risk).

Ocean Health Index (West Central Australian Shelf)



OHI: 75.82

Very low | Low | Medium | High | Very high

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 140,036 km^2. A current population of 1 698 thousand in 2010 is projected to increase to 2 056 thousand in 2100, with a density of 12 persons per km^2 in 2010 increasing to 15 per km^2 by 2100. About 19% of coastal population lives in rural areas, and is projected to increase in share to 28% in 2100.

Total population		Rural population	
2010	2100	2010	2100
1,698,214	2,055,745	318,686	570,334

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the medium-risk category based on percentage and in the low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
242,756

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $174 million for the period 2001-2010. Fish protein accounts for 8% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$15 953 million places it in the medium-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with very low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
173,578,189	8.3	15,953,310,210	11.7	0.6258

Legend: Very low, Low, Medium, High, Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.942, this LME has an HDI Gap of 0.058, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and increasing population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9423	0.9820	0.7225

Legend: Very low, Low, Medium, High, Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

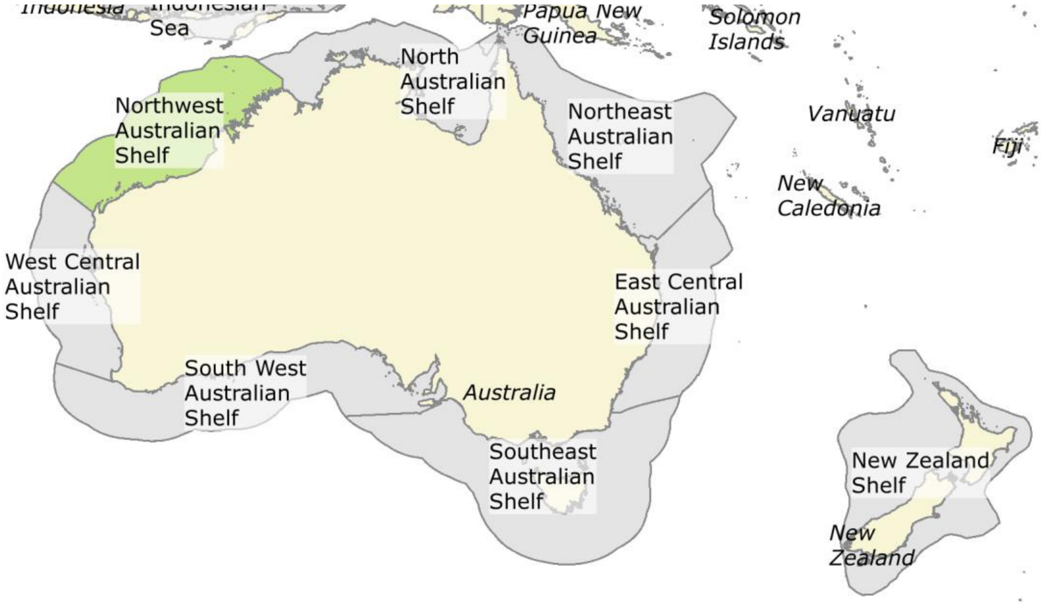
Present day climate threat index of this LME is within the very low-risk (very low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.2473	0.2160	0.2061	0.5004

Legend:

Very low | Low | Medium | High | Very high

LME 45 – Northwest Australian Shelf



Bordering country: Australia.
LME Total area: 911,812 km^2

List of indicators

LME overall risk

This LME falls in the cluster of LMEs that exhibit high rates of increase in MPA coverage.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low.

Very low | Low | Medium | High | Very high

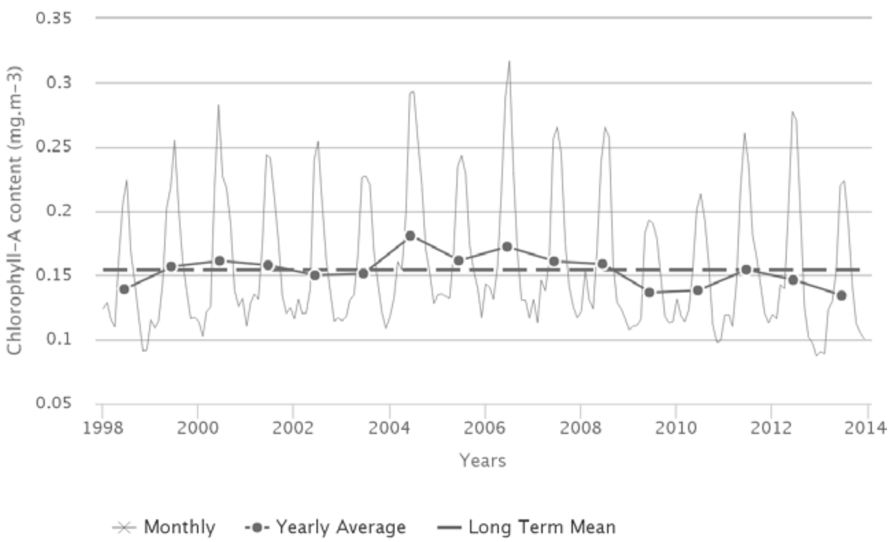
▲ (Very low)

Productivity

Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.246 mg.m^{-3}) in July and a minimum (0.112 mg.m^{-3}) during December. The average CHL is 0.154 mg.m^{-3}. Maximum primary productivity (262 g.C.m^{-2}.y^{-1}) occurred during 2004 and minimum primary productivity (212 g.C.m^{-2}.y^{-1}) during 2013. There is a statistically insignificant decreasing trend in Chlorophyll of -15.6 % from 2003 through 2013. The average primary productivity is 233 g.C.m^{-2}.y^{-1}, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).

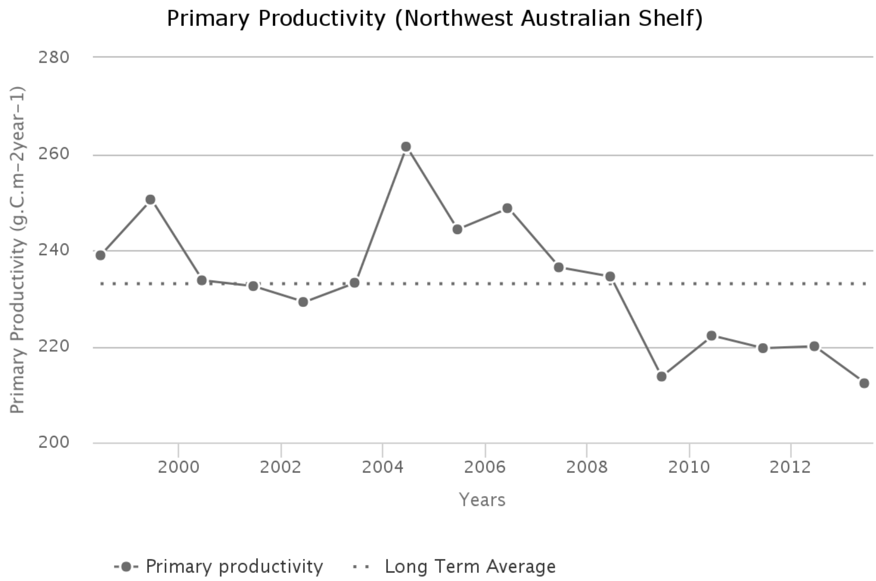
Chlorophyll-A (Northwest Australian Shelf)

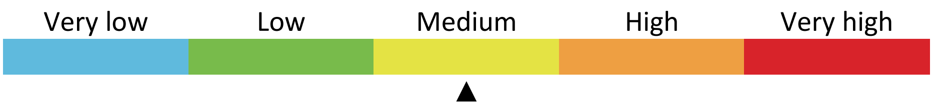


Very low | Low | Medium | High | Very high

▲ (Medium)

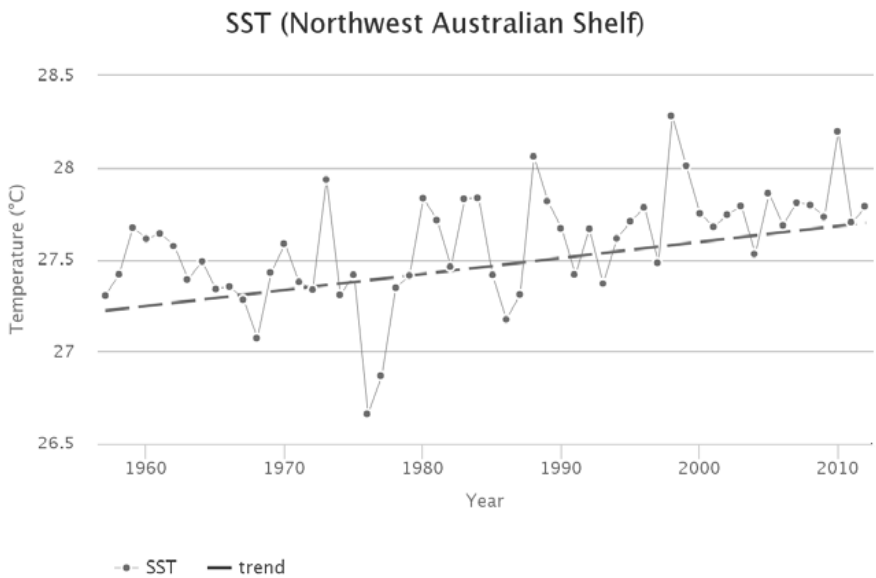
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Northwest Australian Shelf LME #45 has warmed by 0.50°C, thus belonging to Category 3 (moderate warming LME). The interannual variability of SST in this LME is rather small, with year-to-year variations of SST being <0.5°C. The only significant warm event, the all-time maximum of SST>28.2°C in 1998, was caused by the El Niño 1997-98. The most significant cold event has bottomed out at <26.7°C in 1976, when SST anomaly was about -1°C relative to the long-term trend. This event can be associated with the cold event of 1976-77 in the North Australian Shelf LME #39. This is a rare example of a large signal confined to just two contiguous LMEs that comprise a relatively small area. Another cold signal, of 1968, likely travelled from the Indonesian Sea LME #38, where a cold event occurred in 1967. The proposed travel route is consistent with the regional circulation pattern.

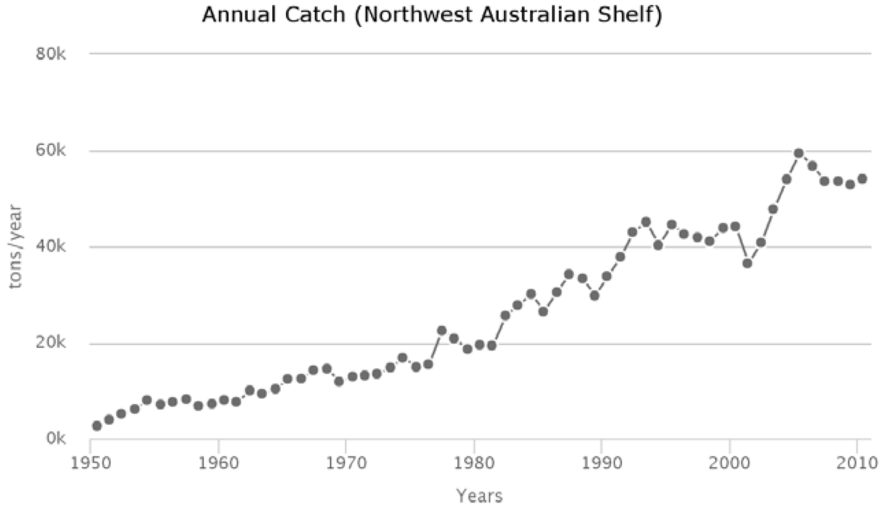


Fish and Fisheries

Northwest Australian waters are relatively nutrient-poor and unable to sustain large fish populations. The level of endemism in the LMEs is low, with most species distributed widely in the Indo-West Pacific region. Demersal species fished in this LME include *Lethrinus*, *Nemipterus*, *Saurida* and *Lutjanus*, which have historically been fished by foreign fleets. Other exploited groups include *Anadara* clams, scallops and goldstripe sardinella, as well as a significant number of unidentified taxa.

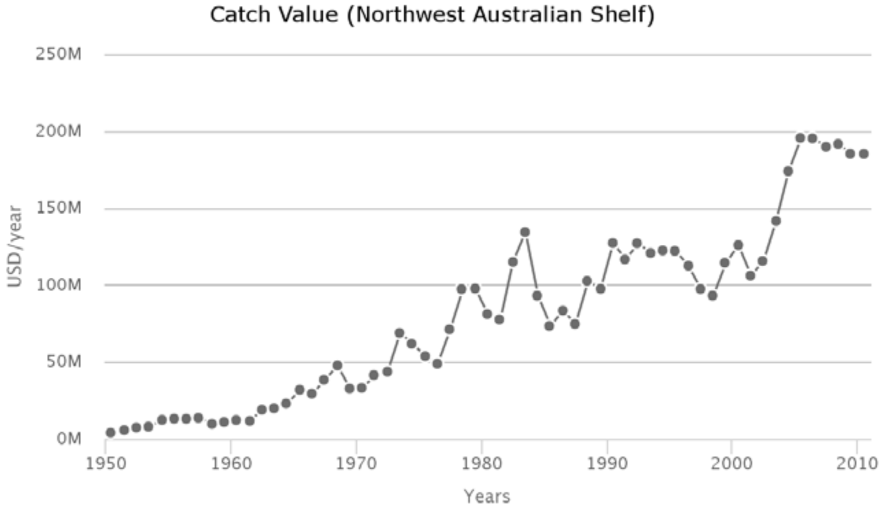
Annual Catch

Total reported landings show a series of peaks in the 1990s over 50,000 t with a record landing of 60,000 t in 2005.



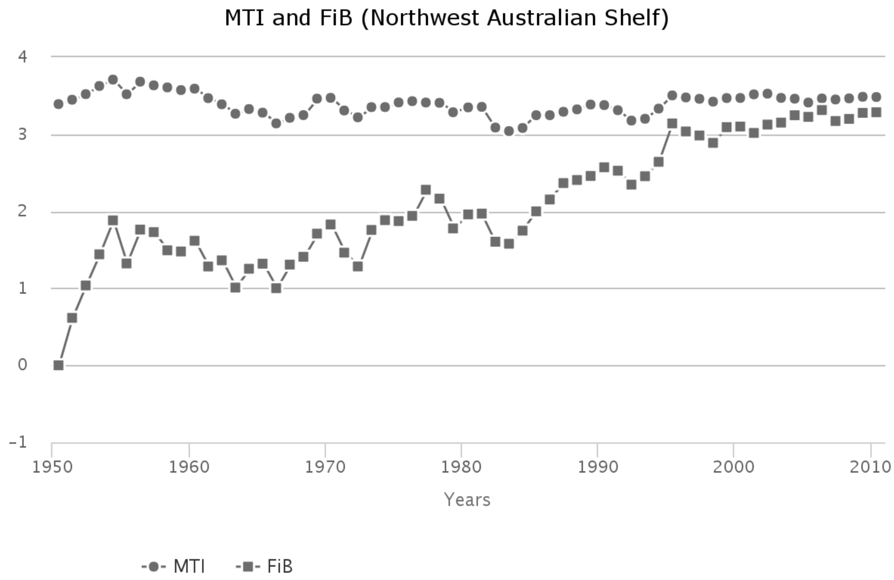
Catch value

From the early 1990s to 2005, the value of the catch increased sharply and then fluctuated between 185 and 195 million US$ (in 2005 real US$) in the recent 5 years.



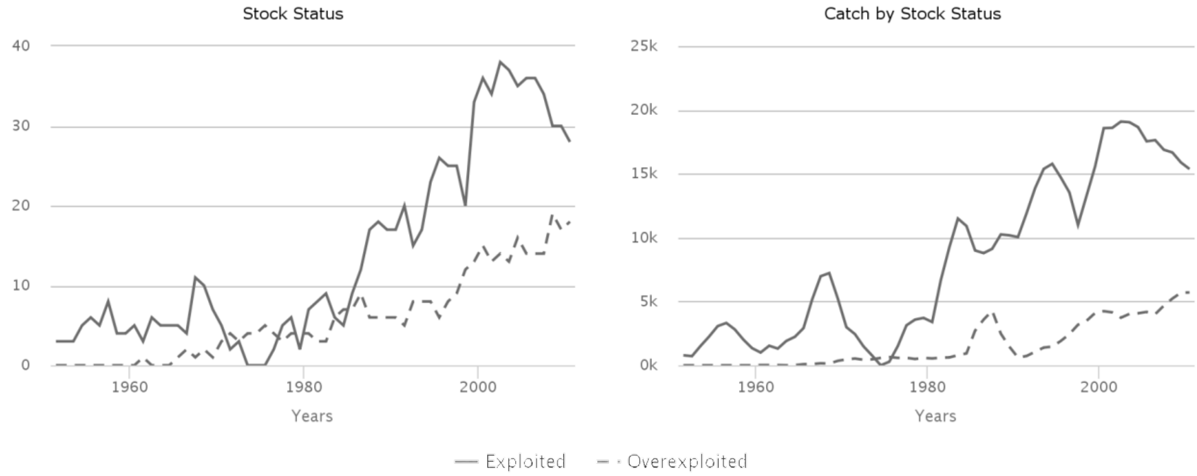
Marine Trophic Index and Fishing-in-Balance index

Since the mid-1980s, both the MTI and the FiB index showed an increase, likely a result of geographic expansion of the fisheries and targeting of large and medium pelagic species.



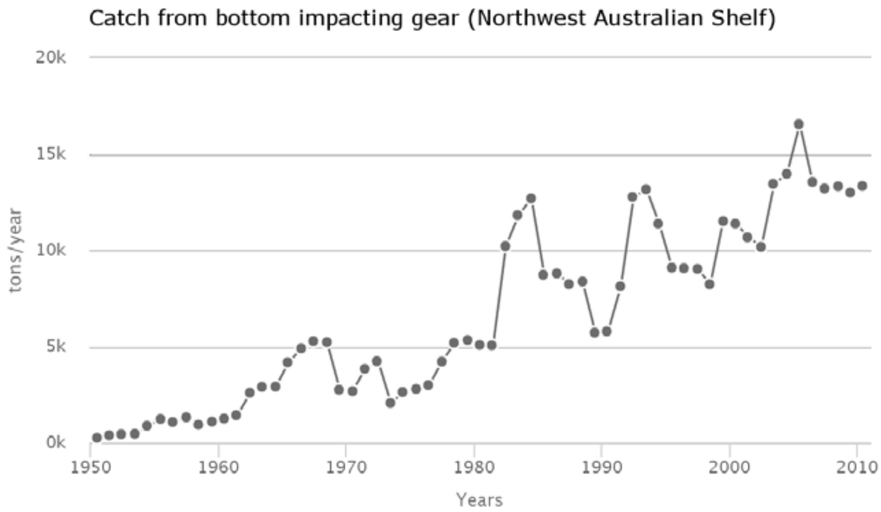
Stock status

The Stock-Catch Status Plots indicate that approximately 35% of the stocks have collapsed or are overexploited in the LME. The reported landings are largely generated by fully exploited and developing stocks.



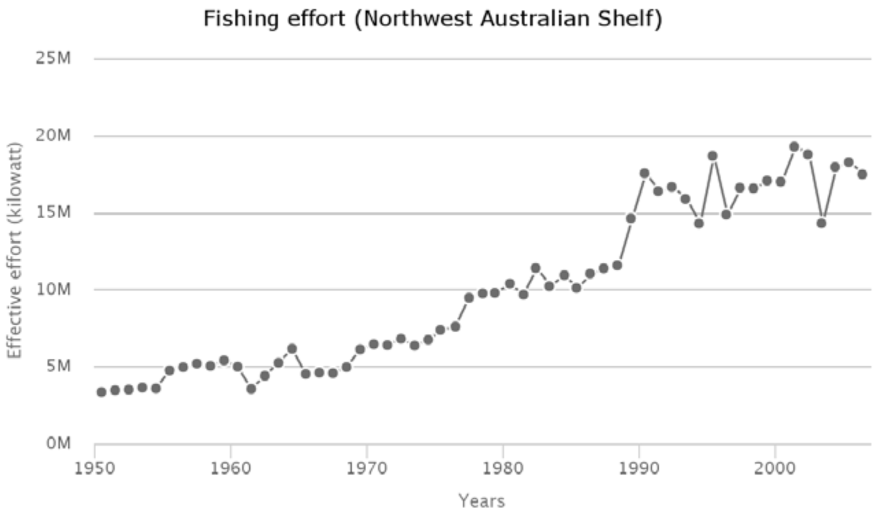
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 7 and 43% from 1950 to 2010. This percentage fluctuated around 25% in the recent decade.



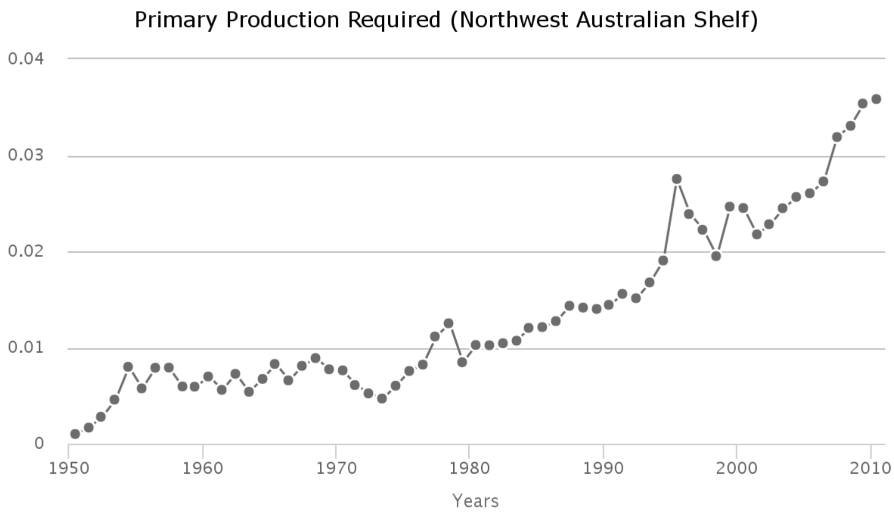
Fishing effort

The total effective effort continuously fluctuated between 0.6% and 3.6% from 1950 to 1991 and then it increased to its first peak at 15 million kW in 1993.



Primary Production Required

The primary production required (PPR) to sustain the reported landings in this LME has reached 2.5% in the 1990s, which is very low.



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An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was very low. (level 1 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a “current trends” scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
1	3	1	1	3	1	1	3	1

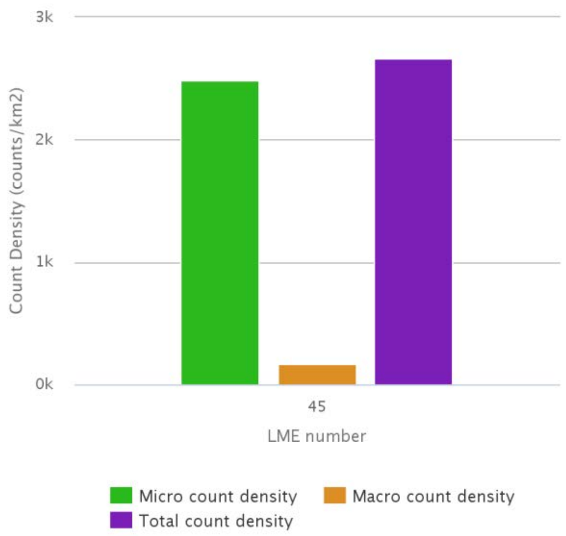
Legend: Very low, Low, Medium, High, Very high

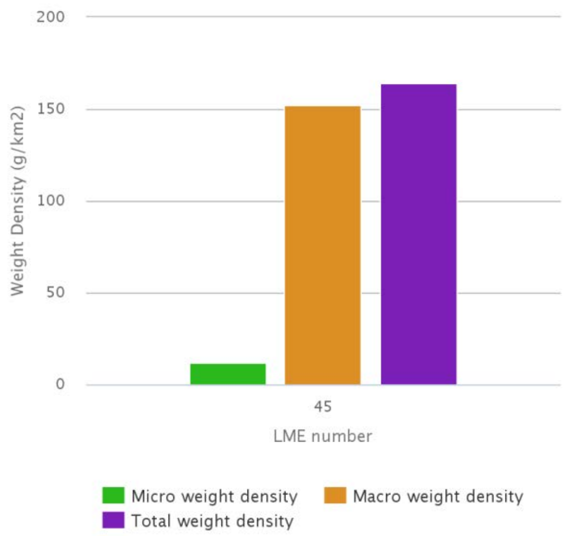
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively moderate levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 12 times lower that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





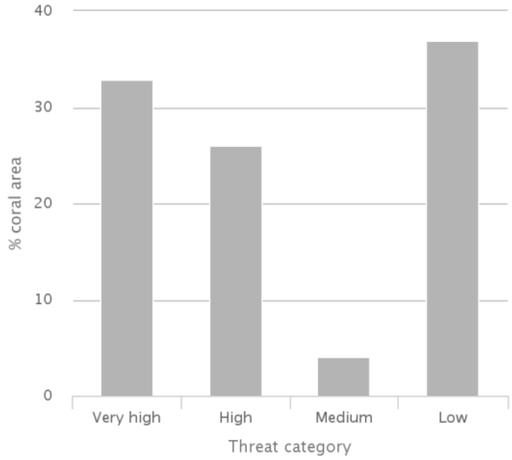
Ecosystem Health

Mangrove and coral cover

0.16% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.31% by coral reefs (Global Distribution of Coral Reefs, 2010).

Reefs at risk

This LME has a present (2011) integrated threat index (combining threat from overfishing and destructive fishing, watershed-based and marine-based pollution and damage) of 118. 0.52% of coral reefs cover is under high threat, and 17% under medium threat (of the 5 possible threat categories, from low to critical). When combined with past thermal stress (between 1998 and 2007), these values increase to 0.52% and 14% for very high and high threat categories respectively. By year 2030, 0% of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification, with 13% under high threat; this proportion increases to 0.52% under very high and 16% under high threat by 2050.

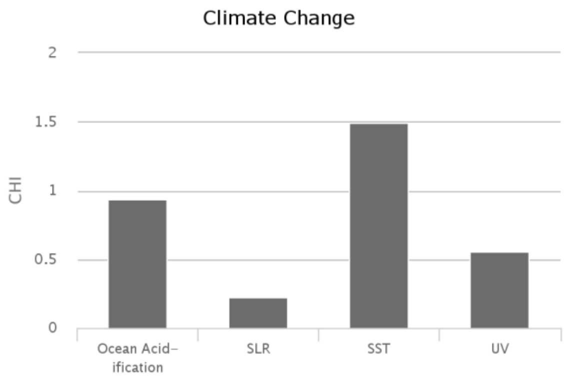


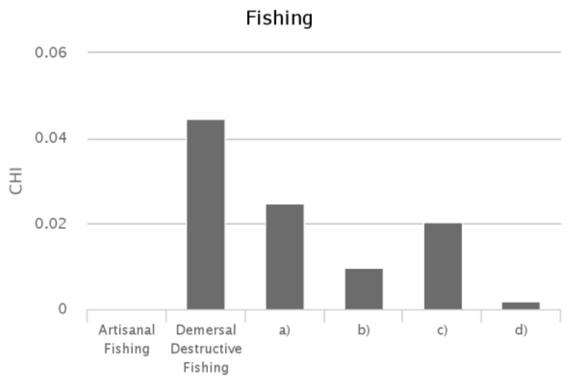
Marine Protected Area change

The Northwest Australian Shelf LME experienced an increase in MPA coverage from 0 km^2 prior to 1983 to 269,117 km^2 by 2014. This represents an increase of 50,000%, within the highest category of MPA change.

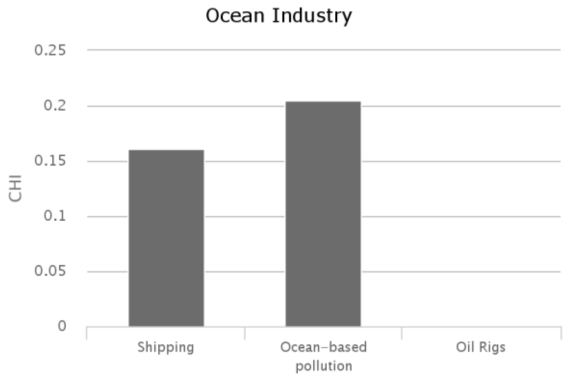
Cumulative Human Impact

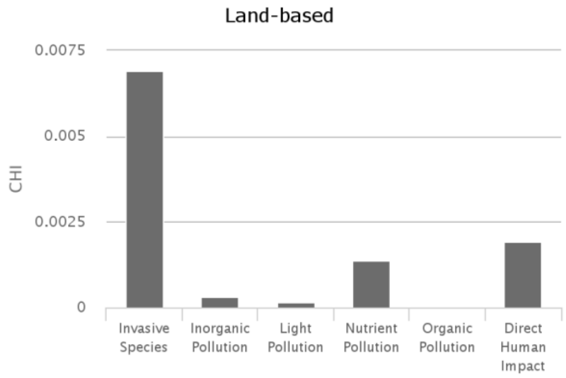
The Northwest Australian Shelf LME experiences above average overall cumulative human impact (score 3.68; maximum LME score 5.22), which is also well above the LME with the least cumulative impact. It falls in risk category 3 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, all four connected to climate change have the highest average impact on the LME: ocean acidification (0.93; maximum in other LMEs was 1.20), UV radiation (0.55; maximum in other LMEs was 0.76), sea level rise (0.23; maximum in other LMEs was 0.71), and sea surface temperature (1.49; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, ocean based pollution, pelagic high-bycatch commercial fishing, and demersal destructive and non-destructive high-bycatch commercial fishing.

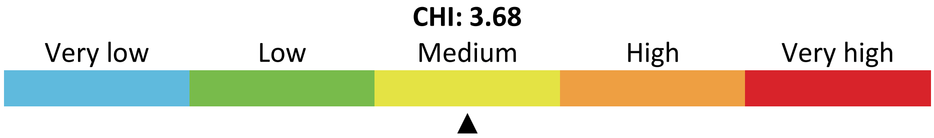




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

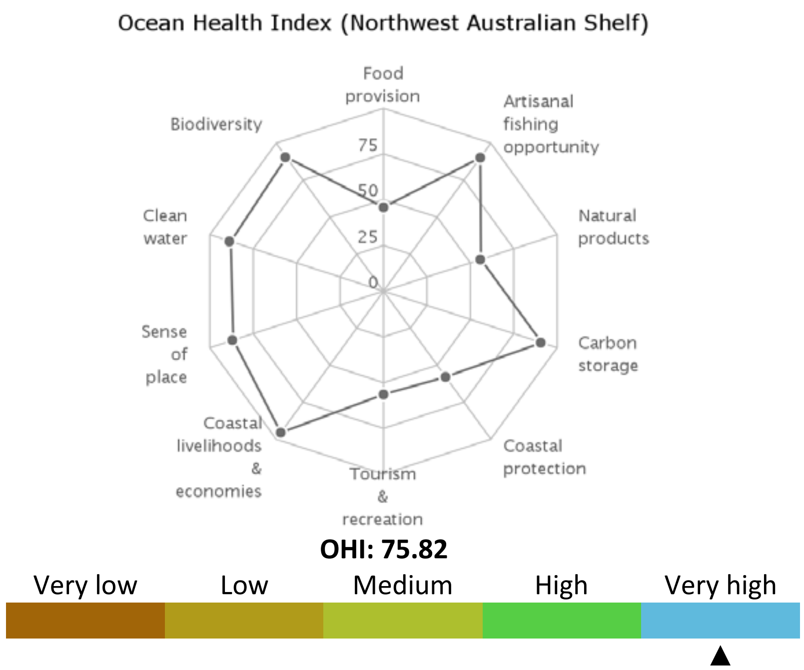






Ocean Health Index

The NorthWest Australian Shelf LME scores above average on the Ocean Health Index compared to other LMEs (score 79 out of 100; range for other LMEs was 57 to 82 but still relatively low. This score indicates that the LME is below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the scores for natural products and coastal livelihoods. This LME scores lowest on food provision and coastal protection goals and highest on artisanal fishing opportunities, carbon storage, coastal livelihoods & economies, clean water and habitat biodiversity goals. It falls in risk category 1 of the five risk categories, which is the lowest level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 213,798 km^2. A current population of 61 thousand in 2010 is projected to decrease to 13 thousand in 2100, with a density of 29 persons per 100 km^2 in 2010 decreasing to 6 per 100 km^2 by 2100. About 79% of coastal population lives in rural areas, and is projected to slightly decrease in share to 78% in 2100.

Total population		Rural population	
2010	2100	2010	2100
61,371	12,860	48,643	10,056

Legend: Very low, Low, Medium, High, Very high

Coastal poor

The indigent population makes up 14% of the LME's coastal dwellers. This LME places in the medium-risk category based on percentage and in the very low-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
8,773

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $200 million for the period 2001-2010. Fish protein accounts for 8% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$15 953 million places it in the medium-revenue category. On average, LME-based tourism income contributes 12% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with very low risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
199,870,040	8.3	15,953,310,210	11.7	0.6258 (Very low)

Legend: Very low | Low | Medium | High | Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.942, this LME has an HDI Gap of 0.058, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a medium-risk category (medium HDI) because of reduced income levels and population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9423 (Very low)	0.9820 (Very low)	0.7225 (Medium)

Legend: Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (e.g. overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the very low-risk (very low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is very low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and maintains this even under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.2228	0.1982	0.1716	0.4191

Legend:

Very low, Low, Medium, High, Very high

LME 46 – New-Zealand Shelf

Bordering country: New-Zealand.
LME Total area: 980,420 km^2

List of indicators

LME overall risk

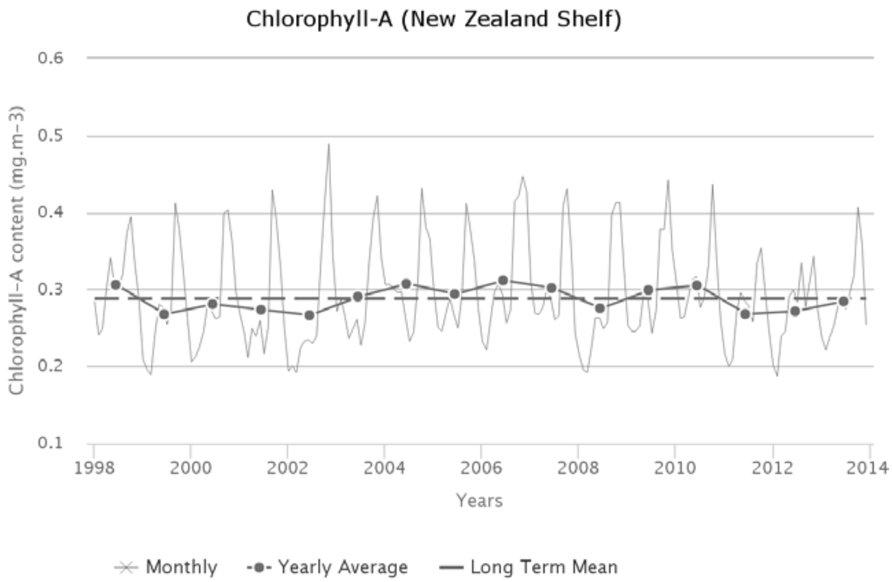
This LME falls in the cluster of LMEs that exhibit medium numbers of collapsed and overexploited fish stocks, as well as very high proportions of catch from bottom impacting gear.
Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very low.

Very low | Low | Medium | High | Very high

Productivity

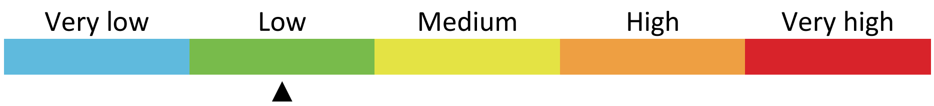
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.396 mg.m^{-3}) in October and a minimum (0.232 mg.m^{-3}) during February. The average CHL is 0.288 mg.m^{-3}. Maximum primary productivity (175 g.C.m^{-2}.y^{-1}) occurred during 1998 and minimum primary productivity (140 g.C.m^{-2}.y^{-1}) during 2012. There is a statistically insignificant decreasing trend in Chlorophyll of -5.54 % from 2003 through 2013. The average primary productivity is 155 g.C.m^{-2}.y^{-1}, which places this LME in Group 2 of 5 categories (with 1 = lowest and 5= highest).



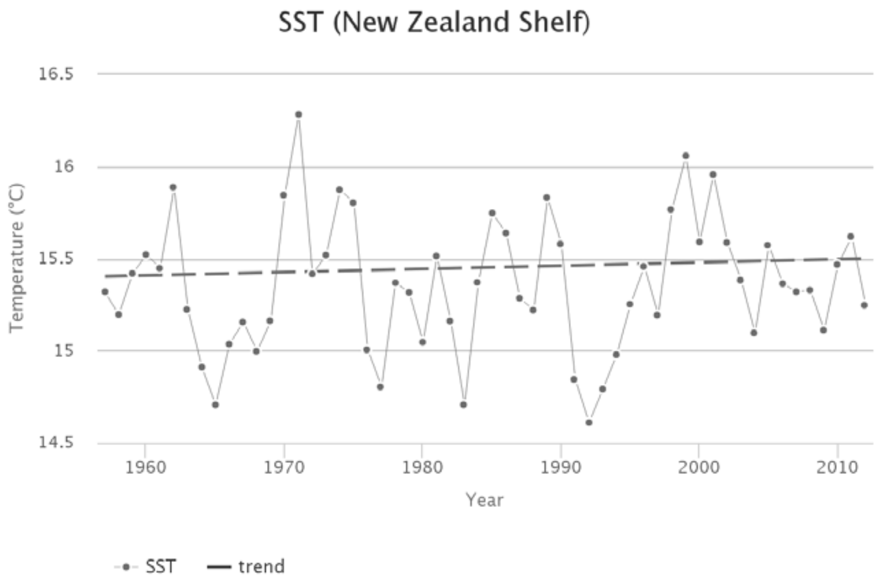
Very low | Low | Medium | High | Very high

Primary productivity



Sea Surface Temperature

From 1957 to 2012, the New Zealand Shelf LME #46 has warmed by 0.09°C, thus belonging to Category 4 (slow warming LME). The New Zealand Shelf features strong interannual variability, with a magnitude exceeding 1°C, superimposed over a slow-warming trend. Ocean currents link different parts of the New Zealand Shelf LME with different Australian LMEs. For example, the North Island is oceanographically linked to the Northeast Australian Shelf LME #40, whereas the South Island is oceanographically connected to the Southeast Australian Shelf LME #42. The 1971 all-time maximum off New Zealand occurred two years prior to the 1973 near-all-time maximum in the East-Central Australian Shelf LME #41. Therefore, these events are not oceanographically connected because the time lag is too long. Another warm peak, of 1974, occurred off New Zealand next year after the 1973 warm peak in LME #41, making ocean connection possible. The warm events of 1971-1974 were confined to these two LMEs connected by the East Australian Current and its eastward extensions, namely Tasman Front, North Cape Current Front, and East Tasman Sea Front.

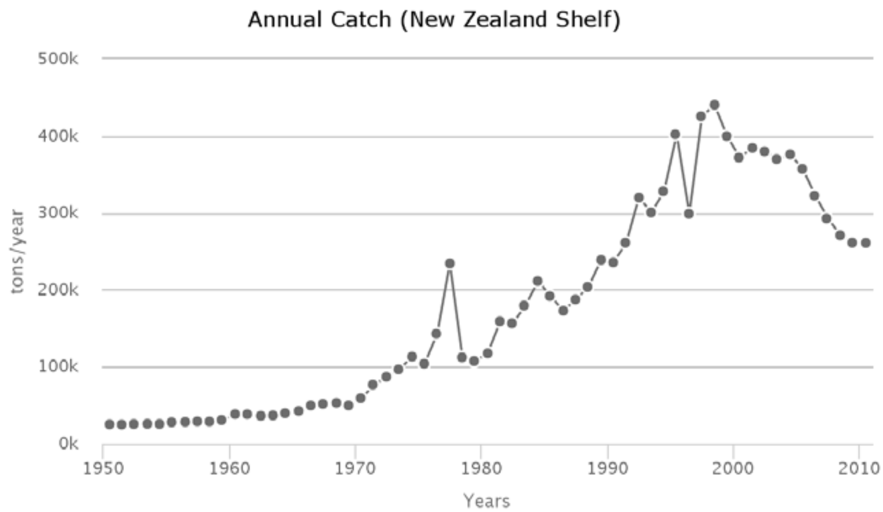


Fish and Fisheries

About 750,000 t of seafood is harvested annually by New Zealand's fisheries - 70% from deepwater and midwater fisheries, 11% pelagic, 10% farmed species, and 9% from their inshore fisheries. About 20% of the population engages in marine recreational fishing annually and expenditure made by recreational fishers to catch 5 key recreational species is nearly $1 billion NZD per year.

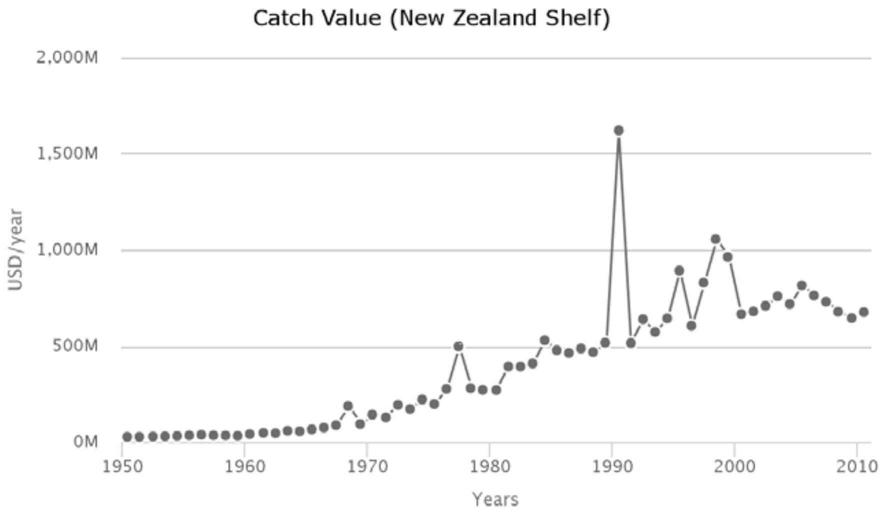
Annual Catch

Total reported landings show a sharp spike in 1977 of 230,000 t, likely associated with the declaration of the 200 nautical mile Exclusive Economic Zone around the LME by New Zealand, followed by a continuous increase through the 1980s and 1990s and a decline in the 2000s. The reported landing reached a peak at 440,000 t in 1998.



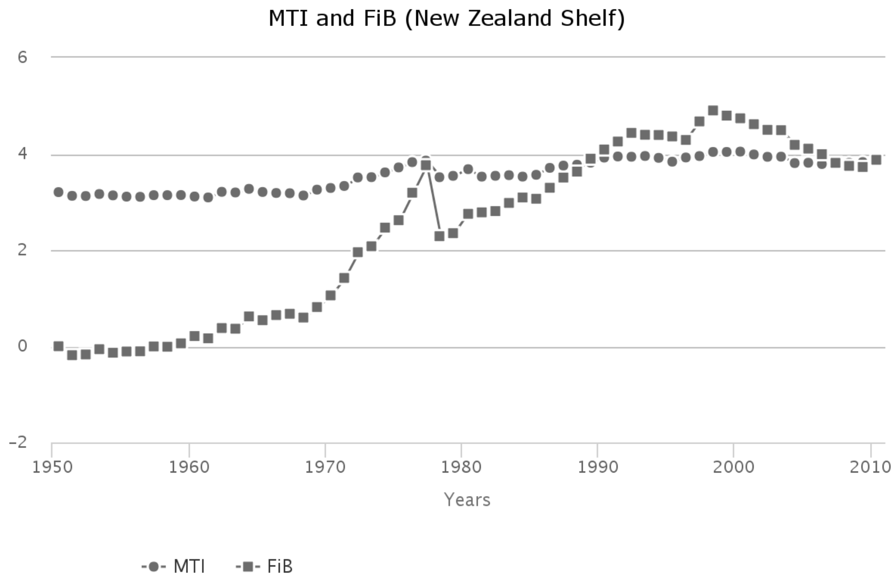
Catch value

The value of the reported landings reached 1.6 billion US$ (in 2005 real US$) in 1990, followed by a decline to between 640 million US$ and 820 million US$ in recent years.



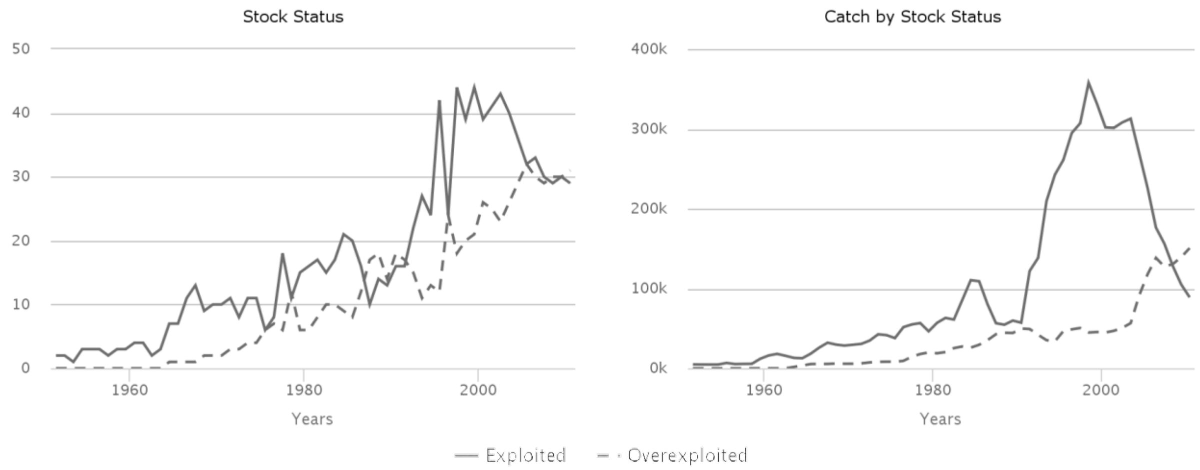
Marine Trophic Index and Fishing-in-Balance index

The MTI has been on a rise since the mid-1970, as has the FiB index, suggesting the development of previously under-utilized, high trophic-level fisheries resources by local as well as foreign fleets.



Stock status

The Stock-Catch Status Plots for the LME illustrate that more than half of the stocks in the region are currently either overexploited or have collapsed. And the majority of the reported landings (over 60%) are supplied by stocks classified as "overexploited".



Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch fluctuated between 4 and 8% from 1950 to 2010. This percentage fluctuated around 6% in the recent decade.

Fishing effort

The total effective effort continuously increased from around 1 million kW in the 1950s to its peak around 46 million kW in 2005.

Primary Production Required

The primary production required (PPR) to sustain the reported landings is currently below 4% with New Zealand accounting for the great majority of the ecological footprint in the LME.

Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

The Nitrogen Load risk level for contemporary (2000) conditions was moderate (level 3 of the five risk categories, where 1 = lowest risk; 5 = highest risk). Based on a "current trends" scenario (Global Orchestration), this remained the same in 2030 and 2050.

Nutrient ratio

The Nutrient Ratio (ICEP) risk level for contemporary (2000) conditions was very low (1). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

Merged nutrient indicator

The risk level for the Merged Nutrient Indicator for contemporary (2000) conditions was moderate (3). According to the Global Orchestration scenario, this remained the same in 2030 and 2050.

2000			2030			2050		
Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator	Nitrogen load	Nutrient ratio	Merged nutrient indicator
3	1	3	3	1	3	3	1	3

Legend: Very low, Low, Medium, High, Very high

POPs

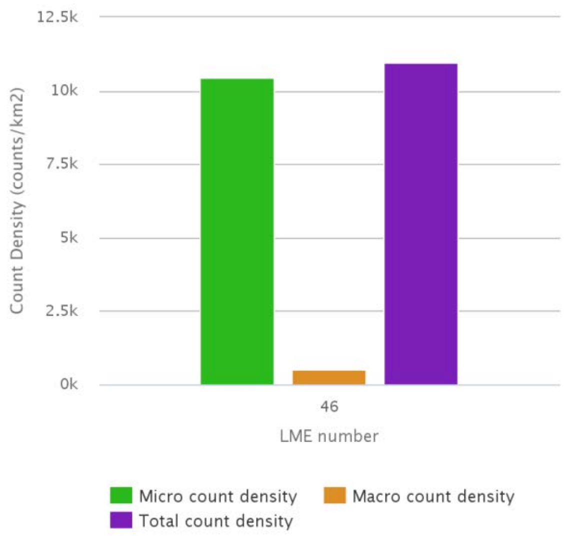
The New Zealand Shelf LME has 4 samples from 4 locations. They show low, moderate, and high average concentrations (ng.g-1 of pellets) of PCBs (16, range 0.3-65), DDTs (20.8, range 3-42), and HCHs (15.6, range 0.4-28.9), corresponding to categories 2, 3, and 4, respectively, of the five risk categories (1 = lowest risk; 5 = highest risk). The highest concentration of PCBs (65 ng.g-1) was recorded in a sample from the city of Auckland. This can be explained by legacy pollution. Extremely high concentrations of HCHs, corresponding to risk category 4 and 5 were detected in this LME. The collection was made in 2012 and 2013, after the onset of regulation by the Stockholm Convention. Illegal usage is suspected. Source identification of HCHs is necessary. Moderate concentrations of DDTs were observed in this LME, and could be attributed to agricultural application. However, dominance of DDT over the degradation products was not observed for the locations with higher DDT concentrations, suggesting past inputs of DDTs.

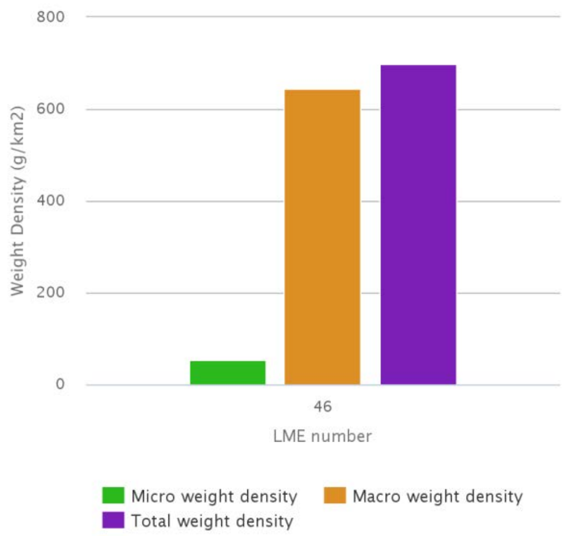
	PCBs		DDTs		HCHs	
Locations	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk	Avg. (ng/g)	Risk
4	16	**2**	21	**3**	15.6	**4**

Legend: Very low, Low, Medium, High, Very high

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with relatively high levels of plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The high values are due to the relative importance of these sources in this LME. The abundance of floating plastic in this category is estimated to be on average over 100 times higher that those LMEs with lowest values. There is limited evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

0.03% of this LME is covered by mangroves (US Geological Survey, 2011).

Reefs at risk

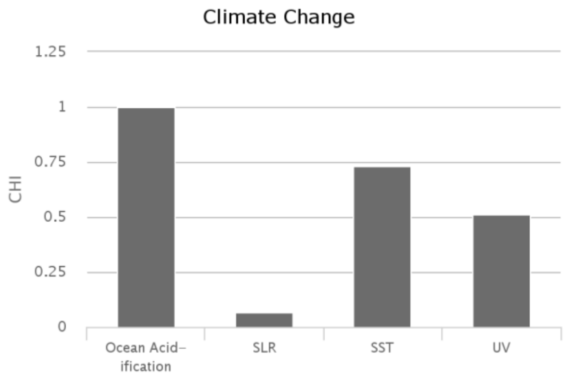
Not applicable.

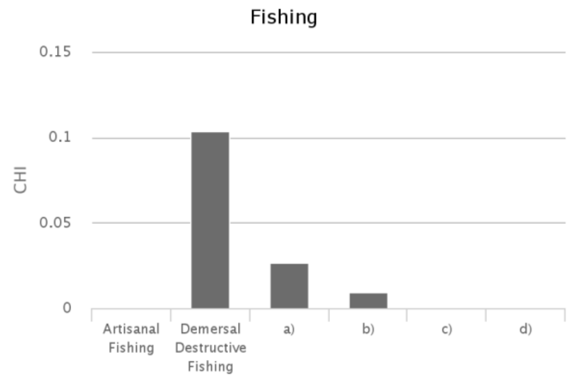
Marine Protected Area change

The New Zealand Shelf LME experienced an increase in MPA coverage from 1,674 km^2 prior to 1983 to 50,036 km^2 by 2014. This represents an increase of 2,890%, within the medium category of MPA change.

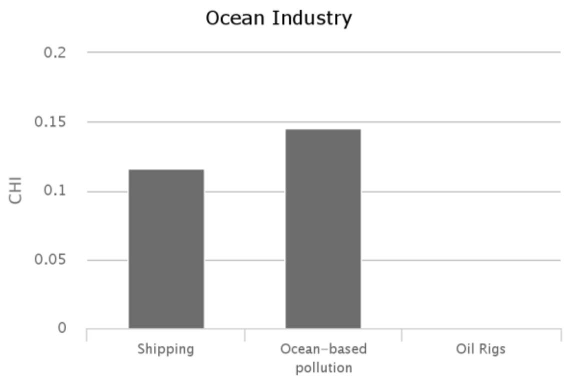
Cumulative Human Impact

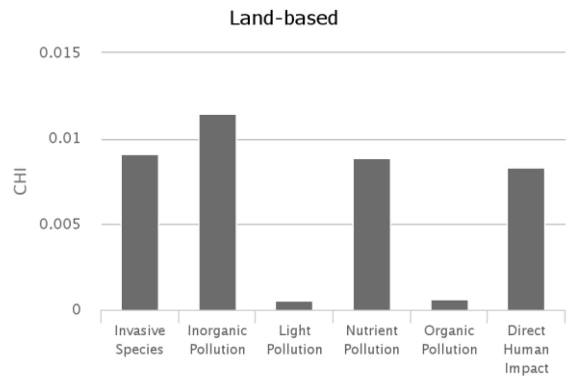
The New Zealand Shelf LME experiences below average overall cumulative human impact (score 2.75; maximum LME score 5.22), but which is still well above the LME with the least cumulative impact. It falls in risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (1.00; maximum in other LMEs was 1.20), UV radiation (0.51; maximum in other LMEs was 0.76), and sea surface temperature (0.73; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, sea level rise, ocean based pollution, and demersal destructive and demersal non-destructive high-bycatch commercial fishing.

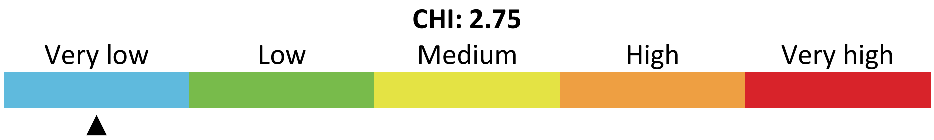




a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing

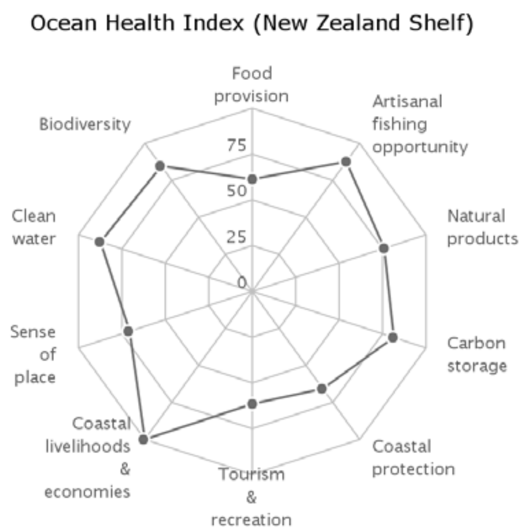






Ocean Health Index

The New Zealand Shelf LME has one of the highest scores on the Ocean Health Index compared to other LMEs (score 81 out of 100; range for other LMEs was 57 to 82), but still relatively low. This score indicates that the LME is below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 decreased 1 point compared to the previous year, due in large part to changes in the scores for clean waters and lasting special places. This LME scores lowest on fisheries and iconic species goals and highest on mariculture, artisanal fishing opportunities, natural products and coastal livelihoods & economies goals. It falls in risk category 1 of the five risk categories, which is the lowest level of risk (1 = lowest risk; 5 = highest risk).



OHI: 77.61

Very low	Low	Medium	High	Very high
				▲

Socio-economics

Indicators of demographic trends, economic dependence on ecosystem services, human wellbeing and vulnerability to present-day extreme climate events and projected sea level rise, are assessed for this LME. To compare and rank LMEs, they were classified into five categories of risk (from 1 to 5, corresponding to lowest, low, medium, high and highest risk, respectively) based on the values of the individual indicators. In the case of economic revenues, the LMEs were grouped to 5 classes of revenues from lowest, low, medium, high and highest, as revenues did not translate to risk.

Population

The coastal area stretches over 255,265 km^2. A current population of 4 276 thousand in 2010 is projected to increase to 5 722 thousand in 2100, with a density of 17 persons per km^2 in 2010 increasing to 22 per km^2 by 2100. About 20% of coastal population lives in rural areas, and is projected to slightly decrease in share to 29% in 2100.

Total population		Rural population	
2010	**2100**	**2010**	**2100**
4,276,380	5,721,885	846,540	1,641,487

Legend: Very low | Low | Medium | High | Very high

Coastal poor

The indigent population makes up 11% of the LME's coastal dwellers. This LME places in the very low-risk category based on percentage and in the medium-risk category using absolute number of coastal poor (present day estimate).

Coastal poor
466,456

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the high-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $853 million for the period 2001-2010. Fish protein accounts for 11% of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for 2004-2013 of US 2013

$24 640 million places it in the medium-revenue category. On average, LME-based tourism income contributes 16% to the national GDPs of the LME coastal states. Spatial distribution of economic activity (e.g. spatial wealth distribution) measured by night-light and population distribution as coarse proxies can range from 0.0000 (totally equal distribution and lowest risk) to 1.0000 (concentrated in 1 place and most inequitable and highest risk). The Night Light Development Index (NLDI) thus indicates the level of spatial economic development, and that for this LME falls in the category with medium risk.

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
852,738,287	10.6	24,639,700,000	16.3	0.7779

Legend:

Very low | Low | Medium | High | Very high

Human Development Index

Using the Human Development Index (HDI) that integrates measures of health, education and income, the present-day LME HDI belongs to the very high HDI and very low-risk category. Based on an HDI of 0.921, this LME has an HDI Gap of 0.079, the difference between present and highest possible HDI (1.000). The HDI Gap measures an overall vulnerability to external events such as disease or extreme climate related events, due to less than perfect health, education, and income levels, and is independent of the harshness of and exposure to specific external shocks.

HDI values are projected to the year 2100 in the contexts of shared socioeconomic development pathways (SSPs). This LME is projected to assume a place in the very low risk category (very high HDI) in 2100 under a sustainable development pathway. Under a fragmented world scenario, the LME is estimated to place in a high-risk category (low HDI) because of reduced income levels and increasing population values from those in a sustainable development pathway.

	HDI 2100	
HDI	SSP1	SSP3
0.9205	0.9713	0.6855

Legend:

Very low | Low | Medium | High | Very high

Climate-Related Threat Indices

The Climate-Related Threat Indices utilize the HDI Gaps for present-day and projected 2100 scenarios. The contemporary climate index accounts for deaths and property losses due to storms, flooding and extreme temperatures incurred by coastal states during a 20-year period from 1994 to 2013 as hazard measures, the 2010 coastal population as proxy for exposure, and the present day HDI Gap as vulnerability measure.

The Contemporary Threat Index incorporates a Dependence Factor based on the fish protein contribution to dietary animal protein, and on the mean contribution of LME tourism to the national GDPs of LME coastal states. The HDI Gap and the degree of dependence on LME ecosystem services define the vulnerability of a coastal population. It also includes the average of risk related to extreme climate events, and the risk based on the degrading system states of an LME (*e.g.* overexploited fisheries, pollution levels, decrease in coastal ecosystem areas).

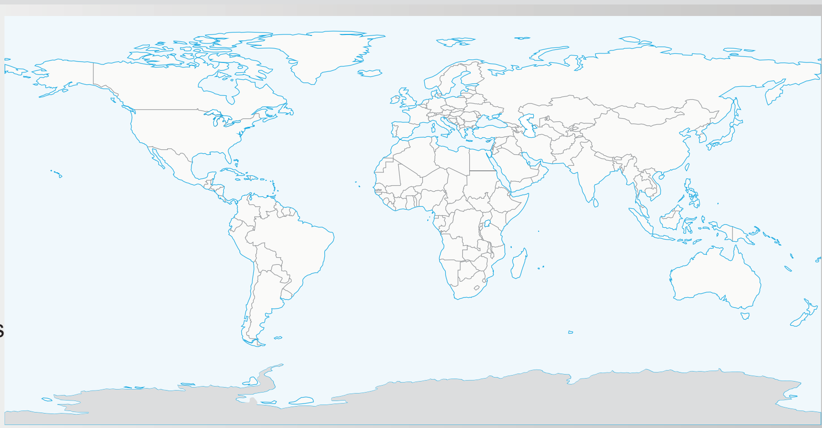
The 2100 sea level rise threat indices, each computed for the sustainable world and fragmented world development pathways, use the maximum projected sea level rise at the highest level of warming of 8.5 W/m^2 in 2100 as hazard measure, development pathway-specific 2100 populations in the 10 m × 10 km coast as exposure metrics, and development pathway-specific 2100 HDI Gaps as vulnerability estimates.

Present day climate threat index of this LME is within the very low-risk (very low threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is low. In a sustainable development scenario, the risk index from sea level rise in 2100 is very low, and increases to low under a fragmented world development pathway.

2010		2100	
Climate Threat	**Contemporary Threat**	**SSP1**	**SSP3**
0.1292	0.2417	0.2384	0.5177

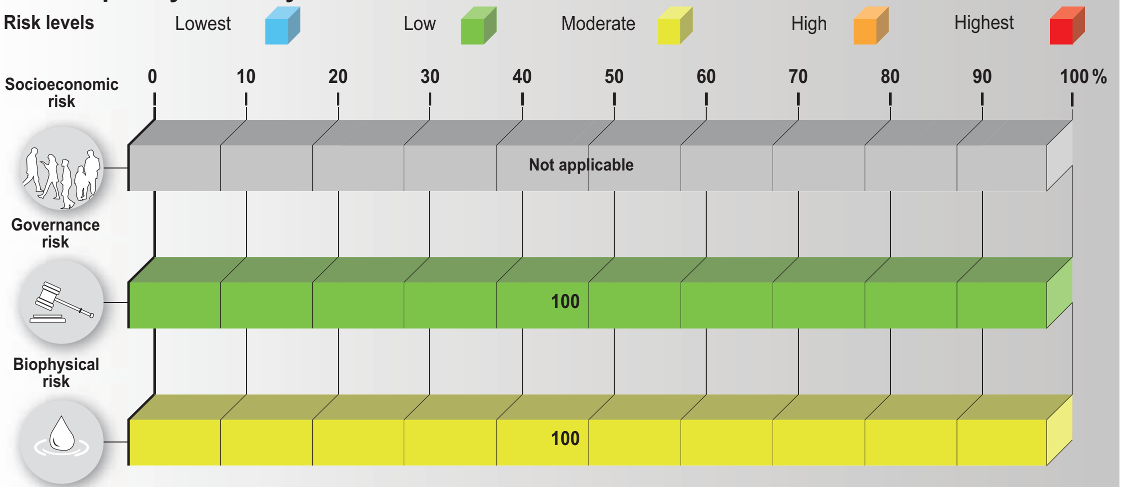
Legend: Very low, Low, Medium, High, Very high

TRANSBOUNDARY WATERS: ANTARCTICA

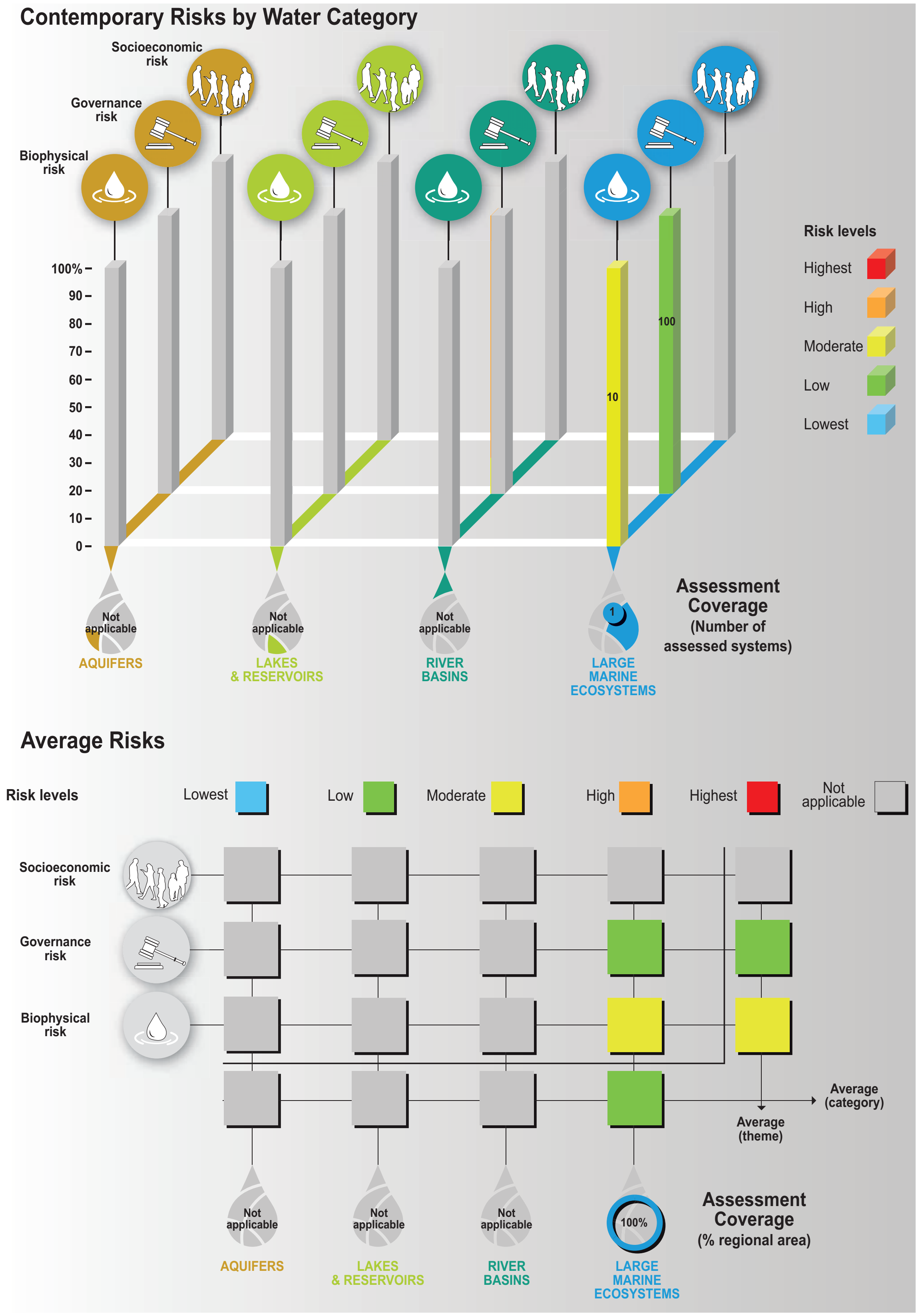


The Antarctic continent is not inhabited by resident citizens so that conventional country-based socioeconomic indicators are not applicable for assessing socioeconomic activities that take place on land and in surrounding waters. For the period 2001-2010, Antarctic LME average annual fish catch is estimated at 12 000 tons, worth 2013 US$ 2.4 million per year. Average annual tourism revenues for the period 2004-2013 are estimated to reach 2013 US$ 1229 million. The Antarctic LME is subject to low governance risk and moderate biophysical risk.

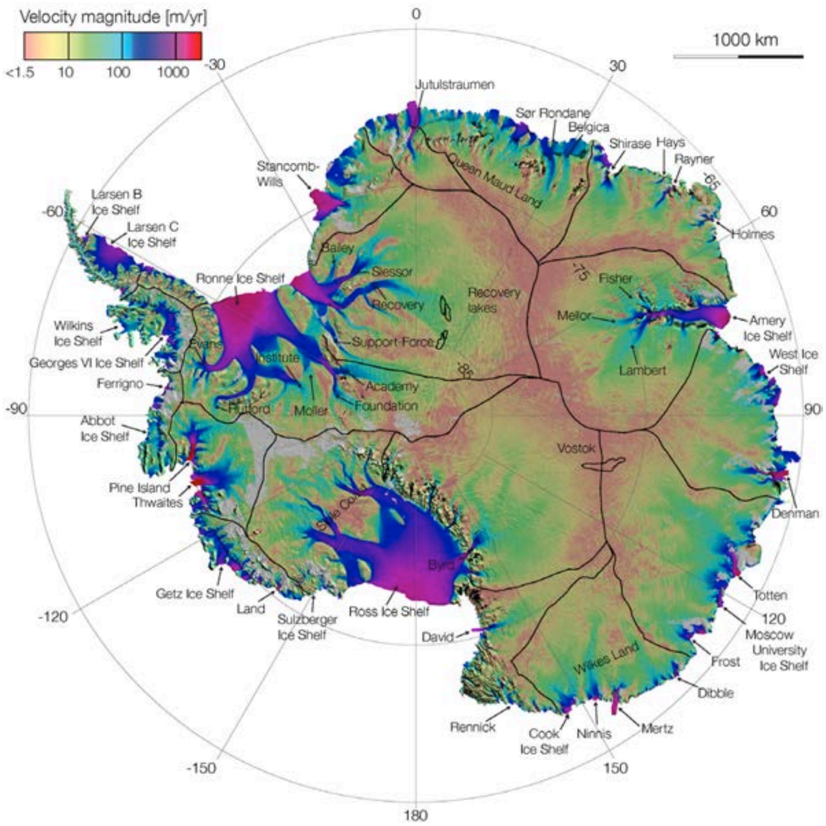
Contemporary Risks by Theme



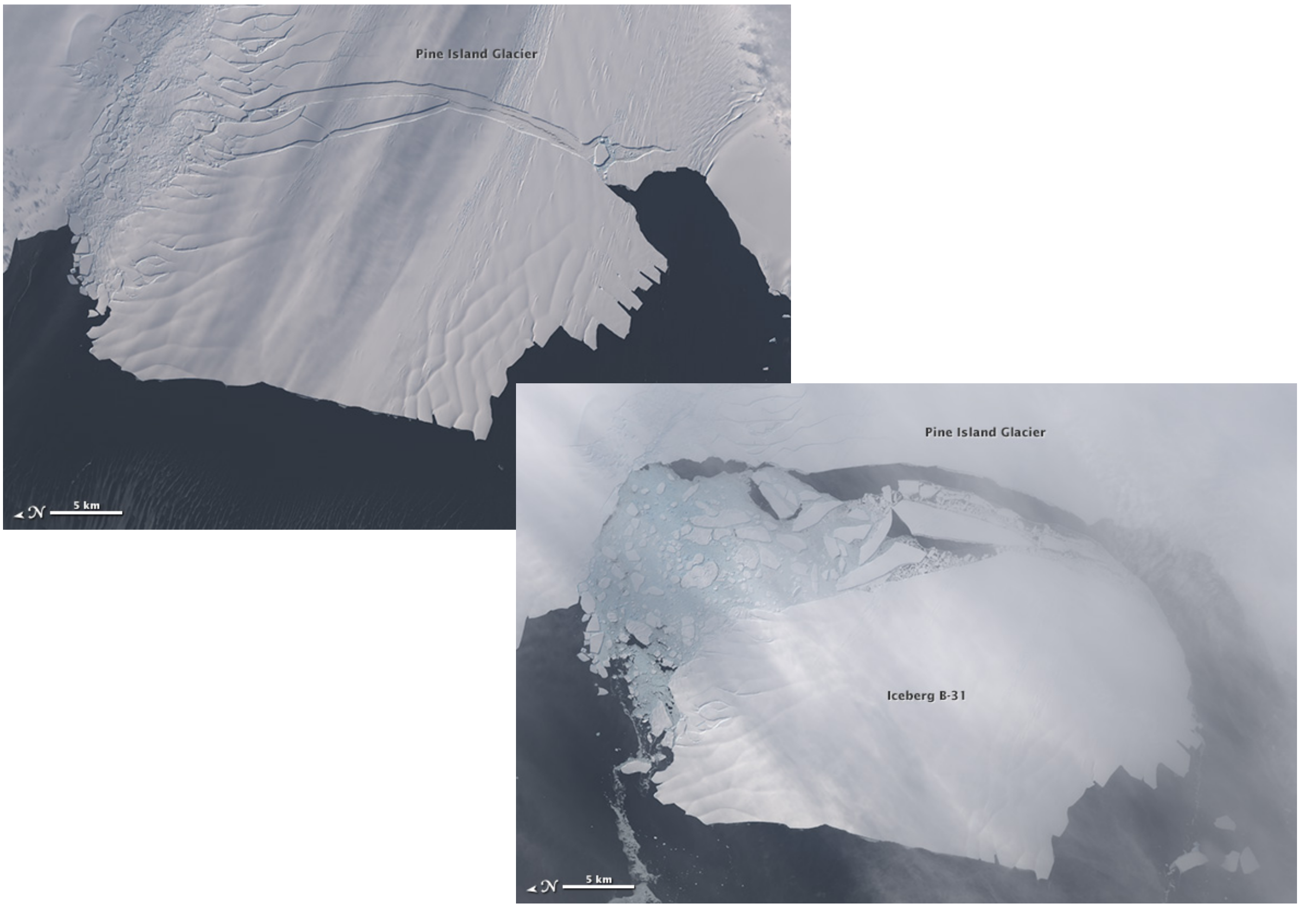
Regional Risks by Water Category



LME 61 - Antarctica

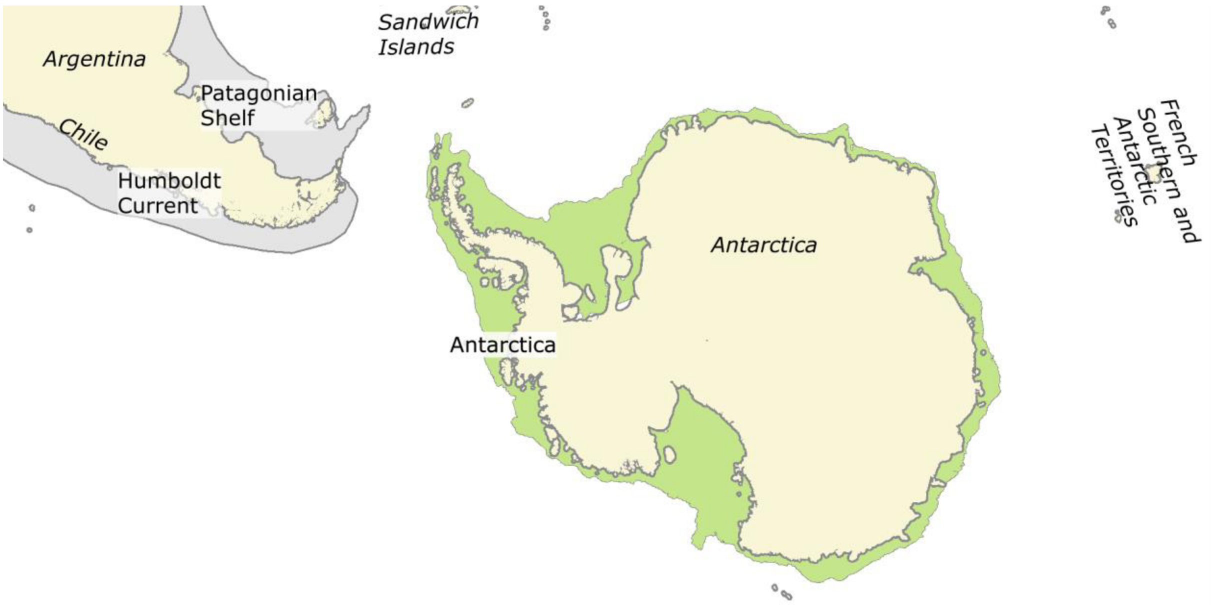


Velocity of Antarctic ice movement (image by Eric Rignot, NASA Jet Propulsion Laboratory and University of California Irvine).



Iceberg B-31 (about the size of Singapore) broke off from Pine Island Glacier between November 9-11, 2013 (NASA Earth Observatory images by Holli Riebeek using Landsat 8 data from the USGS Earth Explorer).

LME 61 – Antarctica



Bordering country: Antarctica
LME Total area: 3,486,169 km^2

List of indicators

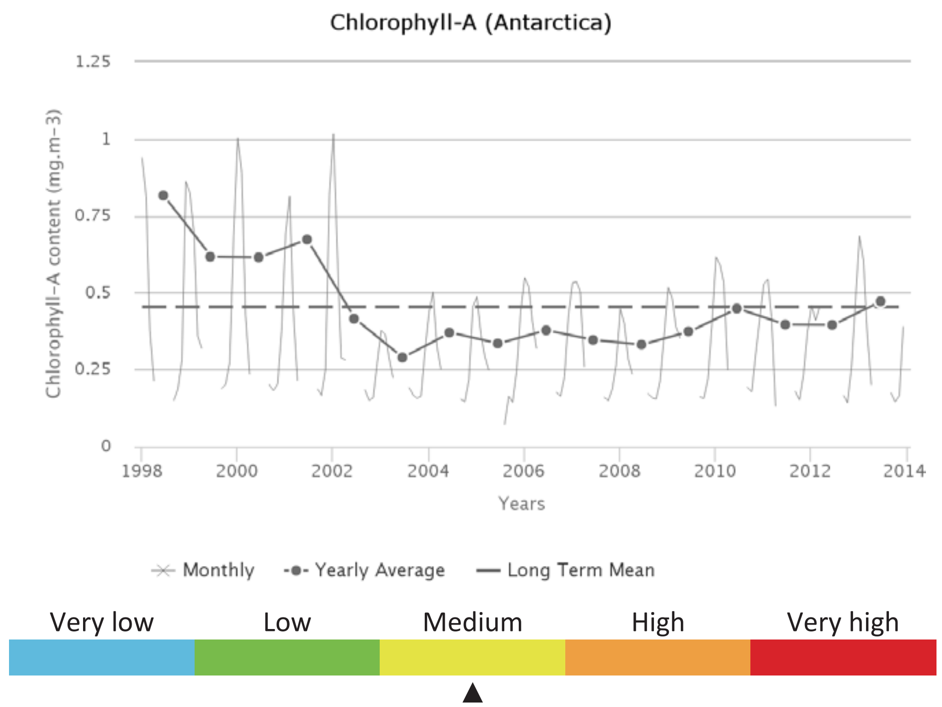
LME overall risk

This LME falls in the cluster of LMEs that exhibit high percentages of rural coastal population, high numbers of collapsed and overexploited fish stocks, as well as high proportions of catch from bottom impacting gear.
Because this LME does not have resident citizens, it has no Human Development Index and no risk score.

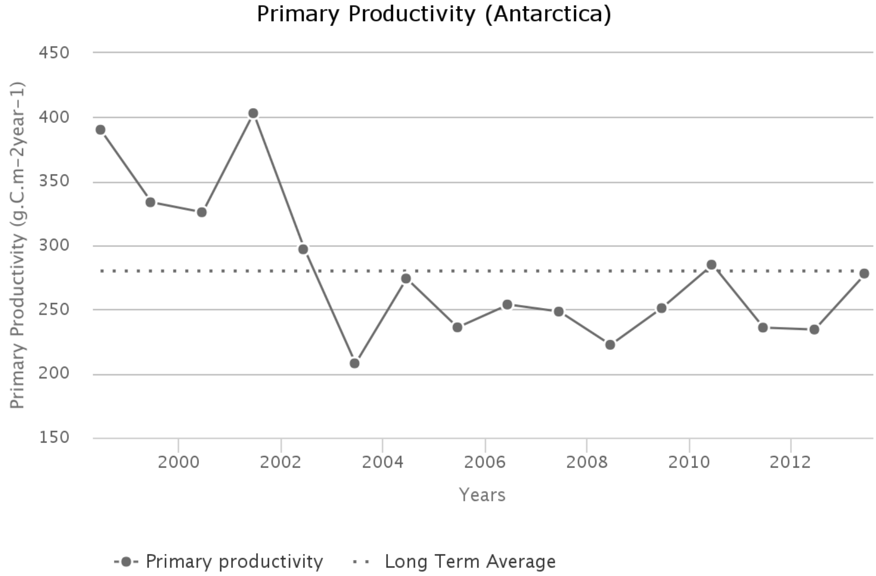
Productivity

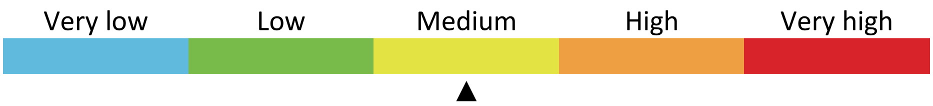
Chlorophyll-A

The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.543 mg.m^{-3}) in February and a minimum (0.145 mg.m^{-3}) during October. The average CHL is 0.454 mg.m^{-3}. Maximum primary productivity (403 g.C.m^{-2}.y^{-1}) occurred during 2001 and minimum primary productivity (208 g.C.m^{-2}.y^{-1}) during 2003. There is a increasing trend in Chlorophyll of 17.8 % from 2003 through 2013. The average primary productivity is 280 g.C.m^{-2}.y^{-1}, which places this LME in Group 3 of 5 categories (with 1 = lowest and 5= highest).



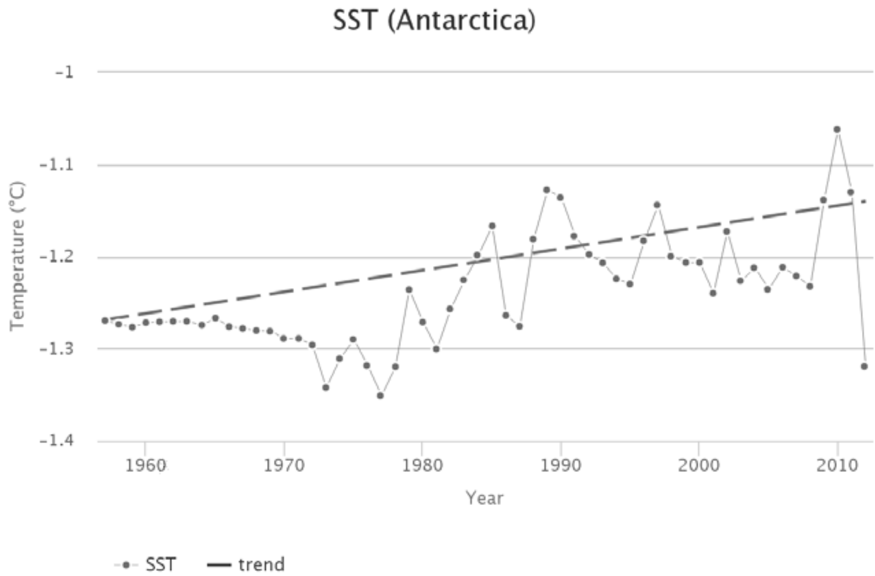
Primary productivity





Sea Surface Temperature

From 1957 to 2012, the Antarctica LME #61 has warmed by 0.12°C, thus belonging to Category 4 (slow warming LME). The long-term stability of the Antarctic Zone is striking. It can be explained by the insulating effects of the Antarctic Circumpolar Currents and winds that blow around the Antarctica. The currents and winds can insulate the Antarctica from relatively rapid changes elsewhere. Yet this stability may be just an appearance, not reality, because of the perennial sea ice cover in the near-coastal zone where the Antarctic LME is largely located. The thermal history of this LME was not detailed in the previous analysis (Belkin, 2009) since the near-coastal zone is covered by drifting sea ice, landfast ice, and icebergs almost year round; therefore SST data here are deemed severely contaminated by the presence of ice. The extremely rapid cooling since 2010 might have resulted from the concomitant increase of the Antarctic sea ice cover extent and concentration.

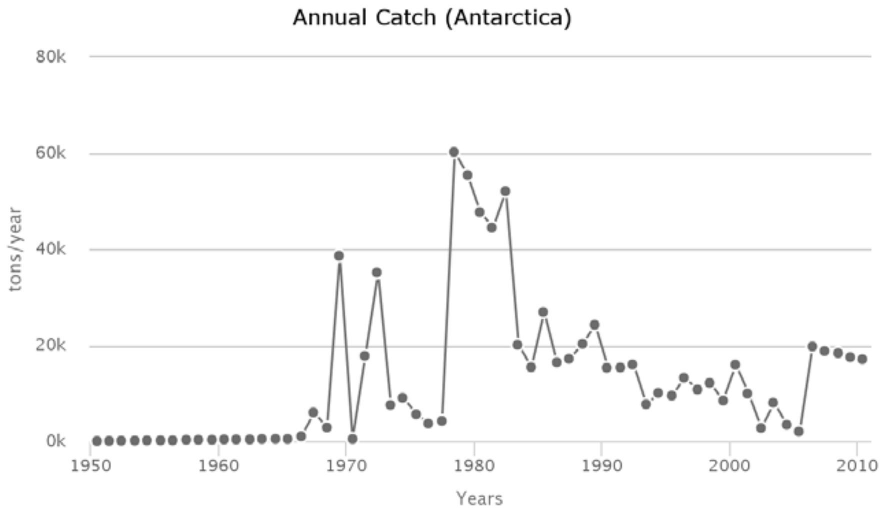


Fish and Fisheries

Major interest in the Antarctic's marine living resources developed after the 1959 Antarctic Treaty. Species caught include krill (*Euphausia superba*), which has dominated the reported landings since early 1980s, rockcod (*Notothenia rossii*, *Lepidonotothen squamifrons*), icefish (*Champsocephalus gunnari*, *Chaenodraco wilsoni*) and toothfish (*Dissostichus mawsoni*). The catch data from this LME are too crude for ecosystem indicators such as PPR, MTI or FiB index to be computed.

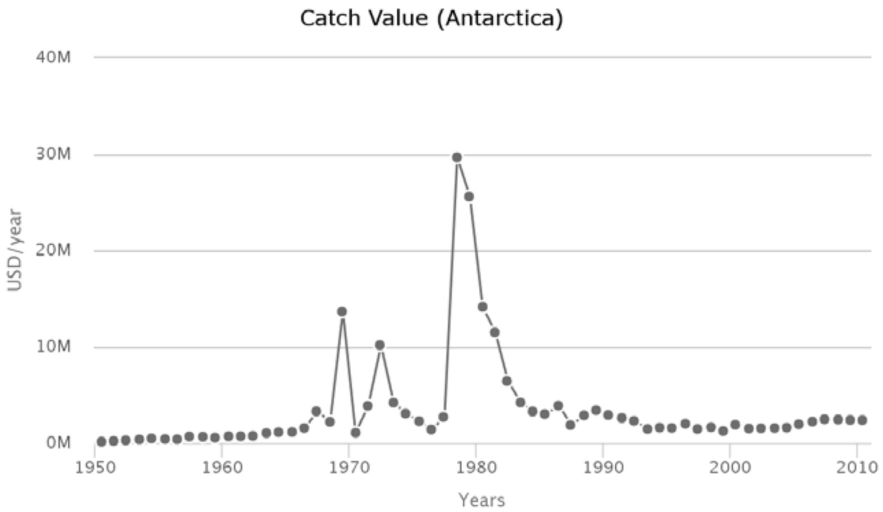
Annual Catch

There have been major fluctuations in the reported landings in this LME, with a major peak at 60,000 t in 1978. When the Soviet Union was dissolved in 1991, its components republics drastically reduced their fishing activities in the Antarctic. Nevertheless, the decreasing total landings in recent years can be attributed to stock depletions.



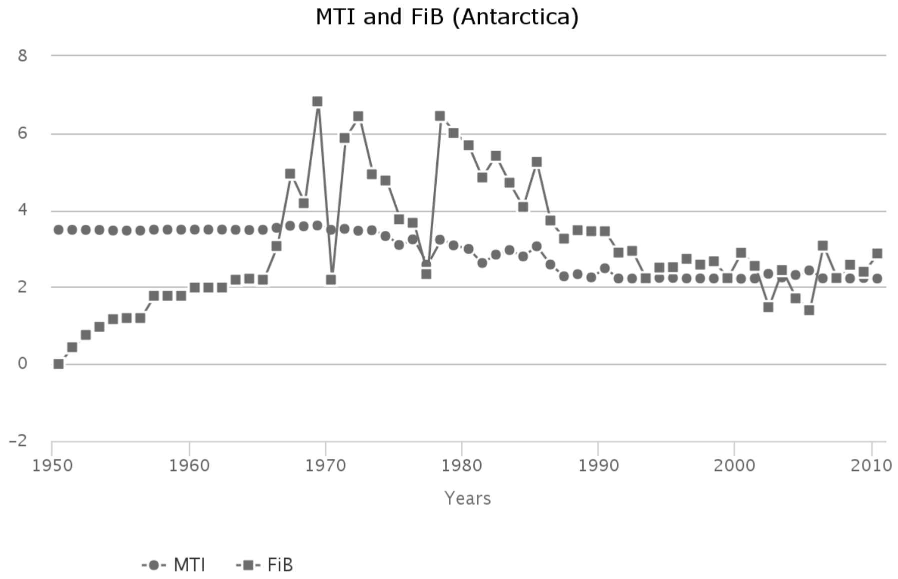
Catch value

The trend in the value of the reported landings closely mirrors the landings, with a major peak of about 30 million US$ (in 2005 real US$) in 1978. However, given the large amounts of unreported catch from this LME, these estimates express only a small fraction of the value of Antarctic fisheries.

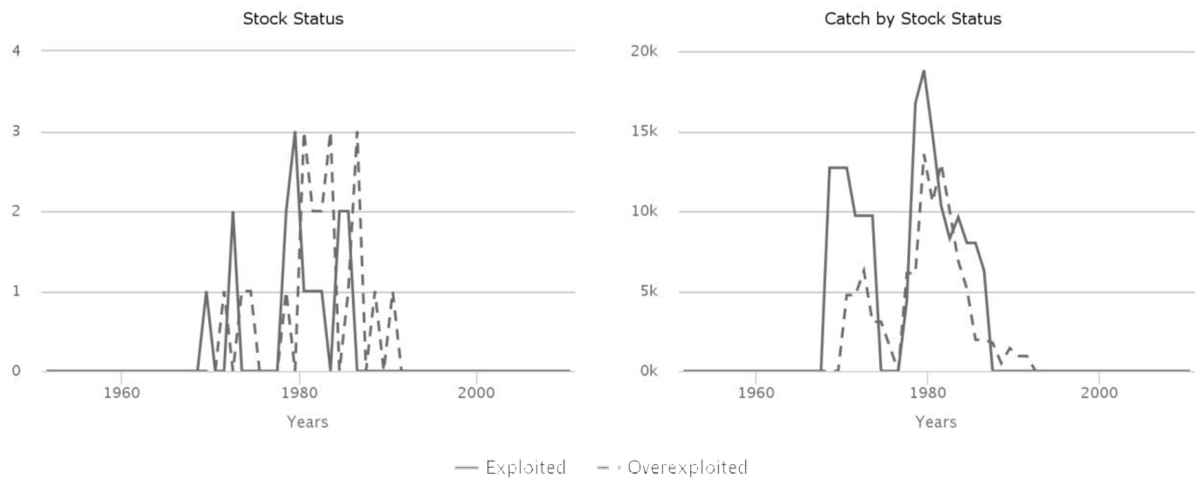


Marine Trophic Index and Fishing-in-Balance index

Although based on partial catches the MTI shows a rapid and strong decline in the 1970s and 1980s, reflecting the transition in landings from fish (mainly rockcod) to krill, while the FiB index remains stable, suggesting that no geographic extension took place since the early 1970s.

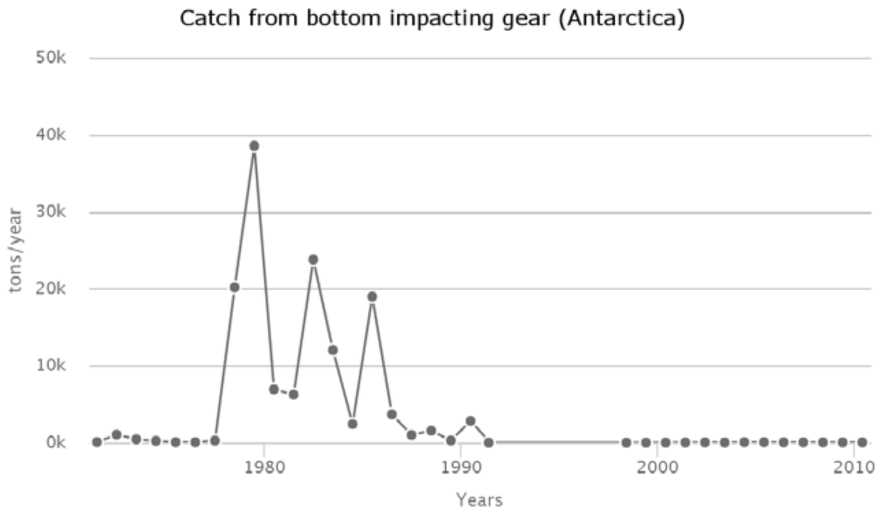


Stock status



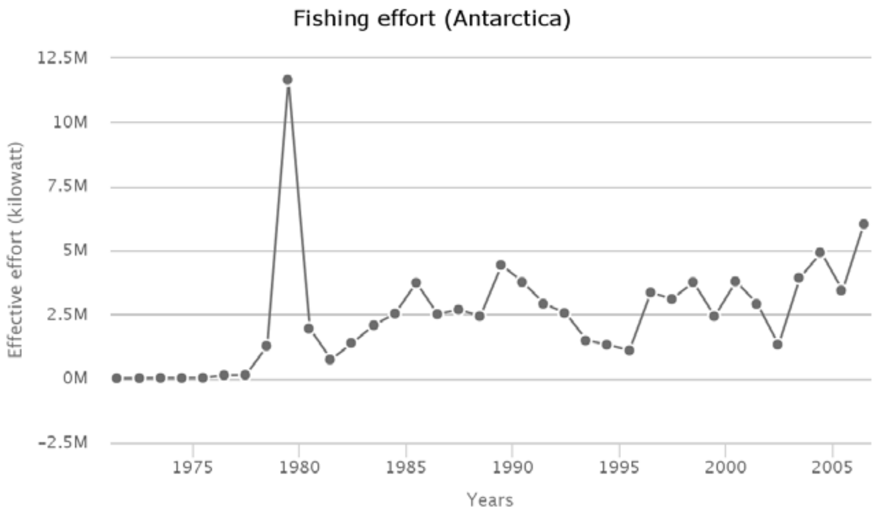
Catch from bottom impacting gear

The percentage of catch from the bottom gear type to the total catch reached its peaks at 70% in 1957 and 1963, respectively. Then, the percentage fluctuated around 1% in recent decade.



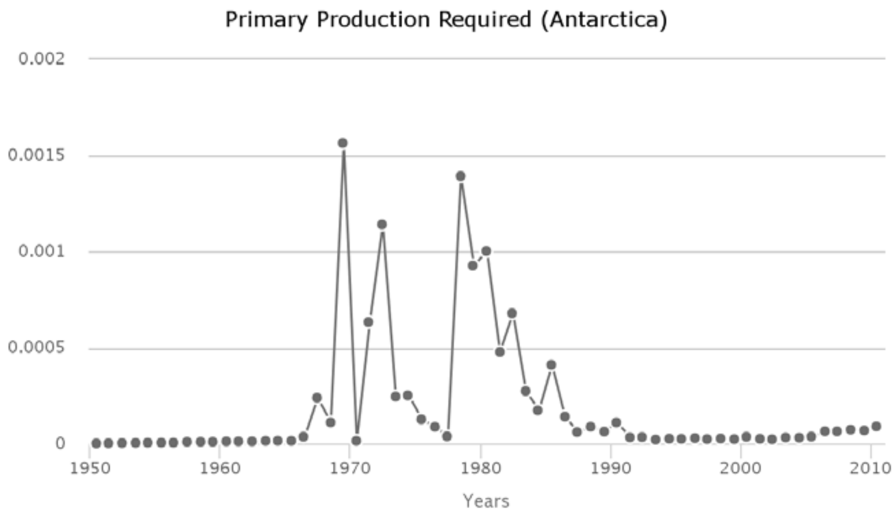
Fishing effort

The total effective effort reached its peak at 12 million in 1979 and then fluctuated around 4 million in the recent few years.



Primary Production Required

Primary production data in a format suitable for estimating the primary production required (PPR) to sustain the reported landings are not available for this LME.



Pollution and Ecosystem Health

Pollution

Nutrient ratio, Nitrogen load and Merged Indicator

Human activities in watersheds are affecting nutrients transported by rivers into LMEs. Large amounts of nutrients (in particular *nitrogen load*) entering coastal waters of LMEs can result in high biomass algal blooms, leading to hypoxic or anoxic conditions, increased turbidity and changes in community composition, among other effects. In addition, changes in the *ratio of nutrients* entering LMEs can result in dominance by algal species that have deleterious effects (toxic, clog gills of shellfish, etc.) on ecosystems and humans.

An overall nutrient indicator (*Merged Nutrient Indicator*) based on 2 sub-indicators: *Nitrogen Load* and *Nutrient Ratio* (ratio of dissolved Silica to Nitrogen or Phosphorus - the Index of Coastal Eutrophication Potential or ICEP) was calculated.

Nitrogen load

No data for this LME.

Nutrient ratio

No data for this LME.

Merged nutrient indicator

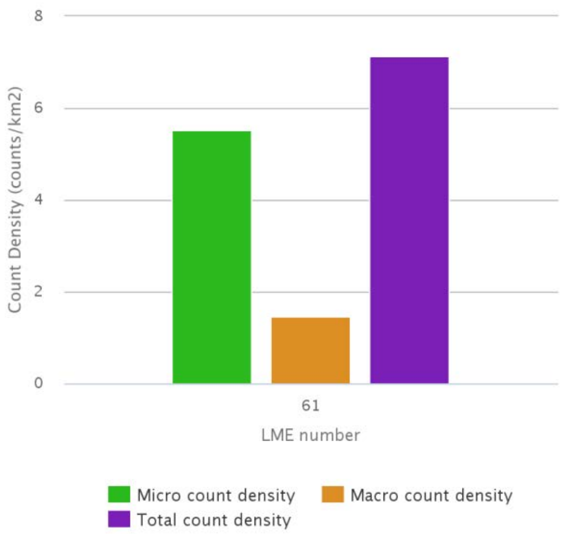
No data for this LME.

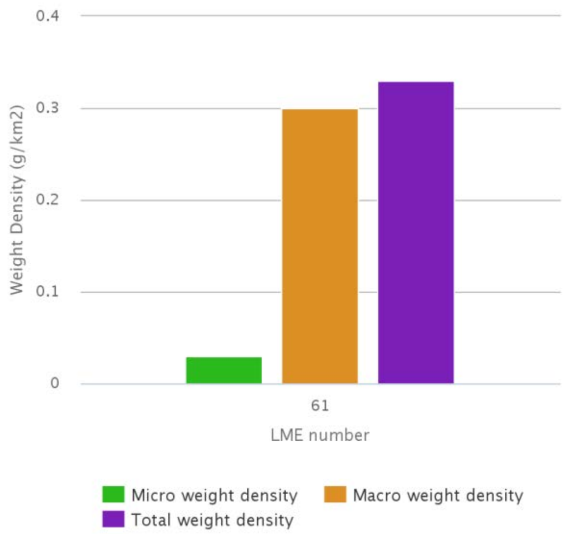
POPs

No pellet samples were obtained from this LME.

Plastic debris

Modelled estimates of floating plastic abundance (items km^{-2}), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the lowest plastic concentration. Estimates are based on three proxy sources of litter: shipping density, coastal population density and the level of urbanisation within major watersheds, with enhanced run-off. The low values are due to the remoteness of this LME from significant sources of plastic. The abundance of floating plastic in this category is estimated to be over 400 times lower than those LMEs with the highest values. There is evidence from sea-based direct observations and towed nets to support this conclusion.





Ecosystem Health

Mangrove and coral cover

Not applicable.

Reefs at risk

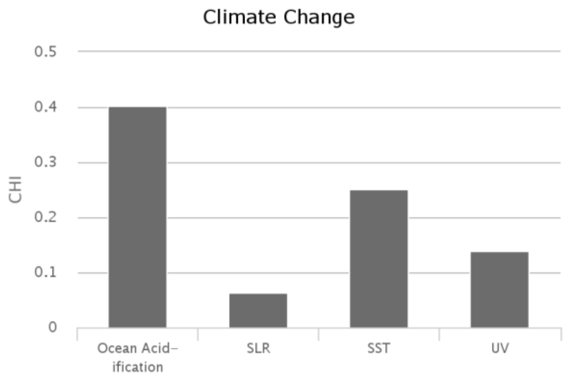
Not applicable.

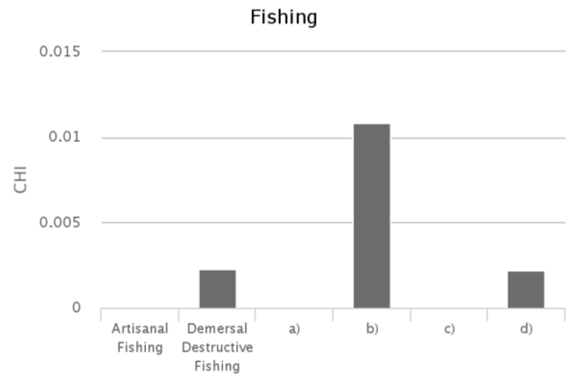
Marine Protected Area change

Not applicable.

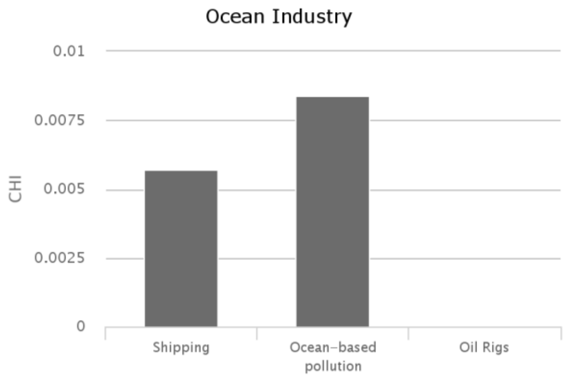
Cumulative Human Impact

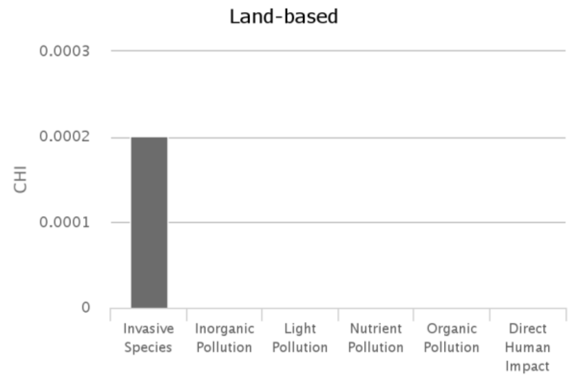
The Antarctica LME experiences one of the lowest overall cumulative human impact (score 0.88; maximum LME score 5.22). It falls in risk category 1 of the five risk categories (1 = lowest risk; 5 = highest risk). This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification (0.40; maximum in other LMEs was 1.20), UV radiation (0.14; maximum in other LMEs was 0.76), and sea surface temperature (0.25; maximum in other LMEs was 2.16). No other stressors had any significant impact in this LME.



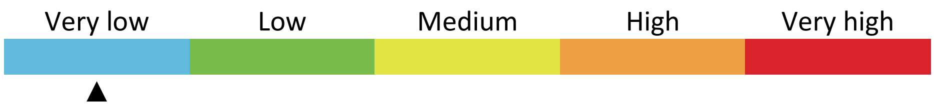


a) Demersal Non-destructive High Bycatch Fishing
c) Pelagic High Bycatch Fishing
b) Demersal Non-destructive Low Bycatch Fishing
d) Pelagic Low Bycatch Fishing



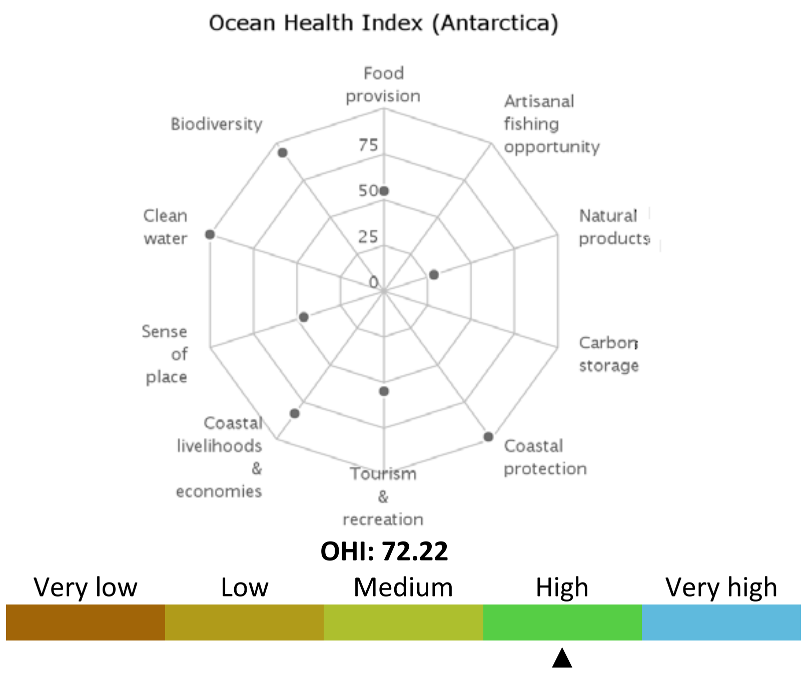


CHI: 0.88



Ocean Health Index

The Antarctica LME scores [relatively level] on the Ocean Health Index (score XX out of 100; range for other LMEs was 57 to 82). This score indicates that the LME is [far from] its optimal level of ocean health, although [there are some aspects that are doing well/there are still areas that need improvement]. Its score in 2013 [improved/decreased] compared to the previous year, due in large part to changes in the scores for [GOALS]. This LME scores lowest on [LIST GOALS] goals and highest on [LIST GOALS] goals. It falls in risk category X of the five risk categories, which is a [level] level of risk (1 = lowest risk; 5 = highest risk).



Socio-economics

This LME has no resident population so population-related indicators are not evaluated. However, nearby countries and distant fishing nations utilize this LME for fishing and tourism, the revenues for which are reported here.

Population

Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the very low-revenue category in fishing revenues based on yearly average total ex-vessel price of US 2013 $2.4 million for the period 2001-2010. Its yearly average tourism revenue for 2004-2013 of US 2013 $1 229 million places it in the very low-revenue category.

Revenues and Spatial Wealth Distribution

Fisheries Annual Landed Value	% Fish Protein Contribution	Tourism Annual Revenues	% Tourism Contribution to GDP	NLDI
2,362,484	No data	1,229,157,306	No data	No data

Legend: Very low, Low, Medium, High, Very high

Governance

Governance architecture

Given that decision making for the entire Antarctic Treaty System (ATS) rests primarily with the Antarctic Treaty Consultative Meeting, transboundary issues within this LME appear to be highly integrated, despite the scoring for individual agreements within the Treaty system. Consequently, this LME has been assigned an overall integration score of 1.0.

The overall scores for the ranking of risk were:

Engagement	Completeness	Integration
59	70	1

Legend: Very low, Low, Medium, High, Very high

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The water systems of the world – aquifers, lakes, rivers, large marine ecosystems, and open ocean- sustain the biosphere and underpin the socioeconomic wellbeing of the world's population. Many of these systems are shared by two or more nations. These transboundary waters, stretching over 71% of the planet's surface, in addition to the subsurface aquifers, comprise humanity's water heritage.

Recognizing the value of transboundary water systems and the reality that many of them continue to be degraded and managed in fragmented ways, the Global Environment Facility Transboundary Waters Assessment Programme (GEF TWAP) was developed. The Programme aims to provide a baseline assessment to identify and evaluate changes in these water systems caused by human activities and natural processes, and the consequences these may have on dependent human populations. The institutional partnerships forged in this assessment are envisioned to seed future transboundary assessments as well.

The final results of the GEF TWAP are presented in the following six volumes:
Volume 1 – ***Transboundary Aquifers and Groundwater Systems of Small Island Developing States: Status and Trends***
Volume 2 – ***Transboundary Lakes and Reservoirs: Status and Trends***
Volume 3 – ***Transboundary River Basins: Status and Trends***
Volume 4 – ***Large Marine Ecosystems: Status and Trends***
Volume 5 – ***The Open Ocean: Status and Trends***
Volume 6 – ***Transboundary Water Systems: Crosscutting Status and Trends***

A Summary for Policy Makers accompanies each volume. All TWAP publications are available for download at http://www.geftwap.org

This annex – Transboundary waters: A Global Compendium, Water System Information Sheets: Pacific Island Countries, Australia & Antarctica, Volume 6 - Annex K -- is one of 12 annexes to the Crosscutting Analysis discussed in Volume 6. The global compendium organized into 14 TWAP regions, compiles information sheets on 765 international water systems including the baseline values of quantitative indicators that were used to establish contemporary and relative risk levels at system and regional scales. Over the long term, it is envisioned that these baseline information sheets will continue to be updated by future assessments at multiple spatial and temporal scales to better track the changing states of transboundary waters that are essential in sustaining human wellbeing and ecosystem health.

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