TWAP
TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME



Large Marine Ecosystems

Status and Trends

SUMMARY FOR POLICY MAKERS

VOLUME 4: LARGE MARINE ECOSYSTEMS

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

Published by the United Nations Environment Programme (UNEP), January 2016

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ISBN: 978-92-807-3531-4
Job Number: DEW/1953/NA

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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.

Citation
This document may be cited as:
IOC-UNESCO and UNEP (2016). Large Marine Ecosystems: Status and Trends, Summary for Policy Makers. United Nations Environment Programme (UNEP), Nairobi.

DI No. 16-03589/500

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Summary for policy makers

Recognizing the value of large marine ecosystems (LMEs) and other transboundary water systems (open ocean, groundwater aquifers, lakes and reservoirs, and river basins), their continued degradation, the fragmented approach to their management, and the need for better prioritization of interventions, the Global Environment Facility (GEF) embarked on the Transboundary Waters Assessment Programme (TWAP) from 2009 to 2015. TWAP objectives were to undertake global assessments of the five transboundary water systems to assist GEF and other international organizations set priorities for interventions; and develop formal institutional partnerships for periodic assessments of these systems.

Key Messages

1. **Several millions of people around the world depend on the natural living resources of LMEs for food, income, recreation, and other less tangible benefits like spirituality and inspiration.** Coastal populations living around LMEs make up about 37 per cent of the global population. LMEs contribute an estimated US$28 trillion annually to the global economy. Sustainable use of LMEs' resources can make a significant contribution to the achievement of a number of targets of the UN Sustainable Development Goals, especially those related to hunger (SDG #2), poverty reduction (SDG#1), and the ocean (SDG#14).
2. **Changes in natural global processes, human use of natural resources in LMEs, and activities on land and in the sea put LME health and productivity at risk, compromising the sustainability of the natural benefits LMEs provide.**
   - 2.1 The global ocean is warming, which is expected to have a range of consequences, both beneficial and detrimental, to marine ecosystems. Sea surface temperatures have increased in all but two LMEs since 1957. Precautionary management actions are necessary in light of the uncertainties about the effects of climate change in LMEs.
   - 2.2 Sources of pressure and degree of risk from fisheries vary among LMEs, pointing to the need for solutions tailored to individual LMEs. Nearly 80 per cent of LMEs have three or more fisheries indicators in the medium to highest risk categories.
     - Impacts include collapsed fish stocks, depletion of large predatory fish, and destruction of bottom habitat from fishing gear.
     - Globally, close to 50 per cent of fish stocks within LMEs are overexploited or collapsed. The number of stocks in these categories is increasing but the number of rebuilding stocks is also increasing, an encouraging sign.
     - Climate change will reduce fish catches in many LMEs. Reductions of total fish catch in the most affected LMEs are projected to be in the range of 8 to 28 per cent by the 2050s.
     - Fisheries data systems need improvement – for example, through additional measures of catch from artisanal fisheries and more consistent and complete reporting by countries on landings (fish unloaded at ports).
   - 2.3 Floating plastic debris is ubiquitous in the global ocean and is harmful to marine life. Many of the LMEs with high relative abundances of floating plastics are located in east-southeast Asia. As plastic use continues to rise, appropriate waste management solutions are needed, along with improvement in data collection.
   - 2.4 Banned and regulated persistent organic pollutants (POPs) are widespread, but mainly at low levels. Certain hotspots are from past contamination but others suggest current use of POPs. Source identification, regulation and remediation are needed in affected areas.
   - 2.5 Sixteen per cent of LMEs are at high risk from nutrients from sewage and agriculture, and which flow to the sea in rivers and can lead to harmful algal blooms. As nutrient input from many rivers is projected to rise, nutrient reduction is a priority issue for specific watersheds.

2.6 Degradation and loss of habitat is of major concern in LMEs. Twenty per cent of global mangrove area was lost from 1980 to 2005. Loss continues at about 1 per cent per year, mainly driven by land clearing for development. By 2030, more than half of warm-water coral reefs are projected to be at high to critical risk from ocean warming and acidification. This impact is in addition to the ongoing damage to reefs from local pressures such as destructive fishing and pollution.

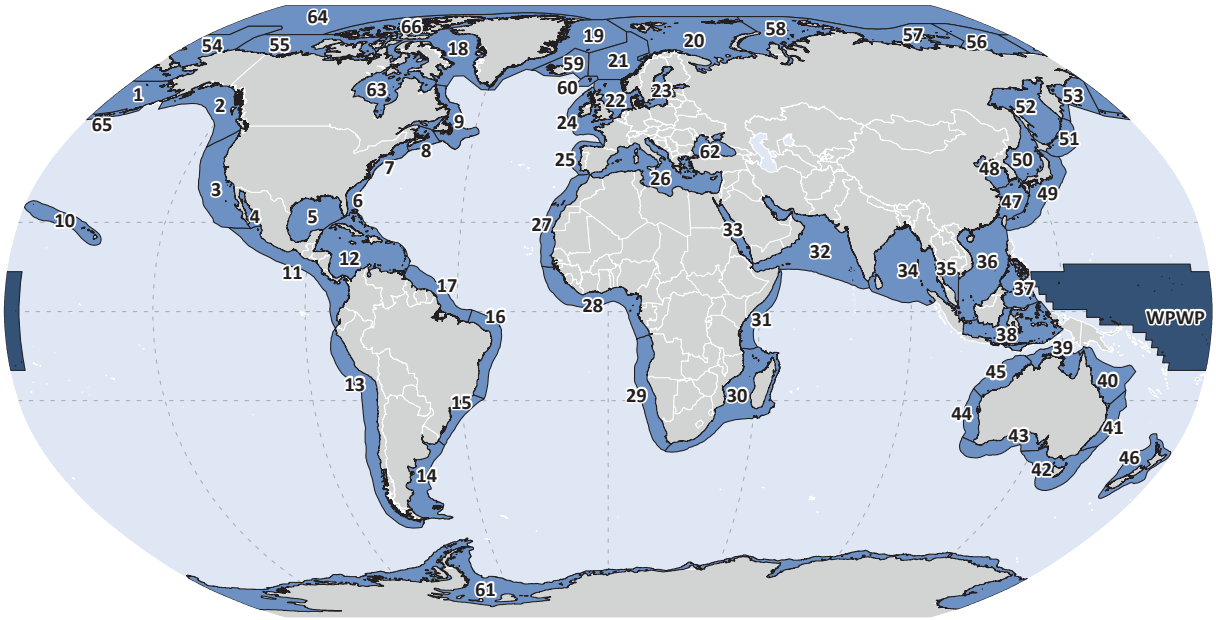
3. **The wide range of human and natural stressors experienced by marine and coastal ecosystems lead to interacting and cumulative environmental impacts, with potentially severe consequences for humans.**
   3.1 Taking each LME's human development status into account, and based on selected biophysical indicators from this assessment, the LMEs at highest overall risk are those fringed by developing countries in Africa and Asia.
   3.2 Coastal populations in highly populated tropical regions are the most at risk from the combined effects of environmental threats, dependence on LME resources, and shortfalls in capacity to adapt. Future deterioration of ecosystem health and climate change will exacerbate an already precarious state for coastal populations of some LMEs – but measures can be taken to mitigate these risks.
4. **Policy responses include protecting marine habitats, improving LME governance, and integrating consideration of the natural benefits humans derive from marine ecosystems into policy.**
   4.1 Options to address the diverse sources of pressures on LMEs include integrated and multisectoral approaches and improvement in transboundary governance architecture.
   4.2 Transboundary governance for LMEs has good country-level engagement but this does not guarantee follow-through actions – improving accountability is crucial. Fisheries arrangements, generally the most well-developed, would benefit from more institutional collaboration. Pollution and biodiversity arrangements often lack repercussions for non-compliance. Biodiversity/habitat protection arrangements are mainly just recommendations with opt-out clauses, and lack adequate data and information provisions.
   4.3 The Ocean Health Index measures progress towards ten public policy goals for healthy oceans, such as food provisioning, carbon storage, and tourism. Priority should be given to improving ocean health in LMEs in tropical regions.
5. **Management of LMEs can be considerably improved by improving the quality of data and information and by assessments at sub-LME scales.** The assessment has been constrained by limitations in the availability and quality of data, which can be addressed through appropriate research and monitoring and observing programmes. Maintenance and regular updating of the LMEs data portal developed under this phase of the TWAP is essential to develop timely interventions as new data and information become available. Assessments are also needed at sub-LME scales so that actions can be taken to address pressures and impacts at the appropriate scale.



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Large marine ecosystems

The world's coastal areas encompass 66 large marine ecosystems, which are coastal areas of 200 000 km² or greater, extending from the shoreline to the edge of continental shelves or to outer margins of major coastal currents. The Western Pacific Warm Pool, an area of open-ocean warm water in the western Pacific included in assessment of some indicators, is also marked on this map.



1. East Bering Sea
2. Gulf of Alaska
3. California Current
4. Gulf of California
5. Gulf of Mexico
6. Southeast US Continental Shelf
7. Northeast US Continental Shelf
8. Scotian Shelf
9. Newfoundland-Labrador Shelf
10. Insular Pacific-Hawaiian
11. Pacific Central-American
12. Caribbean Sea
13. Humboldt Current
14. Patagonian Shelf
15. South Brazil Shelf
16. East Brazil Shelf
17. North Brazil Shelf
18. Canadian Eastern Arctic-West Greenland
19. Greenland Sea
20. Barents Sea
21. Norwegian Sea
22. North Sea
23. Baltic Sea
24. Celtic-Biscay Shelf
25. Iberian Coastal
26. Mediterranean
27. Canary Current
28. Guinea Current
29. Benguela Current
30. Agulhas Current
31. Somali Coastal Current
32. Arabian Sea
33. Red Sea
34. Bay of Bengal
35. Gulf of Thailand
36. South China Sea
37. Sulu-Celebes Sea
38. Indonesian Sea
39. North Australian Shelf
40. Northeast Australian Shelf
41. East-Central Australian Shelf
42. Southeast Australian Shelf
43. Southwest Australian Shelf
44. West-Central Australian Shelf
45. Northwest Australian Shelf
46. New Zealand Shelf
47. East China Sea
48. Yellow Sea
49. Kuroshio Current
50. Sea of Japan
51. Oyashio Current
52. Sea of Okhotsk
53. West Bering Sea
54. Northern Bering-Chukchi Seas
55. Beaufort Sea
56. East Siberian Sea
57. Laptev Sea
58. Kara Sea
59. Iceland Shelf and Sea
60. Faroe Plateau
61. Antarctic
62. Black Sea
63. Hudson Bay Complex
64. Central Arctic Ocean
65. Aleutian Islands
66. Canadian High Arctic-North Greenland

WPWP - Western Pacific Warm Pool

Source: NOAA

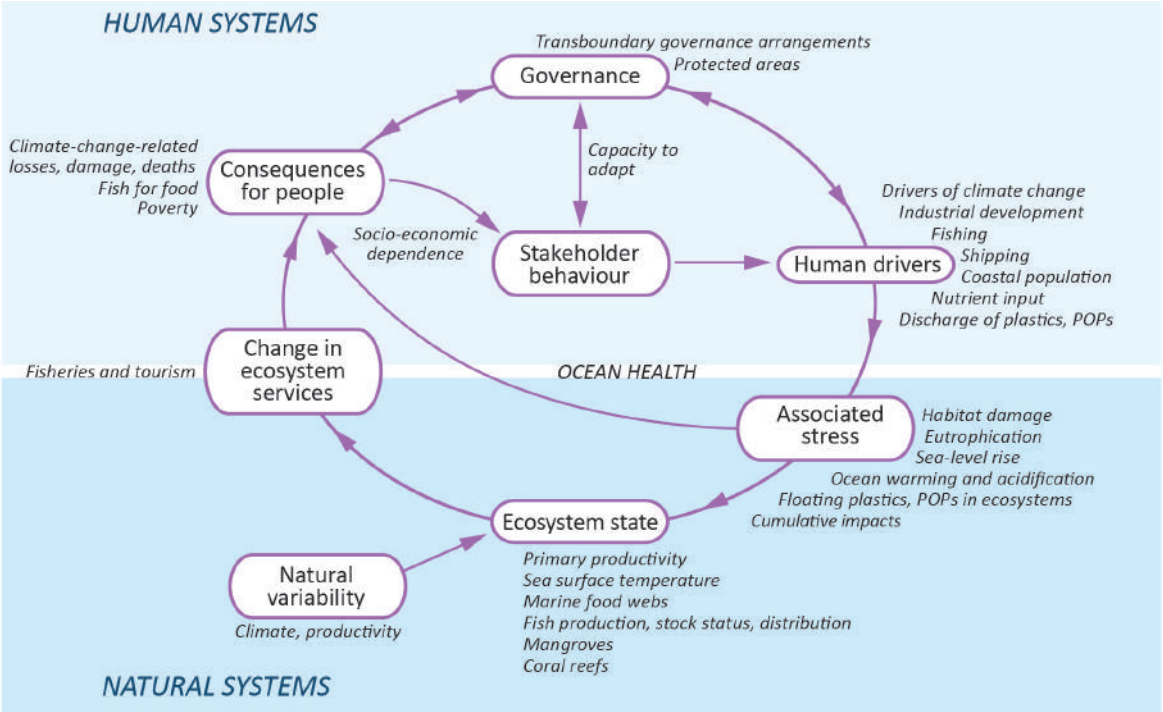
Assessment methodology

TWAP was implemented by the United Nations Environment Programme (UNEP) in collaboration with co-executing partners. The LMEs assessment was conducted by a working group of institutional partners and experts led by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization (IOC-UNESCO).

This LMEs assessment is the first indicator-based global, comparative, baseline assessment of the 66 LMEs. To facilitate the comparative assessment, LMEs were grouped into five colour-coded categories of relative risk, from lowest to highest. Results are at the scale of each entire LME and do not reflect management approaches of any one country within an LME. A sub-set of indicators was also assessed for the Western Pacific Warm Pool.

The assessment is based on five modules (socio-economics, governance, productivity, fish and fisheries, and pollution and ecosystem health), each with a set of indicators (see table below). Central, linked themes of the assessment are the vulnerability of ecosystems and human communities to natural and anthropogenic stressors, impairment of ecosystem services, and consequences for humans. These linkages are captured in a conceptual framework, shown below.

Assessment conceptual framework with examples of topics covered in the LMEs assessment



Based on the values of indicators with clear relationship to 'good' or 'bad' states, LMEs were grouped into five colour-coded categories of relative risk, from lowest to highest. Time trends and projections to 2030, 2050, or 2100 are presented for some indicators, mainly to provide insight into effects of future climate change and increasing human population and activities. Indicators are listed in the indicator box.

Risk categories

Lowest
Low
Medium
High
Highest

MODULES	INDICATORS
SOCIO-ECONOMICS	Indicators of human dependence on LMEs: coastal populations (current and in 2100); fisheries and tourism revenues from LMEs; contribution of fish to animal protein in diet Indicators of ecological degradation and climate change impacts, and threat to humans: measures of risk to ecosystem health and fisheries drawn from other modules; Present-day Climate-related Extreme Events Index; Sea-level Rise Threat Index (2100); Contemporary Threat Index Indicators of capacity to respond or adapt: Night Light Development Index (economic development); Human Development Index (current and in 2100)
GOVERNANCE	Governance arrangements or architecture: • Completeness of formal arrangements to implement transboundary agreements • Integration of institutions in addressing transboundary issues Engagement of countries participating in transboundary arrangements
PRODUCTIVITY	Average annual primary productivity (1998–2013) and average concentrations and trends of chlorophyll a (2003–2013)
FISH AND FISHERIES	Measures of human drivers: ratio of capacity-enhancing subsidies to value of landed catch; effective fishing effort; percentage of total catch from bottom-impacting fishing gear Measures of impacts and state of fisheries and ecosystems: primary production required to sustain fisheries landings (ecological footprint); marine trophic index and fishing in balance index; per cent of fish catch from overexploited and collapsed stocks; projected change in catch potential due to climate change (2050); current global LME fishery production potential
POLLUTION AND ECOSYSTEM HEALTH	Pollution indicator: abundance of floating plastic debris Pollution indicator: persistent organic pollutants (POPs) in plastic pellets washed up on shore Pollution indicator: nutrient inputs from rivers and risk of coastal eutrophication (current, 2030, and 2050) Ecosystem health indicators: extent of mangroves and warm-water coral reefs; Reefs at Risk Index (current risk from local threats; current and projected threats from climate change); increase in marine protected areas since 1983
INTEGRATION OF MULTIPLE INDICATORS	Indices that integrate, at the LME scale, multiple measures of drivers, impacts, and state of ecological and socio-economic systems: Index of Cumulative Human Impacts and Ocean Health Index; patterns of risk among LMEs

Value of LMEs to humans

Socio-economics

Human dependence on LMEs

Large marine ecosystems contribute an estimated US$28 trillion annually to the global economy through benefits provided by nature (called ecosystem services). These services are essential for human well-being and socio-economic development of the bordering countries. Benefits that flow from healthy marine ecosystems include fish for food and trade, cultural services for tourism and recreation, coastal protection from flooding and erosion, and the less tangible benefits from cultural, spiritual, and aesthetic connection to nature.



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Coastal populations living around LMEs made up 37 per cent of the global population in 2010. More than 20 per cent of coastal residents are considered poor. The five most populated LMEs are Bay of Bengal, South China Sea, Mediterranean, Arabian Sea, and Indonesian Sea. Large coastal populations in many nations indicate high dependence on marine living resources as well as high potential to deplete these resources.



The global coastal population was slightly over 2.5 billion in 2010. Estimates of the worldwide coastal population in 2100 range from

- 2.9 billion for a sustainable development pathway that reduces population growth and strengthens education, health, and livelihood, to
- 4.7 billion based on a 'fragmented world' development pathway that is characterized by high material consumption, policy priorities oriented toward security and not environment, and high economic inequality across countries.

Fisheries and marine-based tourism: two important sectors that exploit LMEs

Fish are an important source of income and protein, and fishing is integral to most coastal social and cultural systems. Much of the world's marine fish catch comes from LMEs – an average of around 76 per cent of the global marine catch and 72 per cent of the value of the total global landings over the last decade. Coastal populations rely heavily on fish for animal protein, with an average reliance of 17 per cent across all LMEs with populated coastlines. LMEs with coastal populations having a particularly high reliance (40 per cent or more) on fish protein are the Indonesian Sea, Faroe Plateau, Guinea Current, Greenland Sea, and Sulu-Celebes Sea.



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Globally, tourism revenues attributed to LMEs are about two orders of magnitude more than the gross value added total from fishing. Tourism revenues of 15 to 20 per cent of the total GDP of coastal regions of bordering countries are attributed to the following LMEs: Iceland Shelf and Sea, Caribbean Sea, Gulf of Thailand, New Zealand Shelf, Canary Current, and Iberian Coastal. The average GDP contribution from tourism across all LMEs with populated coastlines is 9 per cent.

Changing state of LMEs

Despite the critical importance of LMEs to humans, changes in global natural processes, human use of natural resources in LMEs, and activities on land and sea are degrading LME health and productivity, compromising the sustainability of their ecosystem services.

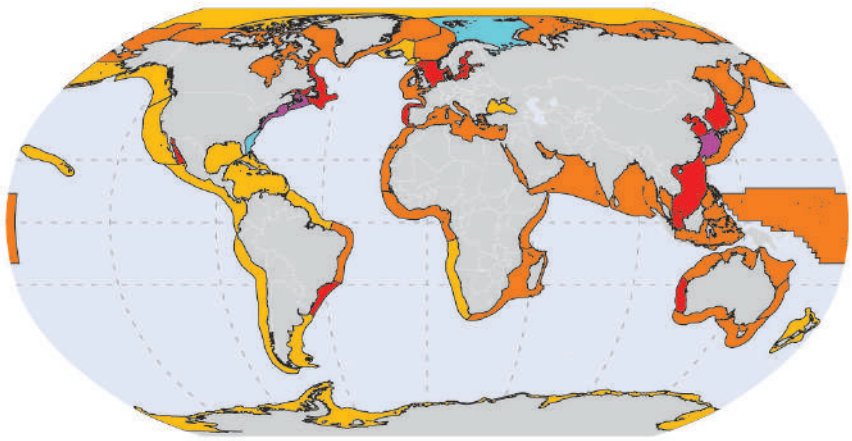
Global natural processes

Productivity

Ocean primary productivity, the basis of all marine life, is changing and is expected to change more as global warming progresses. Recent trends are not consistent, with increases in primary productivity in 36 LMEs and decreases in 31 LMEs from 2003 to 2013.

Average global surface sea temperature has risen over the past century, with many consequences for LMEs such as change in primary productivity and shifts in the distribution of fish and other marine organisms. Negative effects of climate change on LMEs, including from ocean warming, acidification, and sea-level rise, are projected to be increasingly severe. See sections on coral reefs and the Contemporary Threat Index for further examples. Ongoing monitoring and precautionary management actions are needed in the light of the uncertainties about the effects of climate change in LMEs.

How has sea surface-temperature changed? Sea surface temperatures have increased in all but two LMEs since 1957. Most LMEs alternated between warming and cooling periods with an overall warming trend. The LMEs with the greatest ocean warming are in the Northwest Atlantic, Northeast Atlantic, and Western Pacific regions. Three LMEs show 'super-fast' warming (increase of up to 1.6°C): East China Sea, Scotian Shelf, and Northeast US Continental Shelf.



Sea surface temperature trends, 1957–2012

Cooling | Slow warming | Moderate warming | Fast warming | Super-fast warming



Warming seas will reduce the fish catch potential in many LMEs by the 2050s. The LMEs projected to be the most affected are in different regions. The five most at risk are the East Siberian Sea (with the highest projected catch reduction of 28 per cent), Indonesian Sea, Beaufort Sea, East China Sea, and Northeast US Continental Shelf. The catch potential for the Western Pacific Warm Pool is projected to drop by 7 per cent. These declines would affect fisheries and the communities that depend on them for food and livelihoods.

Human activities

Fish and Fisheries

Unsustainable fishing practices lead to depletion of fish stocks, biodiversity changes, and habitat damage. The causes of these changes vary among the LMEs, which suggests that management approaches need to be tailored according to the dominant drivers and sources of pressure in individual LMEs.

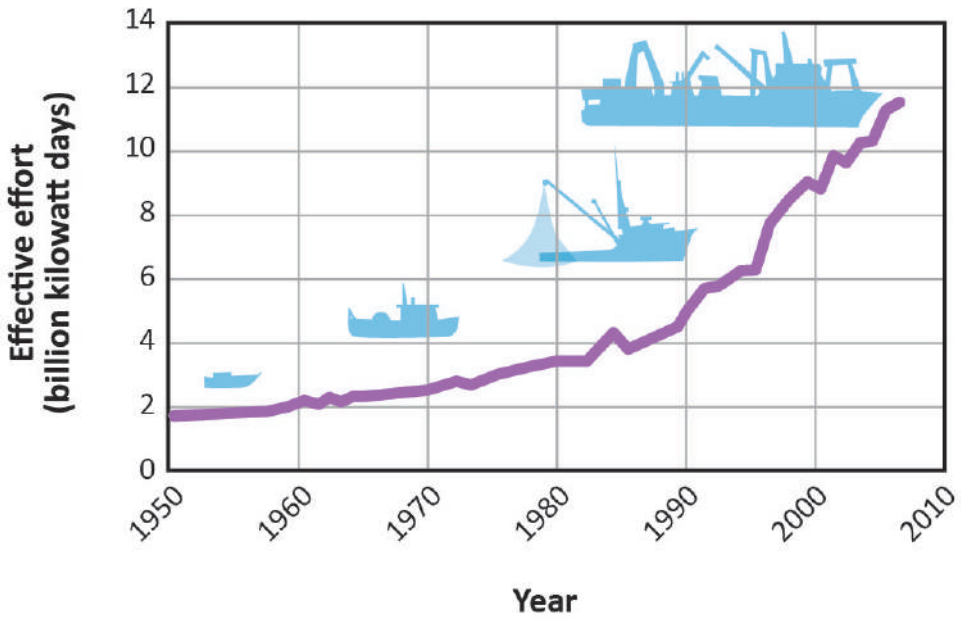
What drives unsustainable fishing?

Excessive fishing effort and harmful subsidies are only two of many factors that drive unsustainable fishing.



Bachellier Christian_flickr

Rapid increase in fishing effort. **The greatest increase in global LME effective fishing effort has been in the last decade. This reflects the changes in fishing technology as well as the increase in size and activity of fishing fleets. LMEs with the greatest increases since 1950 are Bay of Bengal, Sulu-Celebes Sea, Indonesian Sea, Celtic-Biscay Shelf, and Mediterranean.**



Harmful subsidies

The ratio of capacity-enhancing subsidies to the value of landed catch is used as an indicator of harmful subsidies. The more the fishery is subsidized, the greater the potential for overfishing and ecosystem degradation in the absence of appropriate fisheries management.

LME-scale results vary from no subsidy to a subsidization rate of 80 per cent of the catch value. The Baltic Sea, Kara Sea, and Greenland Sea have the highest ratios among the 64 LMEs assessed for this indicator.



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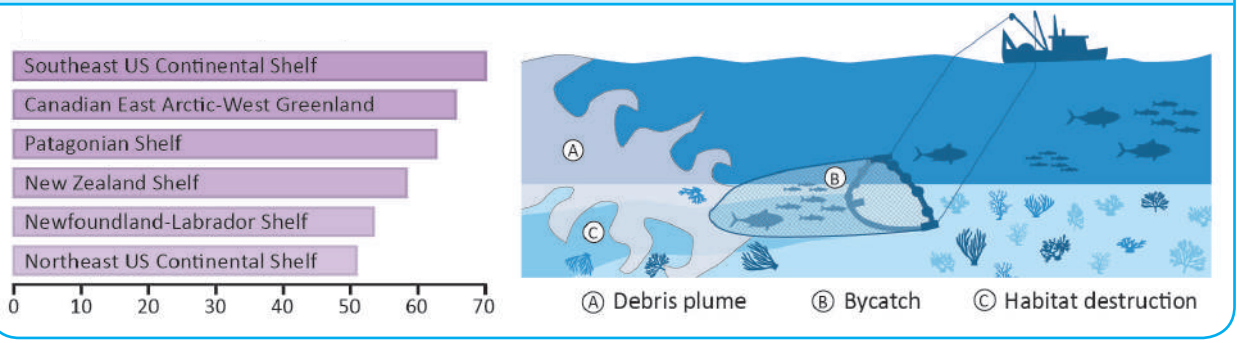
Impacts of fisheries on LMEs

Impacts of unsustainable fishing are manifested in many ways:

Ecosystem degradation

The use of bottom-impacting fishing gear (trawls and dredges) is an indicator of potential habitat damage. On average 20 per cent of total LME fish catch is taken with these types of gear. Over half the catch in the six LMEs shown in this chart is from bottom-impacting gear.

Catch from bottom-impacting gear (per cent of total catch per LME).

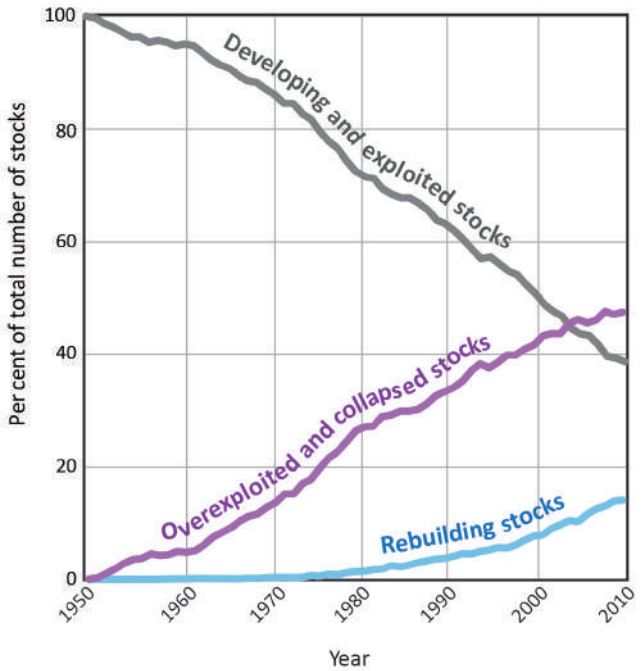


Overexploited fish stocks

Globally, close to 50 per cent of fish stocks within LMEs are overexploited or collapsed. Results suggest that the impact of fishing on the number of stocks is much higher than on the landed biomass. These trends indicate that fisheries tend to affect biodiversity (as reflected in the taxonomic composition of catches) more strongly than they affect the overall mass of fish in the ocean (as reflected in the landed quantities).

The catch from rebuilding stocks forms a small but growing part of global landings, an encouraging sign.

Percentage of stocks of different status, from all LMEs combined, 1950–2010.

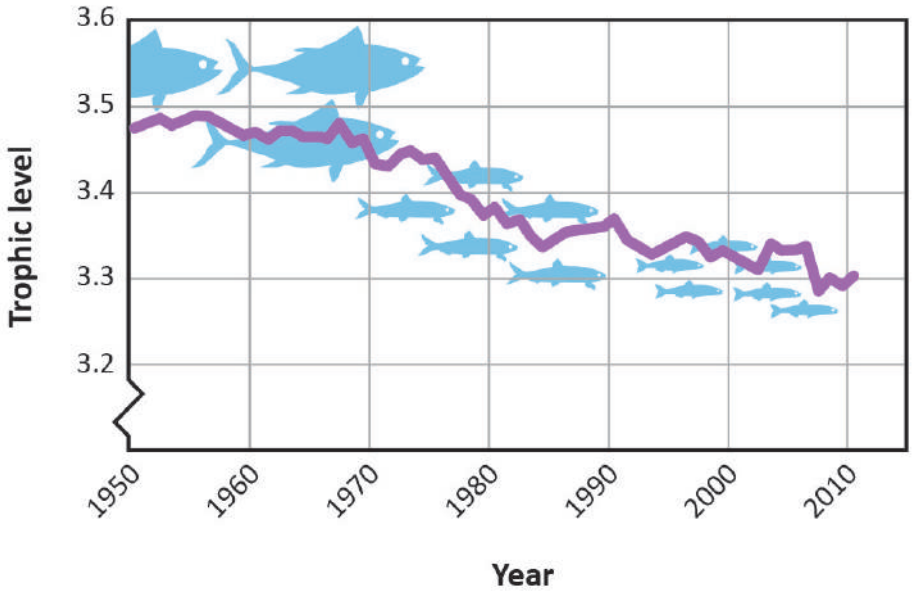


Depleting large predatory fish

Fishing often targets larger fish that are higher in the food chain. Under continued high fishing pressure, these larger fish can be depleted and replaced by smaller fish that are further down the food chain. This phenomenon, known as 'fishing down the food web', is evident in the records of fish catch in LMEs especially since the late 1960s, and reflects impact of fishing on the ecosystem.

Most of the LMEs at highest risk from fisheries are in Asia. Others are the Baltic Sea and the Caribbean Sea LMEs. Highest-risk LMEs in developed regions include the North Sea, Kuroshio Current, and the Northeast US Continental Shelf. LMEs with 'lowest' scores are the Beaufort Sea, East Siberian Sea, and Laptev Sea, where there is limited fishing activity. The Western Pacific Warm Pool shows similar trends to the average LME trends for some indicators, but has experienced greater increases in certain indicators, including fishing effort.

Fishing down the food web. The trend shown in the chart is the average for all LMEs. The five LMEs with the greatest change are the Canadian High Arctic-North Greenland, Newfoundland-Labrador Shelf, Antarctic, Canadian Eastern Arctic-West Greenland, and the Scotian Shelf. Trophic level is the position of the species in the marine food chain.



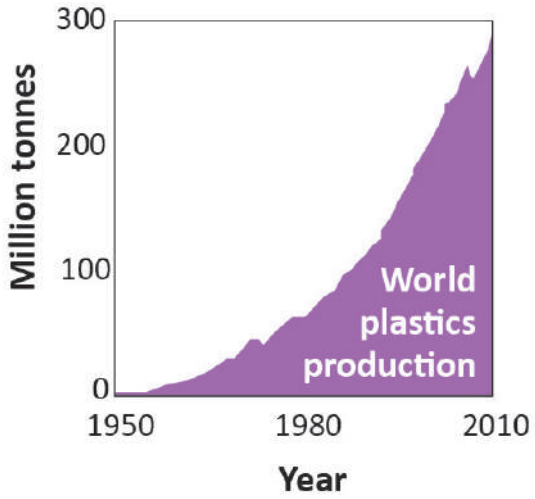
Pollution

Land-based, and to some extent sea-based human activities, are the major drivers of pollution of coastal waters. Pollution of LMEs from floating plastics, persistent organic pollutants (POPs), and nutrients entering LMEs from watersheds was assessed. Several LMEs, especially those with many people living near the coast, have high levels of risk related to some or all of these substances. These LMEs are the South China Sea, Bay of Bengal, East China Sea, Indonesian Sea, Mediterranean, Kuroshio Current, Black Sea, Gulf of Mexico, and Yellow Sea.

Floating plastic debris

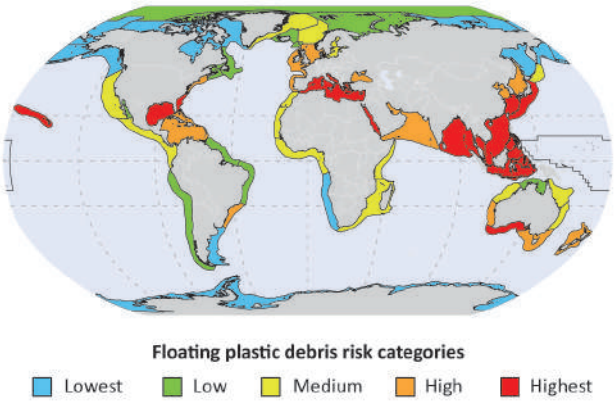
Plastics are widely dispersed in the ocean. The five LMEs at greatest risk from floating plastics are Gulf of Thailand, Southeast US Continental Shelf, Bay of Bengal, Red Sea, and Mediterranean.

Manufacture and use of plastics. The use of plastics has risen almost exponentially since the 1950s and is projected to continue to increase. Good waste management practices can control how much of this plastic ends up in the ocean.



Plastics Europe 2013

Floating plastic debris in LMEs. Risk is based on the amount of plastic debris per unit area of each LME, estimated from models. This map is for plastic pieces of about 5 mm diameter and bigger. Estimated distribution of smaller plastic particles is similar.

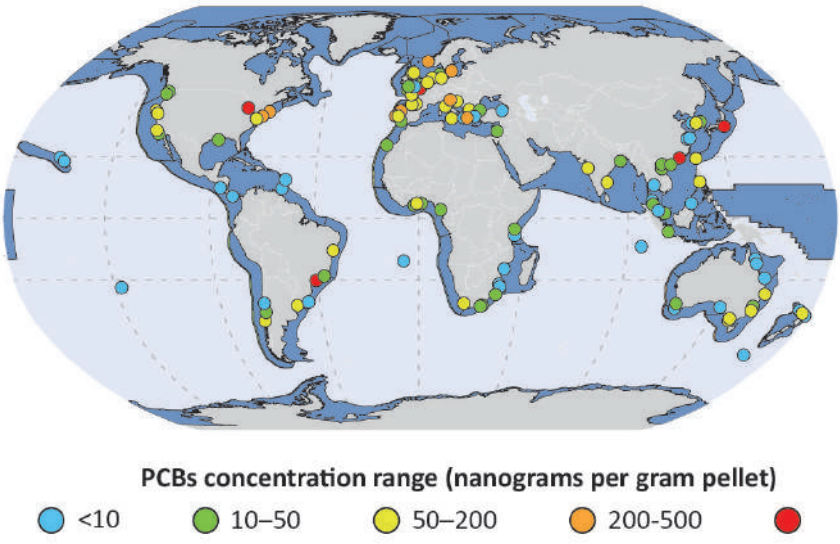


Persistent organic pollutants (POPs): global distribution and hotspots

POPs have spread around the global ocean, including to remote areas. Analysis of three common types of POPs in beached plastic pellets indicates current or recent use or release of banned POPs in some regions.

Several LMEs have hotspots with relatively high levels of PCBs (polychlorinated biphenyl) and DDTs (dichlorodiphenyltrichloroethane), with the South Brazil Shelf LME recording the highest concentrations of PCBs and high levels of DDTs, followed by the California Current, Mediterranean, and Kuroshio Current LMEs. Source identification and regulation and remediation should be implemented.

PCBs concentration range (nanograms per gram pellet).

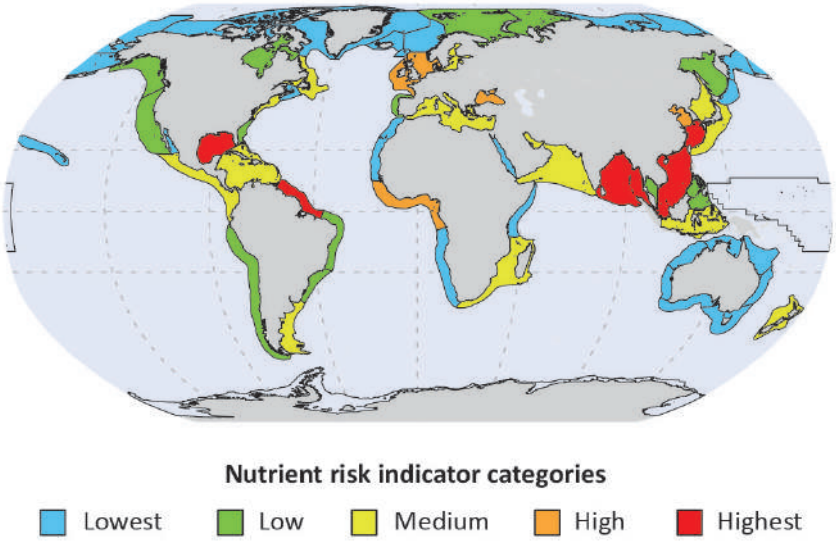


Nutrient inputs and harmful algal blooms

Coastal eutrophication is associated with large urban populations and agricultural production that has high fertilizer use or large numbers of livestock. Nutrients transported by rivers into coastal waters can cause algal blooms that may be toxic and may deplete the oxygen in the water and make it turbid, affecting fish and other marine life.

Policy responses that reduce nutrient inputs to watersheds will decrease risk to LMEs. Strategies include increasing nutrient-use efficiency in crop production, improving management of manure, and upgrading sewage treatment. Sub-LME scale studies help in planning for nutrient reduction.

Which LMEs are at risk of harmful algal blooms? The nutrient risk indicator takes into account both the amount of nutrients discharged by rivers to each LME and the extent to which these added nutrients will lead to harmful algal growth. The five LMEs most at risk from coastal eutrophication are Bay of Bengal, East China Sea, Gulf of Mexico, North Brazil Shelf, South China Sea.





Nutrient loads in many rivers are projected to increase due to increasing human activities. Based on current trends, the risk of coastal eutrophication will increase in 21 per cent of LMEs by 2050. Most of the projected increase is in LMEs in southern and eastern Asia, but also in some South American and African LMEs.



Phytoplankton Bloom off Argentina

© NASA Earth Observatory

Ecosystem Health

Mangroves and coral reefs: two rare and increasingly endangered coastal ecosystems

Mangroves are highly productive tropical coastal systems that are important for fish production, filtering water pollutants, and reducing damage from storms and erosion. Warm-water coral reefs have the highest biodiversity and among the highest economic value per unit area of any marine ecosystem type. An estimated 500 million people depend on coral reefs for food, coastal protection, building materials, and tourism revenue. Mangroves and reefs are being lost and degraded by local and global pressures and both will be placed further at risk from future climate change.

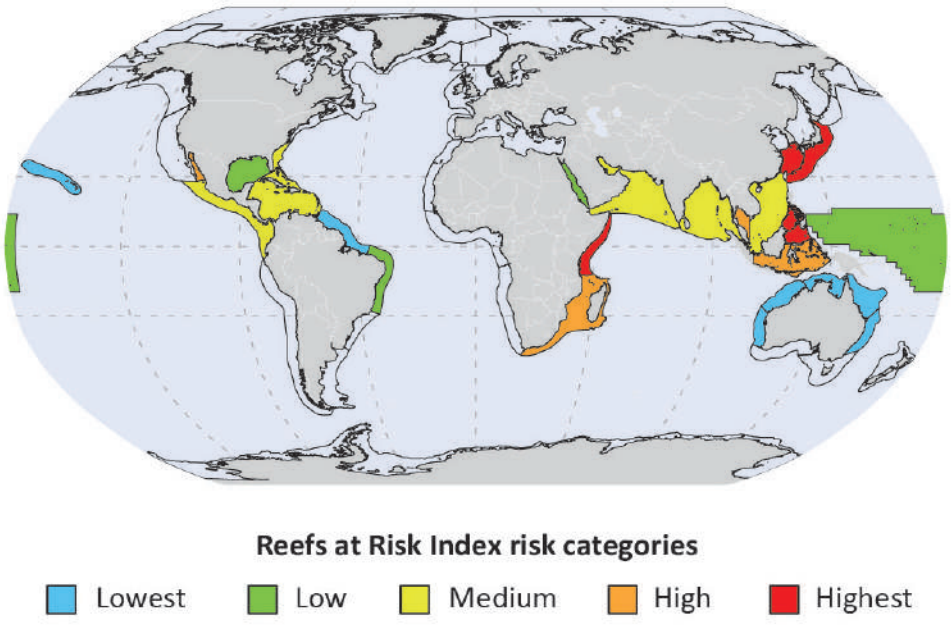


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Which reefs are at risk? Risk from local threats (including fishing and coastal development) and global threats (ocean warming and acidification) to coral reefs is measured with the Reefs at Risk Index. LMEs with the highest risk from local threats are Kuroshio Current, Sulu-Celebes Sea, East China Sea, and Somali Coastal Current.



Pressures on mangroves		Pressures on coral reefs	
	• Land clearing • Overexploitation for timber and fuel • Aquaculture • Sea-level rise Coastal development is the most widespread cause of mangrove loss.		• Overfishing and destructive fishing • Coastal development • Pollution • Damage Ocean warming and acidification Fishing-related threats are the most significant local threats.



Mangroves: Decline will continue or accelerate unless action is taken to reverse current trends. Twenty per cent of global mangrove area was lost from 1980 to 2005 and loss continues at about one per cent per year. Loss rate is highest for southeast Asian mangroves.

Reefs: By 2030, over 50 per cent of warm-water coral reefs are projected to be at high to critical risk from ocean warming and acidification, increasing to almost 80 per cent by 2050. Conditions may be particularly severe in the Gulf of California and Kuroshio Current LMEs.

Multiple stressors acting together

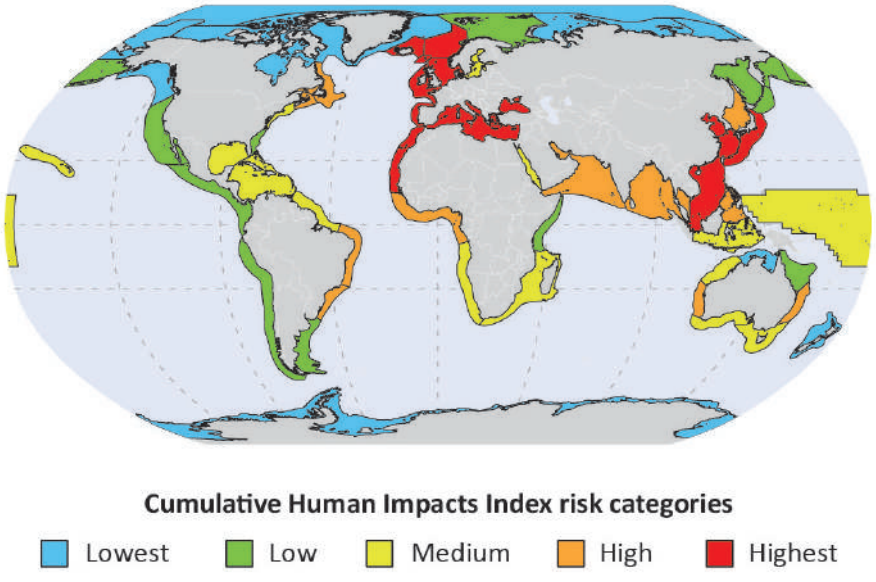
Cumulative Human Impacts

As seen above, marine and coastal ecosystems experience a wide range of stressors. These impact ecosystems cumulatively, in ways that are not always known, and with a combined impact that is always greater than that of the individual stressors. The Cumulative Human Impacts Index combines 19 measures of impacts in four categories: climate change, fishing, land-based pollution, and commercial activities.

The top sources of human impact for nearly every LME are associated with climate change, notably ocean acidification and increasing frequency of high water temperatures. Commercial shipping and fishing for bottom-feeding fish are also major sources of impact at the LME scale.

The five LMEs at greatest risk from cumulative human impacts are East China Sea, North Sea, Faroe Plateau, Yellow Sea, and Celtic-Biscay Shelf.

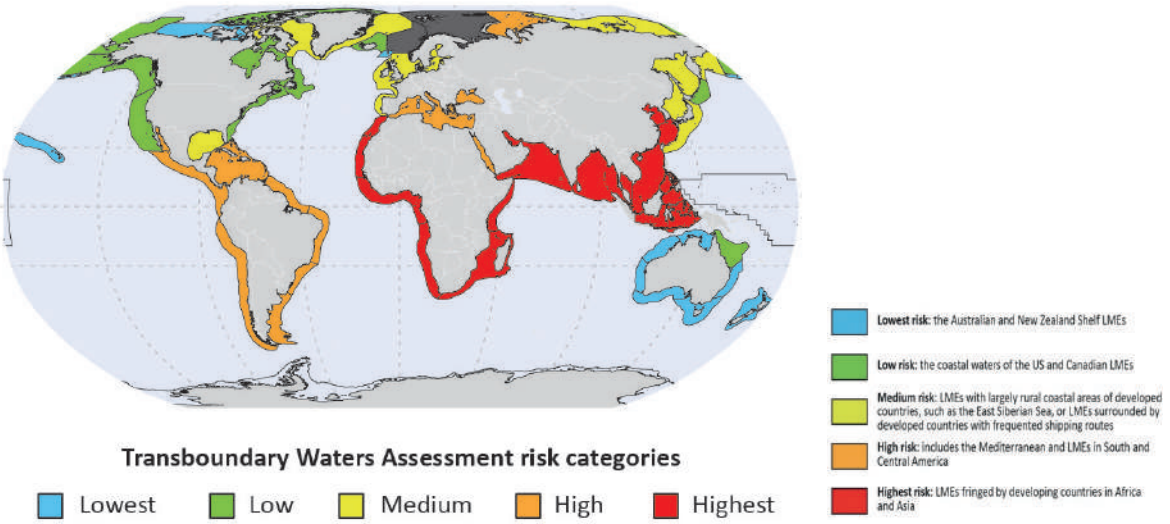
Cumulative human impact index risk categories



Patterns of risk using multiple indicators

The complexity of human-environment interactions in coastal waters presents challenges in developing a single set of criteria to assess risk for LMEs. An overall risk score based on selected fisheries, pollution, and ecosystem health indicators was developed. The score was adjusted based on the Human Development Index, a measure of the socio-economic status of each LME, to rank LMEs. These patterns of risk will be refined as improved data sets for LMEs are developed and as understanding of relationships between environmental, socio-economic and governance risks improve.

Risk to LMEs based on overall risk scores from this Transboundary Waters Assessment



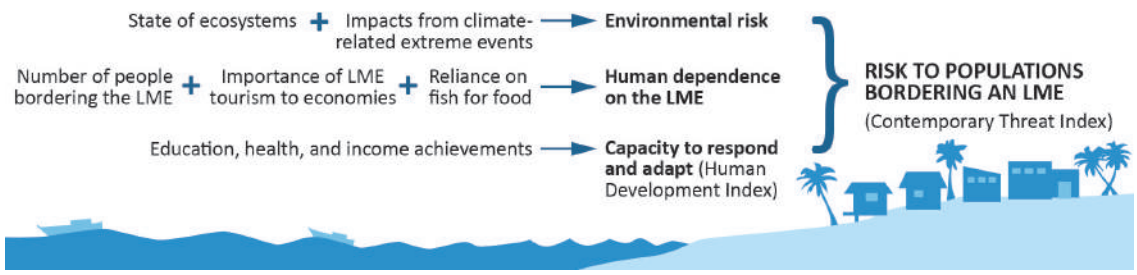
Consequences for Humans

Vulnerable coastal populations

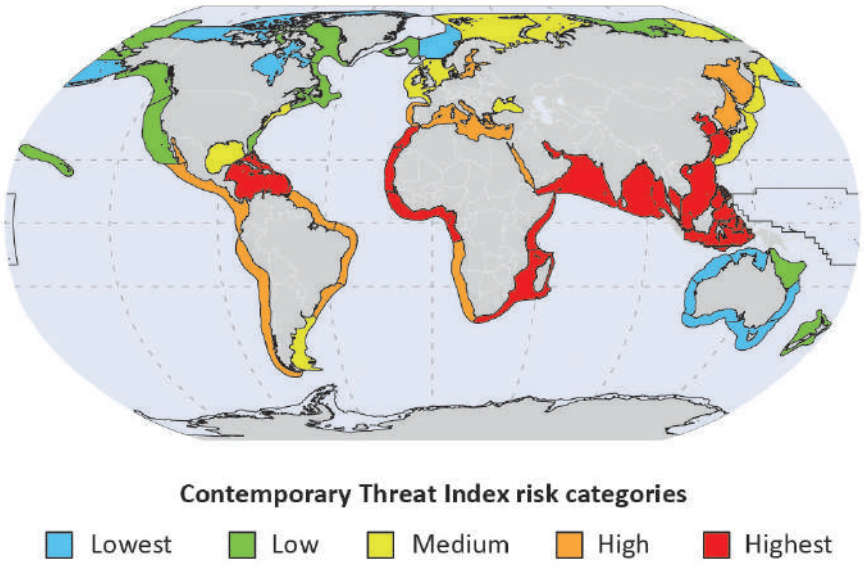
High levels of human well-being and ecosystem health are mutually reinforcing outcomes of sustainable ecosystems. Because the two are so interconnected, actions to enhance the well-being of coastal populations must not sacrifice ecosystem health, and vice-versa.

This assessment of the vulnerability of coastal populations bordering LMEs incorporates measures of environmental risk, dependence on marine ecosystem services, and capacity to respond and adapt to threats. These measures are integrated into the Contemporary Threat Index.

Estimating risk to coastal populations from environmental degradation and climate change



Which populations are at risk? People in highly populated tropical regions are the most at risk based on the Index. Residents of sparsely populated coastal regions of developed countries are the least at risk. Coastal populations with the highest risk levels border the Bay of Bengal, Canary Current, Gulf of Thailand, South China Sea, Sulu-Celebes Sea, and Somali Coastal Current LMEs.





Future threat to coastal populations from sea-level rise. Scenario-based analysis suggests that the most vulnerable coastal regions are in southern Africa where sea-level rise will increasingly become an added burden to populations already at risk from other socio-economic and environmental factors. Sustainable socio-economic development pathways that reduce population growth and strengthen education, health, and livelihood should decrease vulnerability to this added threat.



Typhoon Haiyan damage and survivor, Philippines

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Policy responses assessed

Governance

Policy responses addressed in this assessment include protecting marine areas, expanding and improving LME governance, and building consideration of the natural benefits humans derive from marine ecosystems into policy. Adaptive management of LMEs requires coordination among sectors, as well as among countries, especially as significant sources of impact are global.

Protecting marine ecosystems

Conservation measures such as establishing marine protected areas (MPAs) may enhance ecosystem resilience in the face of increasing global threats. There has been a 15-fold increase in global MPA extent since 1983. This increase indicates progress towards Aichi Target 11 of the Convention on Biological Diversity's target to conserve 10 per cent of the world's coastal and marine areas by 2020.

LMEs with the greatest increase in marine protected areas include three Australian Shelf LMEs, Gulf of California and Red Sea. At the other end of the scale, LMEs with no protected areas or with increases in area protected since 1983 of less than 1 per cent include most Arctic LMEs, the Canary Current, Iberian Coastal, and LMEs in the region around Japan.

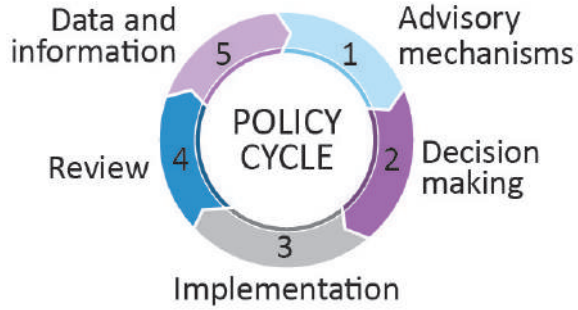


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Transboundary waters governance arrangements

Formal governance arrangements for transboundary agreements on fisheries, pollution, and habitat destruction/biodiversity in the 49 multi-country LMEs and the Western Pacific Warm Pool were assessed using three indicators, with the following conclusions:

1. *Engagement* of countries in governance arrangements is generally good, reflecting a high level of commitment on transboundary issues.
2. *Integration* of institutions in addressing transboundary issues is generally poor, with over 60 per cent of LMEs being in the highest risk category for this indicator. Greater emphasis needs to be placed on collaboration in transboundary governance. Specifically, organizations involved with fisheries governance in many LMEs are currently disconnected from those involved with pollution and biodiversity.
3. *Completeness* of governance arrangements is moderate overall. Current and new agreements should cover all stages of the policy cycle. Strong, knowledge-based arrangements that include measures for accountability, monitoring, and evaluation are needed for adaptive management.



Completeness of transboundary governance arrangements across stages of the policy cycle: main findings

- *The weakest policy stage is usually implementation.*
- *Fisheries arrangements tend to be the most complete.*
- *Pollution arrangements often lack accountability – few include repercussions for noncompliance.*
- *Biodiversity arrangements are the least complete. They are mainly recommendations or decisions that can be opted out of, and they lack provisions for accountability and for data and information.*

The Mediterranean LME has the lowest risk across the three governance indicators because it has an overarching integrating mechanism to address transboundary issues. LMEs with the highest risk are all in developing regions. Future assessments should also evaluate effectiveness of governance arrangements.

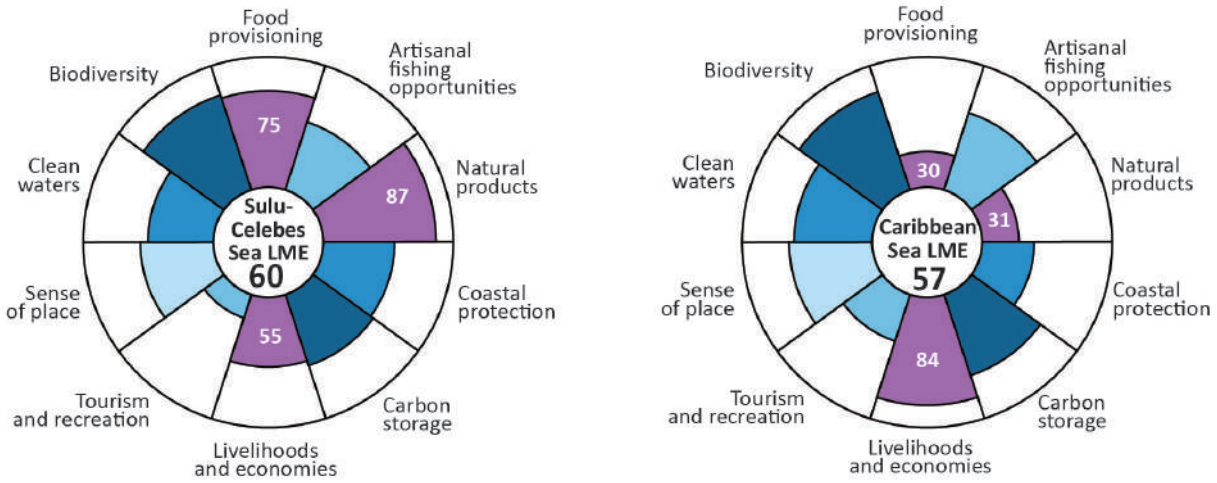
Monitoring progress on public goals for healthy oceans

The Ocean Health Index (OHI) measures progress against ten widely-agreed public goals for healthy oceans (shown in the chart below). Progress is assessed against the optimal and sustainable level that can be achieved for each goal. The lowest-scoring LMEs are all in tropical areas, with the Guinea Current, Somali Coastal Current, Red Sea, Caribbean Sea, and Bay of Bengal having the lowest Index scores. The highest-scoring LMEs are around Australia and New Zealand and in the North Atlantic region, including the Greenland Sea, North Sea, Baltic Sea, and Norwegian Sea.

The Ocean Health Index can be used to track and compare individual goals. It offers insights into which goals may be currently driving ocean health and which goals may be most in need of improved policy.

Low goal scores often highlight common-sense but difficult-to-implement solutions for improving conditions. For example, low food provision scores point towards an emphasis on policy to increase sustainable production of mariculture and improve management of wild-caught stocks to make harvests more sustainable. Similarly, coastal protection, carbon storage, and biodiversity depend strongly on the extent and condition of key habitats. Scores for these goals are low where these habitats have been lost or heavily degraded. Halting habitat loss and restoring habitat would increase scores across multiple goals.

Progress on the ten ocean health goals for two LMEs with relatively low OHI scores. Despite similar overall scores of 60 and 57, the Sulu-Celebes Sea and the Caribbean Sea LMEs show markedly contrasting progress towards goals for food provisioning (fishing and mariculture), sustainable harvest of natural products (such as shells, algae, or fish oil), and livelihoods and economies.



Addressing degradation of LMEs and maintaining their health is critical in helping countries to achieve a number of targets of the UN Sustainable Development Goals, especially those related to hunger (SDG #2), poverty reduction (SDG#1), and sustainable use of the oceans, seas, and marine resources for sustainable development (SDG #14). Regular assessment of LMEs can also contribute to evaluating progress towards achievement of these targets.

Future of TWAP LMEs assessments

Within the framework of the GEF-TWAP a consortium of institutional partners and experts has been established by the IOC for future assessments. However, the sustainability of TWAP LMEs assessments will largely depend on the availability of adequate financial resources and updated data and information as well as incorporation of transboundary considerations and uptake of the assessment in other marine assessment processes. TWAP LME assessments could provide baseline information for existing global and regional ocean assessment processes, such as the UN World Ocean Assessment, relevant Sustainable Development Goals reporting mechanisms, and Regional Seas Programmes. The value of the TWAP LME Assessment is also recognized in terms of informing the Transboundary Diagnostic Analysis and related Strategic Action Programme of GEF LME projects. The current assessment was a global assessment at the LME scale; future TWAP LMEs assessments should incorporate more detailed analysis including at the sub-LME scale to inform management at the appropriate scale.

For more information

Please visit www.onesharedocean.org, the TWAP LMEs interactive website and data portal to access the data, results, and factsheets for individual LMEs and the Western Pacific Warm Pool, the full length LMEs assessment report (Large Marine Ecosystems: Status and Trends), the LMEs Sustaining Mechanism Report, and other documents.
See also the TWAP website and data portal www.geftwap.org.

Acknowledgements

The Large Marine Ecosystem Assessment Partnership is led by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization (IOC-UNESCO), and consists of the US National Oceanic and Atmospheric Administration, the International Geosphere-Biosphere Programme, the Centre for Resource Management and Environmental Studies (University of the West Indies), the University of British Columbia Sea Around Us, the UNEP World Conservation Monitoring Centre, the University of California (Santa Barbara), the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, the Laboratory of Organic Geochemistry (Tokyo University of Agriculture and Technology), and a number of individual experts.

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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 health and 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 overexploited and degraded, and managed in fragmented ways, the Global Environment Facility (GEF) initiated the Transboundary Waters Assessment Programme (TWAP). The Programme aims to provide a baseline assessment to identify and evaluate changes in these water systems caused by human activities and natural processes, as well as the consequences these changes may have on the human populations dependent upon them. The institutional partnerships forged in this assessment are also envisioned to seed future transboundary assessments. 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.

This document — Volume 4 Summary for Policy Makers —highlights the main findings of the first global indicator-based comparative baseline assessment of the world's 66 large marine ecosystems. LMEs produce nearly 80 per cent of the world's annual marine fish catch, and their ecosystem services contribute an estimated US$28 trillion annually to the global economy.

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ISBN: 978-92-807-3531-4
Job Number: DEW/1953/NA