

**Five LME Modules are used to assess the changing states of Large Marine Ecosystems. Each of the 5 modules has its own suite of indicators to assess changes in the LMEs and determine whether an LME is improving or deteriorating.**

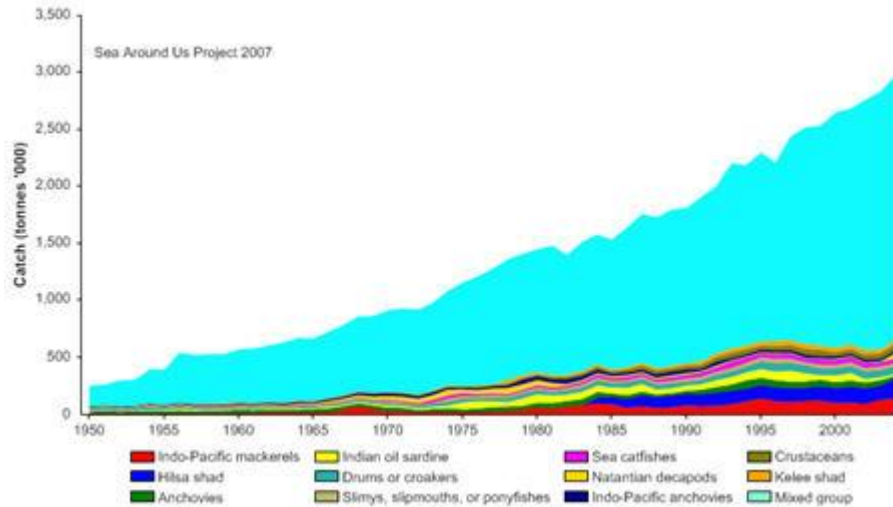
## **(ii) The Fish and Fisheries Module**

### **FISH AND FISHERIES MODULE INDICATORS**

Changes in biodiversity and species dominance within fish communities of Large Marine Ecosystems have resulted from excessive exploitation, naturally occurring environmental shifts due to climate change, and coastal pollution. Changes in biodiversity and species dominance in a fish community can move up the food web to apex predators and cascade down the food web to plankton components of the ecosystem. The fish and fisheries module includes both fisheries independent bottom-trawl surveys and pelagic-species acoustic surveys to obtain time-series information on changes in fish biodiversity and abundance levels.

Standardized sampling procedures, when employed from small calibrated trawlers, can provide important information on changes in fish species. Fish catch provides biological samples for stock identification, length frequencies, stomach content analyses, age-growth relationships, fecundity, and coastal pollution monitoring for possibly associated pathological conditions, as well as data for preparing stock assessments and for clarifying and quantifying multispecies trophic relationships. The survey vessels can also be used as platforms for obtaining water, sediment, and benthic samples for monitoring harmful algal blooms, diseases, anoxia, and changes in benthic communities. Applications of multi-annual time series data on fisheries biomass yields and trophic indexing for the world's 64 LMEs are given in Pauly et al.(2008) and Christensen (2008). Fisheries biomass yield time-series data can be used for examining trends in relation to climate warming (Sherman et al. 2008).

The UNEP LME Report (2008) provides synopses of ecological conditions for each of the world's 64 LMEs, including sea surface temperature (SST) and anomalies in SSTs, 50 years of annual fisheries biomass yields, value, mean trophic levels, fisheries conditions relative to stock conditions, and amount of primary productivity required to support the mean annual catch levels.



**Figure 1.** Total reported landings in the Bay of Bengal LME by species (Sea Around Us 2007, UNEP LME Report 2008).



**Figure 2.** Mean trophic level (i.e., Marine Trophic Index) in the Bay of Bengal LME (Sea Around Us 2007, UNEP LME Report 2008).

### Selected Fish and Fisheries Indicators Module Publications

Christensen V. 2008. Models of the World's Large Marine Ecosystems. Intergovernmental Oceanographic Commission technical series 80. Paris: IOC, UNESCO.

Pauly D, Alder J, Booth S, Cheung WWL, Close C, Sumaila UR, Swartz W, Tavakolie A, Watson R, Wood L and others. 2008. Fisheries in large marine ecosystems: Descriptions and diagnoses. In: Sherman K, Hempel G, editors. The UNEP Large Marine Ecosystems Report: A Perspective on Changing Conditions in LMEs of the World's Regional Seas. Nairobi, Kenya: UNEP.

Sea Around Us Project at [www.searoundus.org/](http://www.searoundus.org/)

- Sherman, K., I. Belkin, K. Friedland, J. O'Reilly, K. Hyde. 2008. Accelerated warming and emergent trends in fisheries biomass yields of the world's large marine ecosystems. 41-80 in Sherman, K. and Hempel, G. (Editors). 2008. The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas. UNEP Regional Seas Report and Studies No. 182. United Nations Environment Programme. Nairobi, Kenya. 872 p.
- The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas. 2008. Sherman K, Hempel G, eds. UNEP Regional Seas Report and Studies No. 182. United Nations Environment Programme. Nairobi, Kenya. 872 p.