Bordering countries: Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Ecuador, Peru
LME Total area: 1,996,659 km²

List of indicators

- LME overall risk: 2
- Productivity: 2
  - Chlorophyll-A: 2
  - Primary productivity: 3
  - Sea Surface Temperature: 3
- Fish and Fisheries: 4
  - Annual Catch: 4
  - Catch value: 4
  - Marine Trophic Index and Fishing-in-Balance index: 5
  - Stock status: 5
  - Catch from bottom impacting gear: 6
  - Fishing effort: 6
  - Primary Production Required: 7
- Pollution and Ecosystem Health: 7
  - Nutrient ratio, Nitrogen load and Merged Indicator: 7
  - Nitrogen load: 7
  - Nutrient ratio: 8
  - Merged nutrient indicator: 8
- POPs: 8
- Plastic debris: 8
- Mangrove and coral cover: 9
- Reefs at risk: 9
- Marine Protected Area change: 9
- Cumulative Human Impact: 10
- Ocean Health Index: 10
- Socio-economics: 11
  - Population: 11
  - Coastal poor: 11
  - Revenues and Spatial Wealth Distribution: 11
  - Human Development Index: 12
  - Climate-Related Threat Indices: 12
- Governance: 13
  - Governance architecture: 13
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 high.

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Very low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very high</th>
</tr>
</thead>
</table>

Productivity

Chlorophyll-A
The annual Chlorophyll a concentration (CHL) cycle has a maximum peak (0.343 mg.m\(^{-3}\)) in March and a minimum (0.230 mg.m\(^{-3}\)) during August. The average CHL is 0.281 mg.m\(^{-3}\). Maximum primary productivity (490 g.C.m\(^{-2}\).y\(^{-1}\)) occurred during 2000 and minimum primary productivity (336 g.C.m\(^{-2}\).y\(^{-1}\)) during 1998. There is a statistically insignificant increasing trend in Chlorophyll of 15.2 % from 2003 through 2013. The average primary productivity is 407 g.C.m\(^{-2}\).y\(^{-1}\), which places this LME in Group 4 of 5 categories (with 1 = lowest and 5 = highest).
Primary productivity

Sea Surface Temperature
Between 1957 and 2012, the Pacific Central-American Coastal LME #11 has warmed by 0.27°C, thus belonging to Category 4 (slow warming LME). The thermal history of this LME was non-monotonous. The cooling phase culminated in two minima, in 1971 and 1975, both associated with major La Niñas (National Weather Service/Climate Prediction Center, 2007), after which SST rose by approximately 1°C over the next 30 years. The absolute minimum of 1975 was synchronous with absolute minima in two other East Pacific LMEs: California Current LME #3 and Gulf of California LME #4. It also was roughly synchronous with the absolute minimum of 1974-1976 on the other side of the Central American Isthmus, in the Caribbean LME #12. The warming phase was accentuated by two sharp peaks, in 1983 and 1997, both associated with major El Niños (National Weather Service/Climate Prediction Center, 2007). Similar warm events were observed in other East Pacific LMEs, namely the Humboldt Current LME #13, Gulf of California LME #4, and California Current LME #3. All significant maxima and minima of SST observed in the Pacific Central-American Coastal LME #11 are associated with El Niños and La Niñas respectively (National Weather Service/Climate Prediction Center, 2007).
Fish and Fisheries

The Pacific Central-American Coastal LME is rich in both pelagic and demersal fisheries resources. The most valuable fisheries in the region are offshore tunas and coastal penaeid shrimps, whose landed fish bycatch is usually not reported. More than 50% of the reported shelf catches consists of small coastal pelagic species such as anchoveta (*Engraulis ringens* and *Cetengraulis mysticetus*), Pacific sardine (*Sardinops sagax*) and Pacific thread herring (*Opisthonema libertate*), most of which are used for fishmeal and fish-oil.

**Annual Catch**

Total reported landings have risen, with some fluctuations, to peak landings of 1 million t in 1985.

**Catch value**

Fluctuations in the value of the reported landings correspond with the landings, with a peak of 680 million US$ (in 2005 real US$) recorded in 1995.
Marine Trophic Index and Fishing-in-Balance index
The MTI is relatively low, and shows a declining trend until the mid-1980s, after which a slight increasing trend became apparent. The FiB index has increased, indicating that whatever "fishing down" may be occurring in the LME would be masked by either the geographic (offshore) expansion of the fisheries or the incompleteness of the underlying catch statistics.

Stock status
The Stock-Catch Status Plots indicate that the number of collapsed and overexploited stocks are rapidly increasing in the LME. Approximately 40% of the reported landings are supplied by fully exploited stocks.
Catch from bottom impacting gear
The percentage of catch from the bottom gear type to the total catch reaches its maximum at 40% in 1953 and then this percentage declined steadily. This percentage ranged between 5 and 9% in the recent decade.

Fishing effort
The total effective effort increased steadily from around 30 million kW in the 1950s to its peak at 145 million kW in early 2000s.
Primary Production Required
The primary production required (PPR) to sustain the reported landings in this LME reached 5% of the observed primary production in 2002.

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.

<table>
<thead>
<tr>
<th>2000</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen load</td>
<td>Nutrient ratio</td>
<td>Merged nutrient indicator</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

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

POPs
Data are available for only two samples at two locations in Costa Rica and Panama. These locations show low concentration for all the indicators. The average concentration (ng.g-1 of pellets) was 5 (range 2 – 7 ng.g-1) for PCBs, 5 (range 5 – 6 ng.g-1) for DDTs, and 0.1 (range 0.04 – 0.3 ng.g-1) for HCHs. The PCBs and HCHs averages correspond to risk category 1 and DDTs average corresponds to risk category 2, 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). More samples and locations are necessary to properly evaluate this LME.

<table>
<thead>
<tr>
<th>Locations</th>
<th>Avg. (ng/g)</th>
<th>Risk</th>
<th>Avg. (ng/g)</th>
<th>Risk</th>
<th>Avg. (ng/g)</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>0.1</td>
<td>1</td>
</tr>
</tbody>
</table>

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
0.39% of this LME is covered by mangroves (US Geological Survey, 2011) and 0.03% 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 235. 7% of coral reefs cover is under very high threat, and 26% 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 20% and 60% for very high and high threat categories respectively. By year 2030, 39% 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 42% by 2050.

Marine Protected Area change
The Pacific Central-American Coastal LME experienced an increase in MPA coverage from 2,040 km² prior to 1983 to 29,444 km² by 2014. This represents an increase of 1,343%, within the low category of MPA change.
Cumulative Human Impact

The Pacific Central-American Coastal LME experiences an average overall cumulative human impact (score 3.36; 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, three connected to climate change have the highest average impact on the LME: ocean acidification (0.97; maximum in other LMEs was 1.20), UV radiation (0.64; maximum in other LMEs was 0.76), and sea surface temperature (1.15; maximum in other LMEs was 2.16). Other key stressors include commercial shipping, ocean based pollution, and demersal destructive commercial fishing.

Ocean Health Index

The Pacific Central-American Coastal LME scores well below average on the Ocean Health Index compared to other LMEs (score 66 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. Its score in 2013 remained unchanged compared to the previous year. This LME scores lowest on food provision, coastal protection, carbon storage, tourism & recreation, and iconic species goals and highest on artisanal fishing opportunities, coastal economies, and lasting special places goals. It falls in risk category 5 of the five risk categories, which is the highest 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 the Pacific Central American Coastal 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 littoral 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.

<table>
<thead>
<tr>
<th></th>
<th>Total population</th>
<th>Rural population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>50,320,369</td>
<td>23,824,558</td>
</tr>
<tr>
<td>2100</td>
<td>97,859,738</td>
<td>50,535,113</td>
</tr>
</tbody>
</table>

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

Coastal poor

The indigent population makes up 44% of the LME’s coastal dwellers. The Pacific Central American Coastal LME places in the very high-risk category based on percentage and absolute number of coastal poor (present day estimate).

Coastal poor

21,995,749

Revenues and Spatial Wealth Distribution

Fishing and tourism depend on ecosystem services provided by LMEs. The Pacific Central American Coastal LME ranks in the medium revenue category in fishing revenues based on yearly average total
ex-vessel price of US 2013 $672 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 $48,482 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 the Pacific Central American Coastal LME falls in the category with high risk.

<table>
<thead>
<tr>
<th>Fisheries Annual Landed Value</th>
<th>% Fish Protein Contribution</th>
<th>Tourism Annual Revenues</th>
<th>% Tourism Contribution to GDP</th>
<th>NLDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>672,041,692</td>
<td>6.9</td>
<td>48,482,410,060</td>
<td>11.9</td>
<td>0.8253</td>
</tr>
</tbody>
</table>

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 Pacific Central American Coastal LME HDI belongs to the low HDI and high-risk category. Based on an HDI of 0.693, this LME has an HDI Gap of 0.307, 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 Pacific Central American Coastal LME is projected to assume a place with the very low risk category (very high HDI) in 2100 under a sustainable development pathway or scenario. Under a fragmented world scenario, this LME is estimated to place in the very high-risk category (very low HDI) because of reduced income level and increased population size compared to estimated income and population values in a sustainable development pathway.

<table>
<thead>
<tr>
<th>HDI 2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSP1: 0.6926</td>
</tr>
<tr>
<td>SSP3: 0.5259</td>
</tr>
</tbody>
</table>

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/m² 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 Pacific Central American Coastal LME is within the very high-risk (very high threat) category. The combined contemporaneous risk due to extreme climate events, degrading LME states and the level of vulnerability of the coastal population, is high. In a sustainable development scenario, the risk index from sea level rise in 2100 is lowest, and increases to very high risk under a fragmented world development pathway.

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Threat</td>
<td>0.8157</td>
<td></td>
</tr>
<tr>
<td>Contemporary Threat</td>
<td>0.4398</td>
<td>0.3978</td>
</tr>
<tr>
<td>SSP1</td>
<td>0.3978</td>
<td></td>
</tr>
<tr>
<td>SSP3</td>
<td>0.6583</td>
<td></td>
</tr>
</tbody>
</table>

**Governance**

**Governance architecture**

There are three separate transboundary arrangements for fisheries in general within the EEZ (CPPS, OLDESPECA and OSPESCA) as well as the arrangement for tuna and tuna-like species (IATTC). No integrating mechanisms, such as an overall policy coordinating organization for the LME, could be found. However, somewhat unique among LMEs, is the Secretariat for the Regional Seas Convention being housed at the Permanent Commission for the South Pacific (CPPS). While specific formal integration is not mentioned in the two Conventions, it is likely that the two Commissions have considerable informal linkages since the secretariats for both CPPS and the Lima Convention are within the same organization. Governance arrangements for this LME appear to be split along geographic lines with arrangements for the southern part of the LME being distinct from those for the northern part.

The overall scores for the ranking of risk were:

**Legend:**

- Very low
- Low
- Medium
- High
- Very high