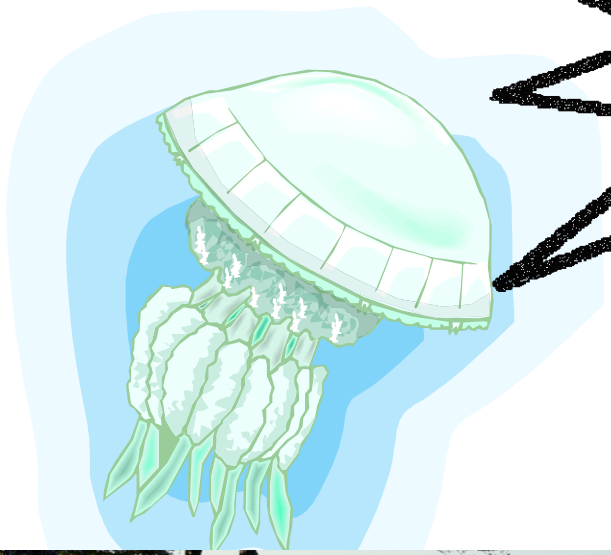
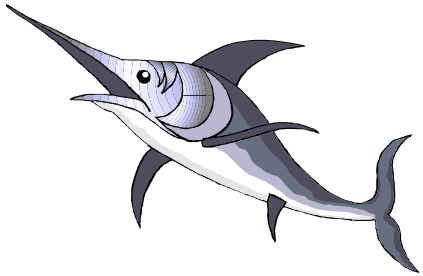
Centre for Marine Living Resources and Ecology

(Ministry of Earth Sciences)

Kochi

Marine Living Resource of India - An overview





History of Marine Living Resources Studies in India

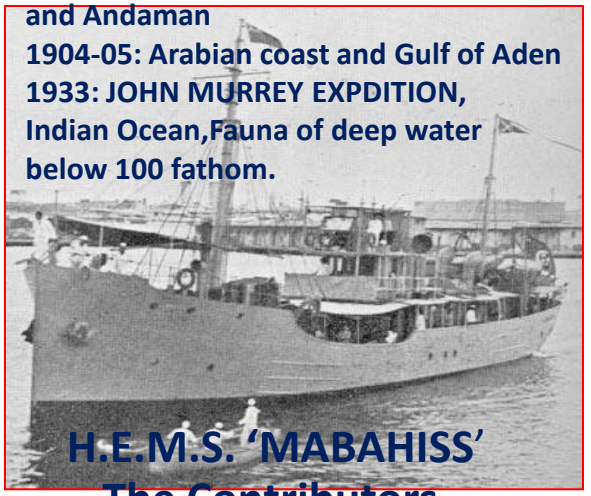
Launched in 1881.
A paddle streamer of 580 t with two funnels

RIMS INVESTIGATOR 1

Launched in 1908.
A steel ship of 1018 tons

RIMS INVESTIGATOR II

1895-96: Lakshadweep, Bay of Bengal and Andaman
1904-05: Arabian coast and Gulf of Aden
1933: JOHN MURREY EXPDITION, Indian Ocean,Fauna of deep water below 100 fathom.



H.E.M.S. 'MABAHISS'

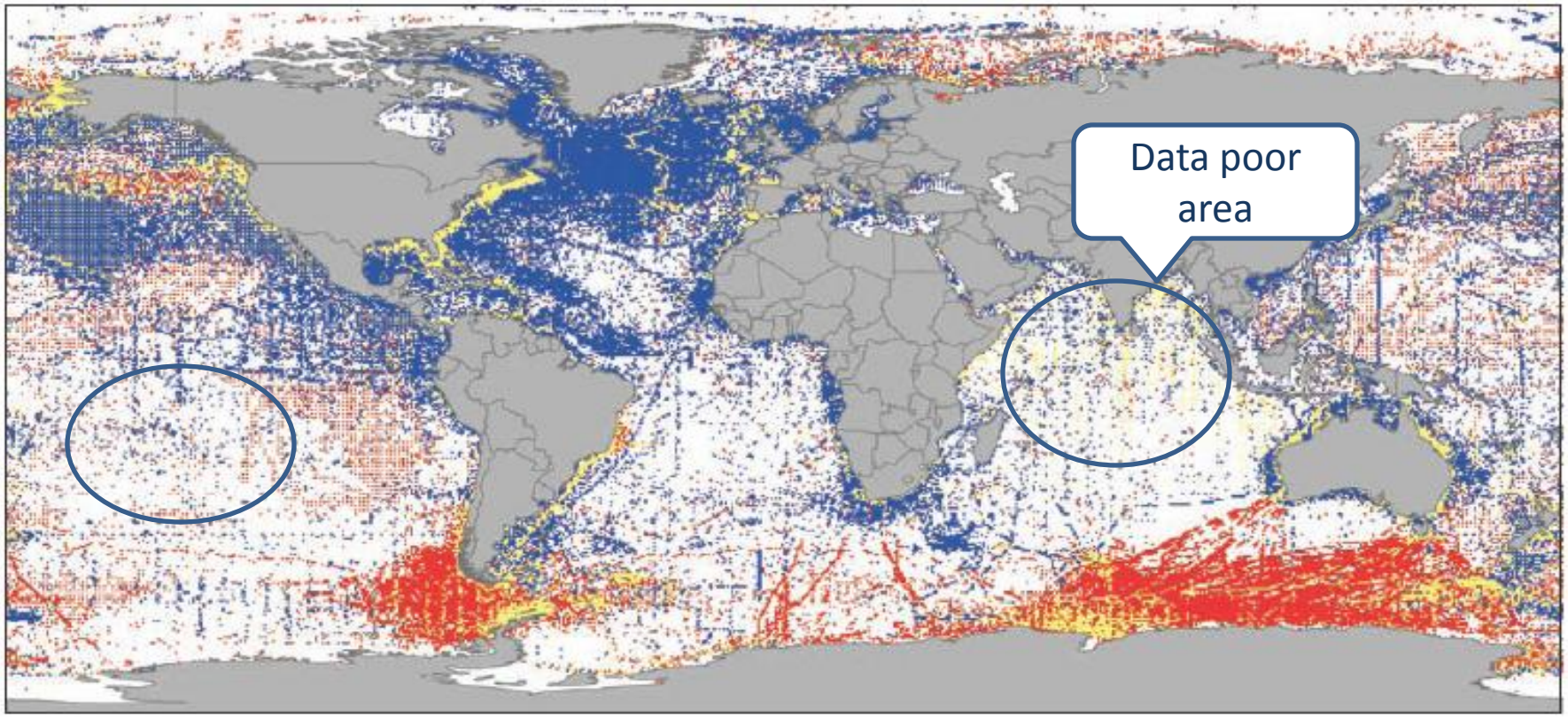
Great Oceanographic expeditions in the Indian ocean

- The British Challenger Expedition (1872-76)
- The German Expedition Valdivia (1898-99)
- The Dutch Expedition Siboga (1899-1900)
- Dana (1928-30)
- The Investigator (1887,1892,1893,1952 to 1938)
- John Murray Expedition (1933-34)
- Albatross (1947-48)
- Galathea (1950-52)
- The International Indian Ocean Expedition (1962-65): One of the greatest international, interdisciplinary oceanographic research efforts to explore Indian Ocean in which 40 oceanographic research vessels belonging to 13 countries took part. The participation of numerous ships (Vema, Argo, Horizon, Pioneer, Chain, Vega, Anton Brunn, Discovery, Challenger II, Vityaz, Meteor, Diamantina etc.,) belonging to several countries

The Contributors

- 1784: Sir William Jones- founder of Asiatic Society
- 1839: Dr. Nathaniel Wallich- Honorary Curator & Superintendent of the Oriental Museum of Asiatic Society
- 1841: John McClelland- forerunner of Geological Survey of India (GSI)
- 1874-1881: J. Armstrong-MSI's First Surgeon Natst.
- 1888-1892: Lt. Col. A.W. Alcock - Surgeon Naturalist
- 1910-1926: Lt. Col. R.B.S. Sewell - Surgeon Natst.
- 1947- to date: CMFRI, NIO, DOD (MoES), NIOT,

Observations around global Oceans



A global map of the nearly 35 million OBIS records of 120,000 species from more than 800 datasets shows the known and unknown ocean in half-degree squares by latitude and longitude.

- **Blue areas – represents data aggregated before the Census programme**
- **Yellow indicates – Census's own expeditions.**
- **Red indicates regions with data from Census expeditions where there were no prior data.**

Marine Living Resources

Total =15042

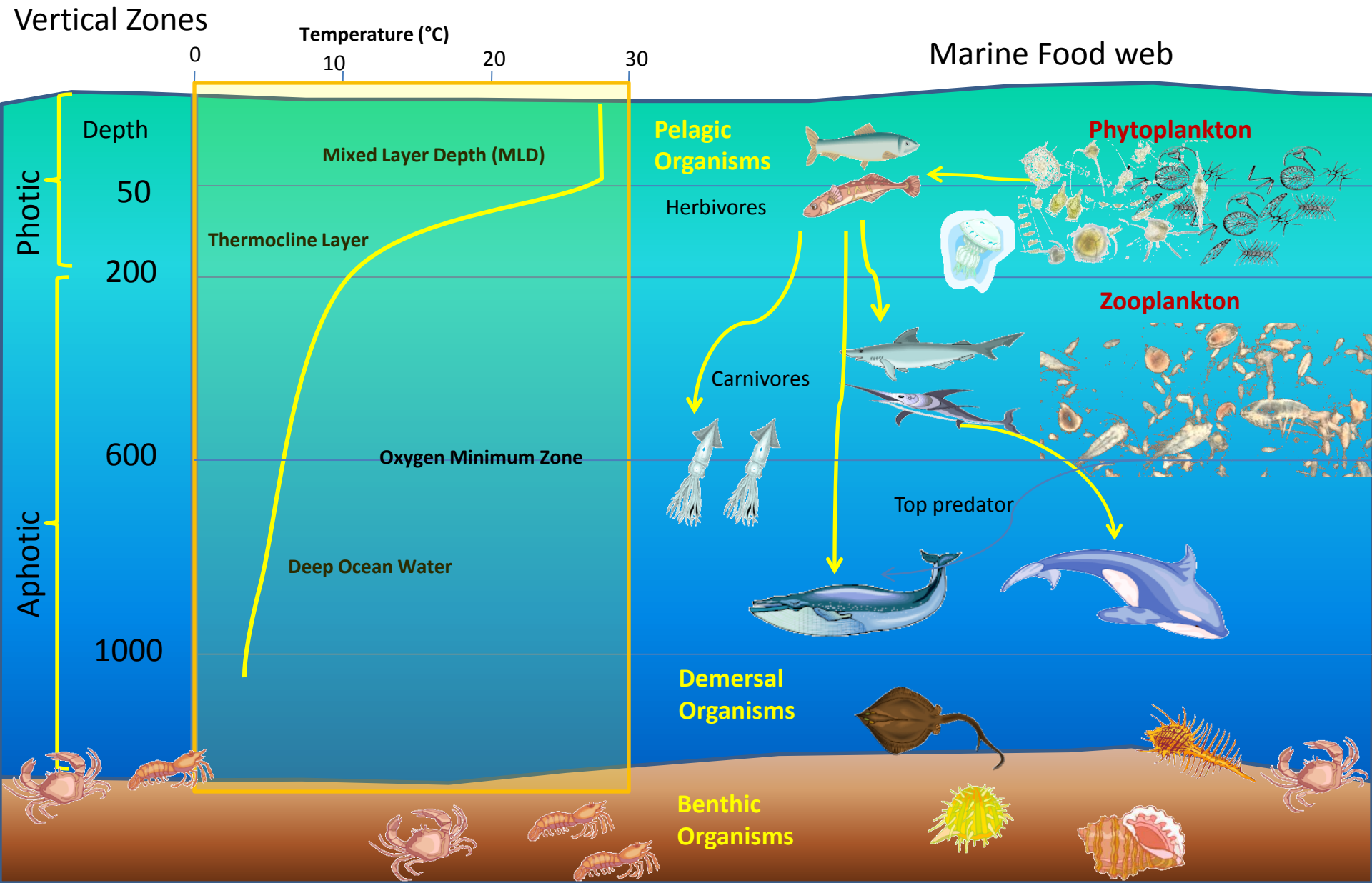
List of species recorded from marine environment in India

Taxa	No of species
Diatoms	200 +
Dinoflagellates	90 +
Algae	844
Rhodophyta	434
Phaeophyta	191
Xanthophyta	3
Chlorophyta	216
Sea grasses	14
Mangroves	39
Protista	
Protzoa	532+
Forminifera	500+
Tintinids	32+
Animalia	
Porifera	486+
Cnidaria	842+
Hydrozoa	212+
Scyphozoa	25+
Cubozoa	5+
Anthozoa	600+
Ctenophora	12

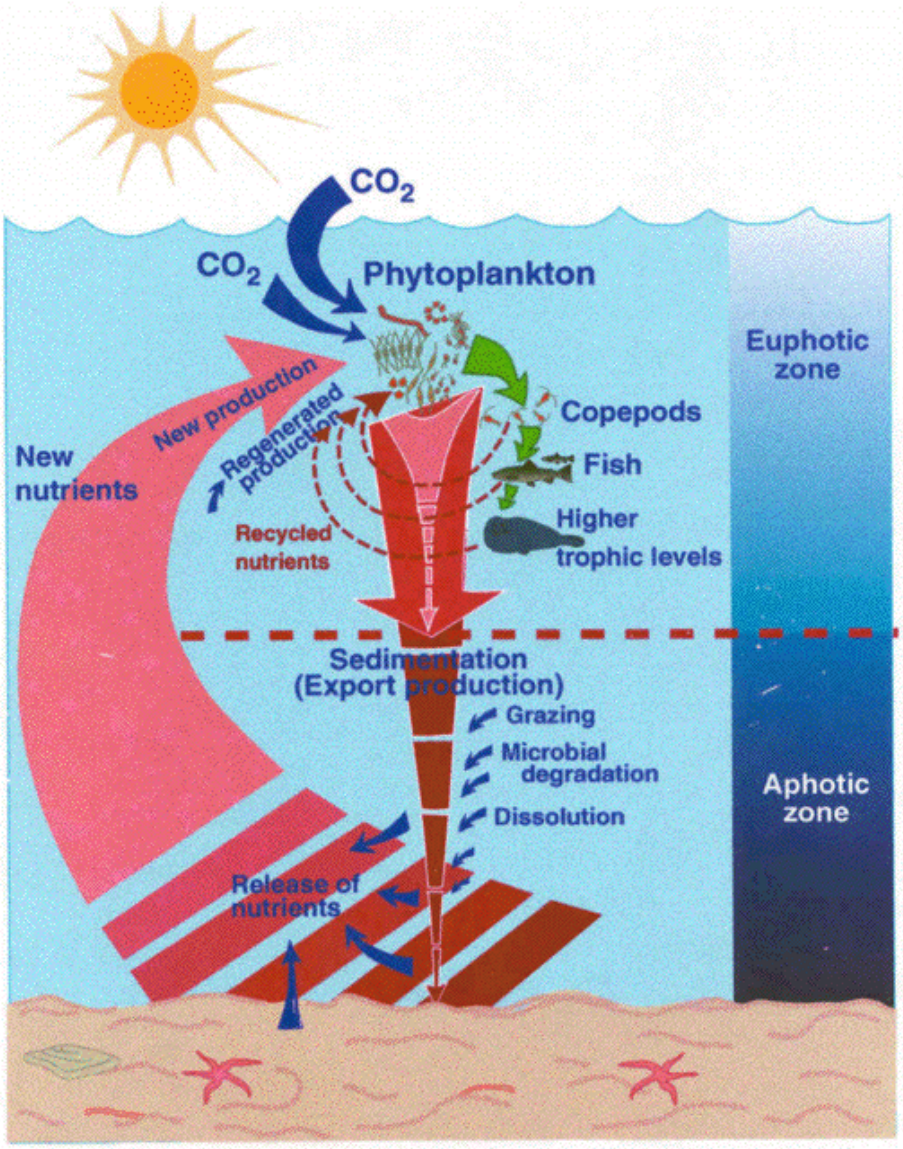
Taxa	No of species
Annelida	
Achianeelida	20
Polychaeta	250+
Sipuncula	35
Echiura	33
Chaetognatha	30+
Tardigrada	10+
Arthropoda	
Crustacea	
Copepoda	1925+
Ostracoda	120+
Branchiura	5+
Cirrepedes	104
Malacostraca	
Mysidacea	75
Cumacea	30
Tanidacea	1+
Isopoda	33+
Amphipoda	139+
Euphasacea	23+
Stomatopoda	121

Taxa	No of species
Decapoda	
Macrura	55+
Branchyura	705+
Anomura	162
Mollusca	3370
Bryozoans	200+
Echinodermata	765
Chordata	
Hemichordata	12
Protochordata	119+
Fishes	2546
Reptiles	35
Mammals	25

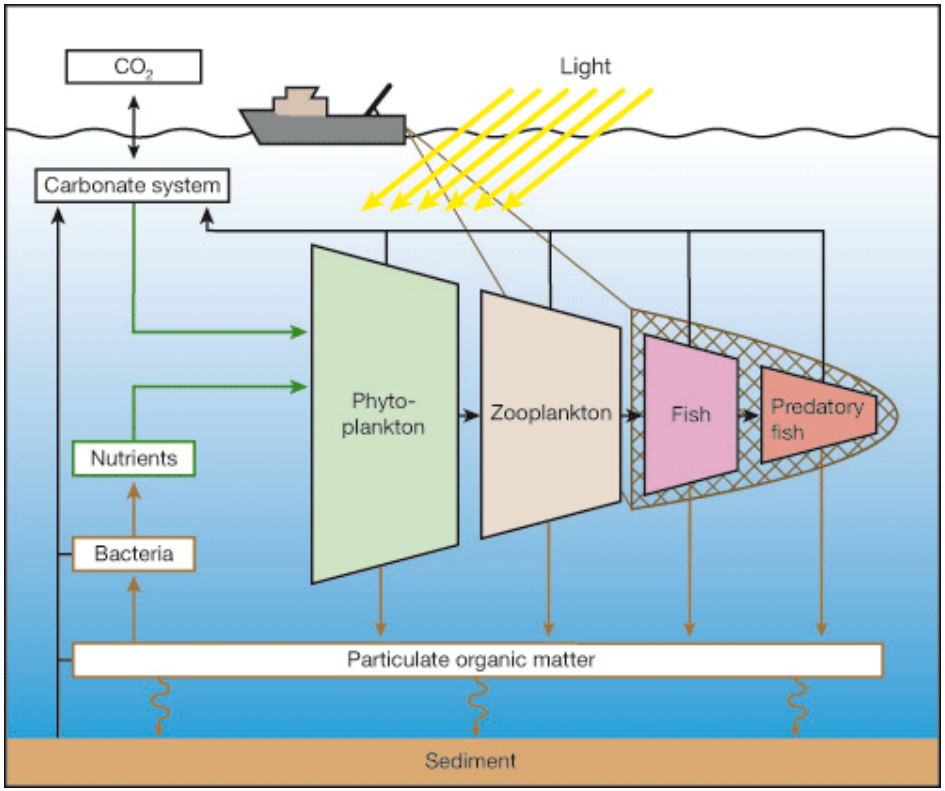
Marine Ecosystem



Marine Productivity



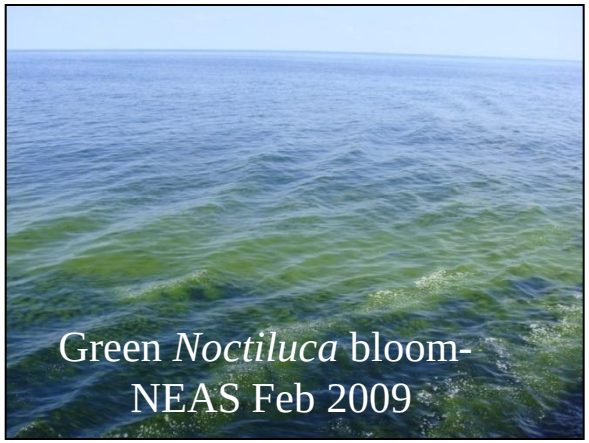
Fishing the marine food web



Major influencing factors/ phenomenon

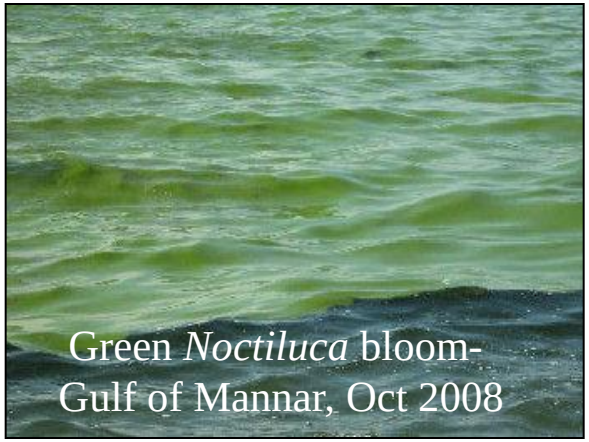
1. Physical process (upwelling, currents and eddies)
2. Biogeochemistry (Anoxia)
3. Algal Blooms
4. Benthic production
5. Fishery (Demersal trawling)
6. Biodiversity (particularly Endemic fauna and flora)

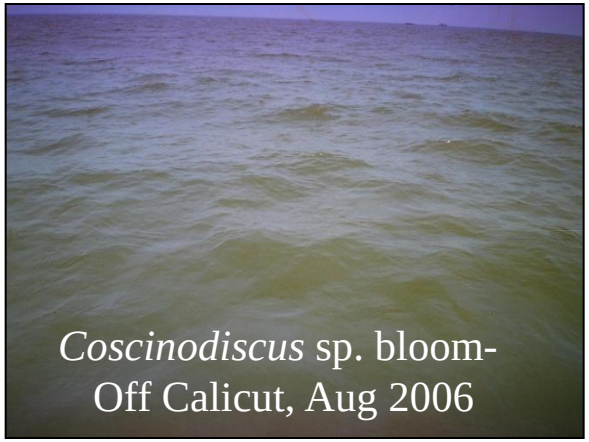
HABs in the Indian EEZ


Green *Noctiluca* bloom-
NEAS Feb 2009


Red *Noctiluca* bloom-
SEAS Aug 2008


Gonyaulax bloom- off M'lore
Oct, 2008


Green *Noctiluca* bloom-
Gulf of Mannar, Oct 2008

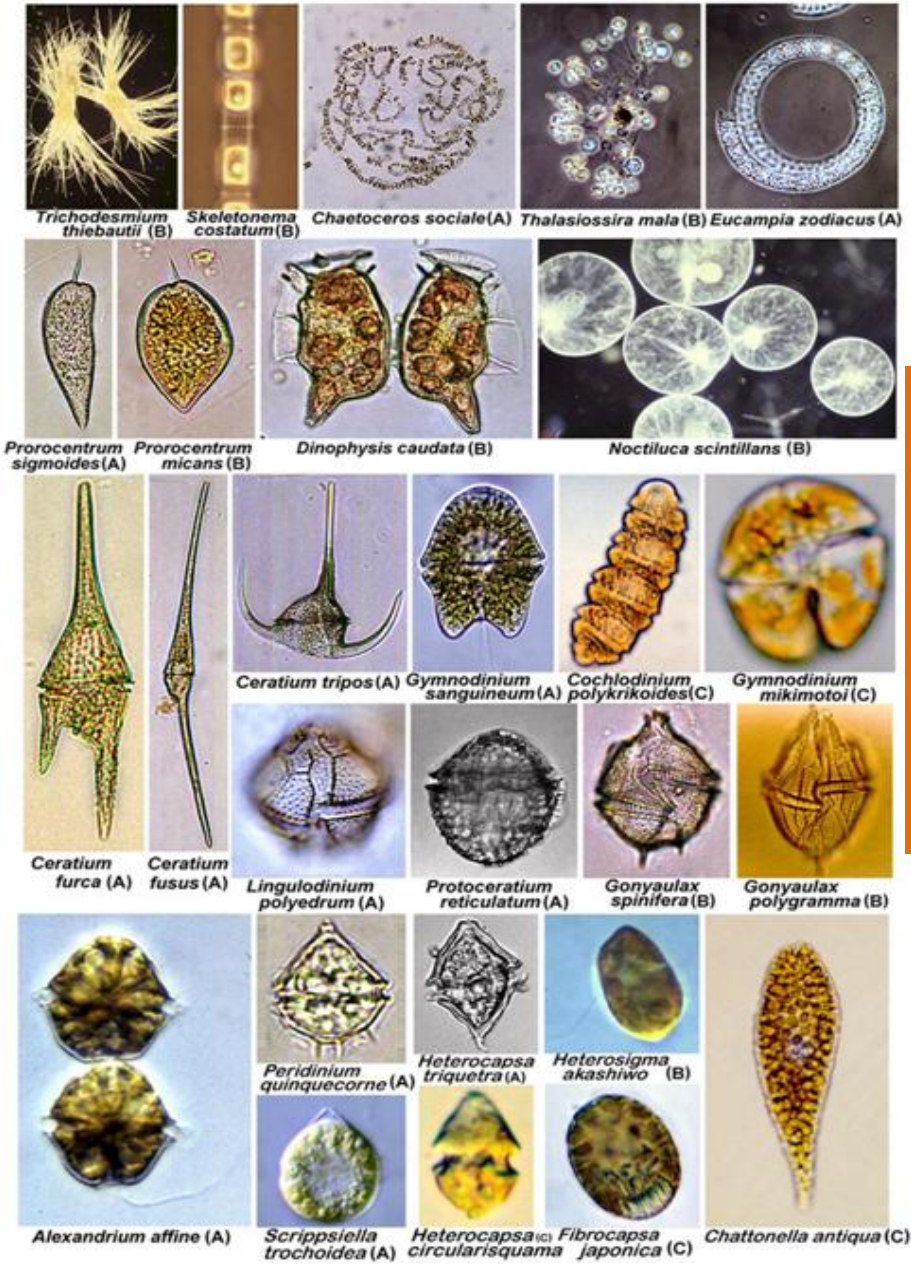

Coscinodiscus sp. bloom-
Off Calicut, Aug 2006


T. erythraeum bloom-
Off M'lore, March 2010

Colour, intensity, endurance and impacts of bloom depends on the nature of the bloomed species, cell density, age and the state of Sea

Some of bloom forming Microalgae

B:Potentially harmful by O_2 depleti



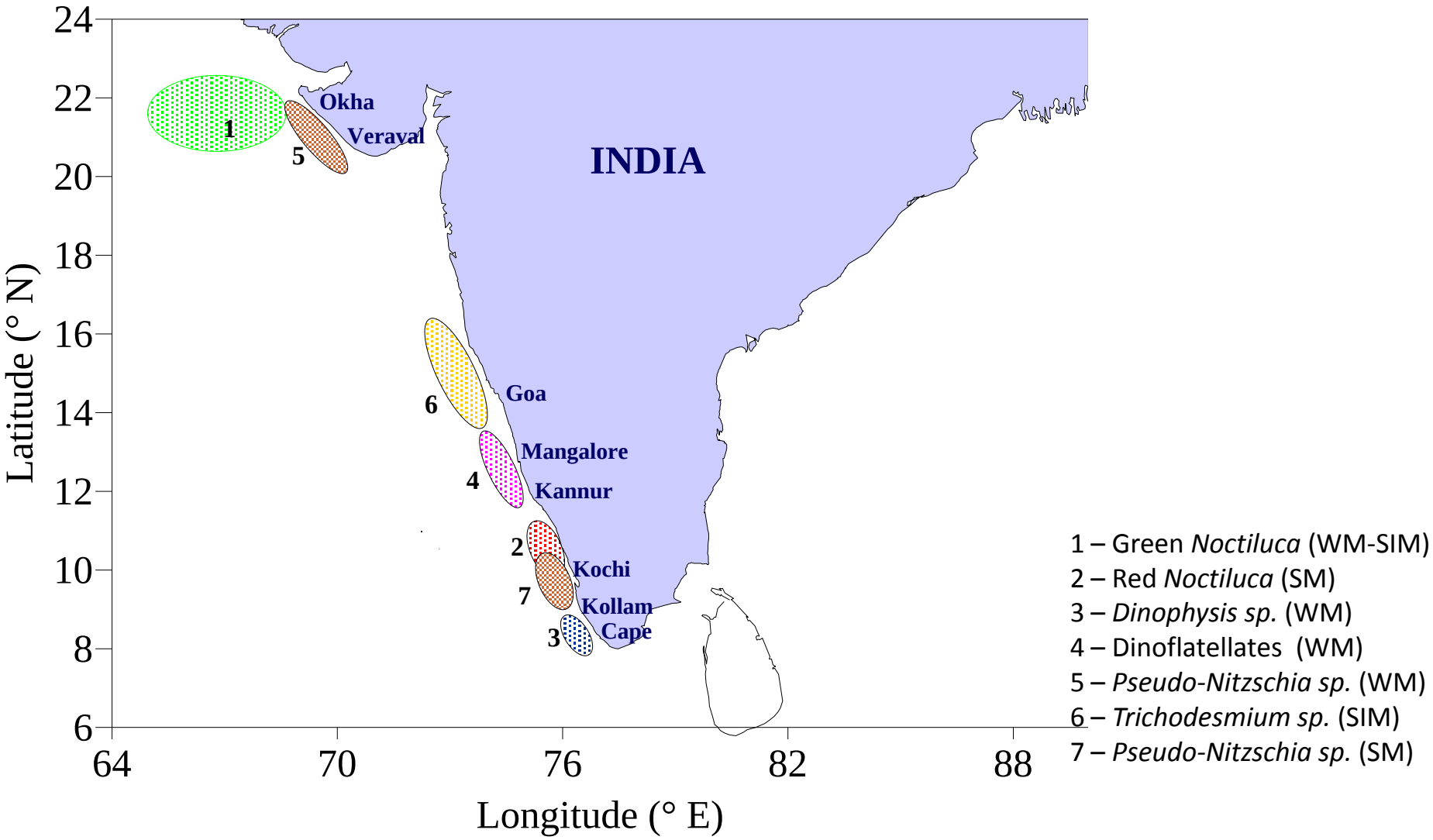
A:Useful

C: Harmful, fish mortalit

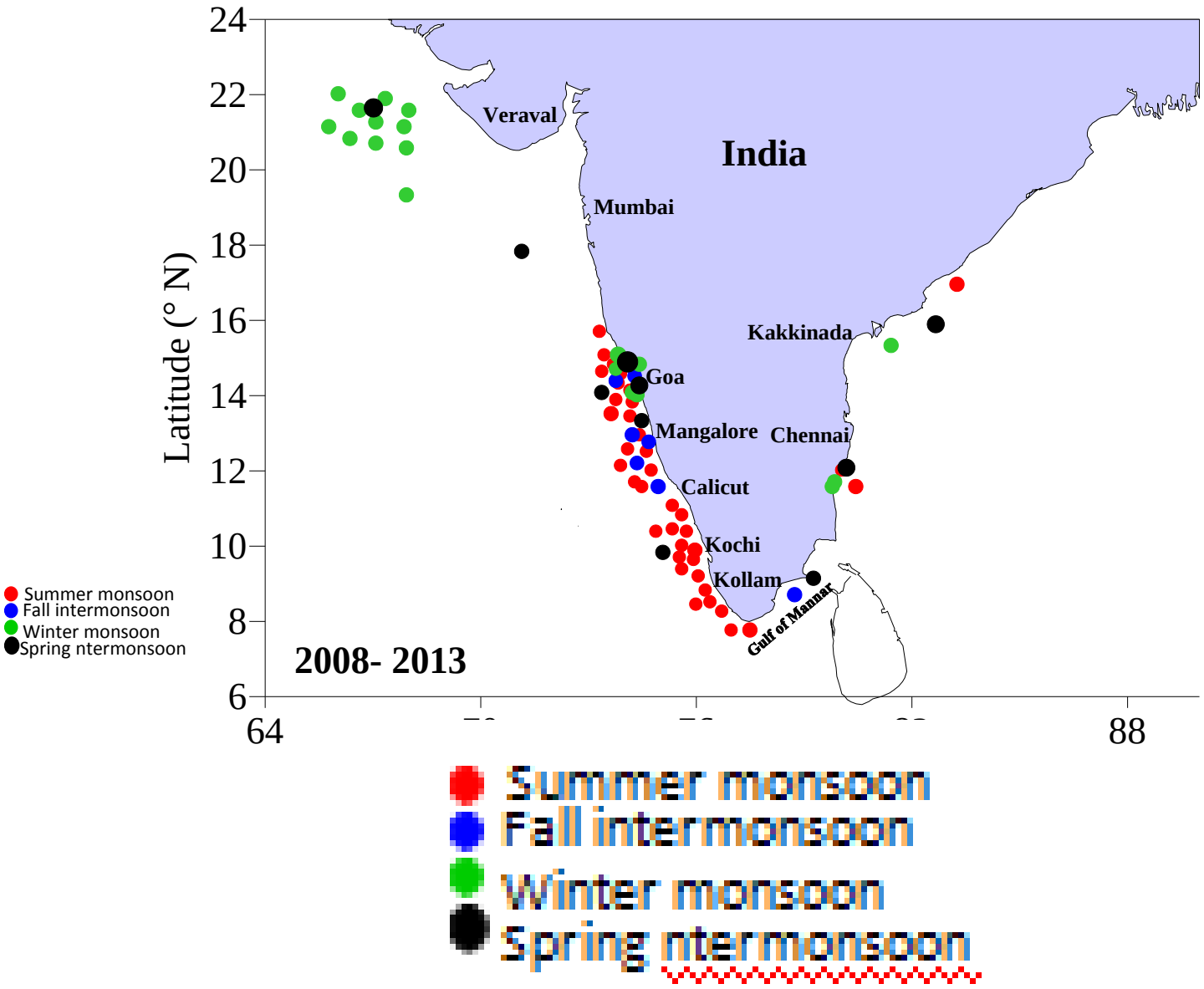
452 species of micro algae observed so far, of which
86 are bloom species and ~45 toxic species.

Harmful Algal Blooms (HABs) along the Indian EEZ

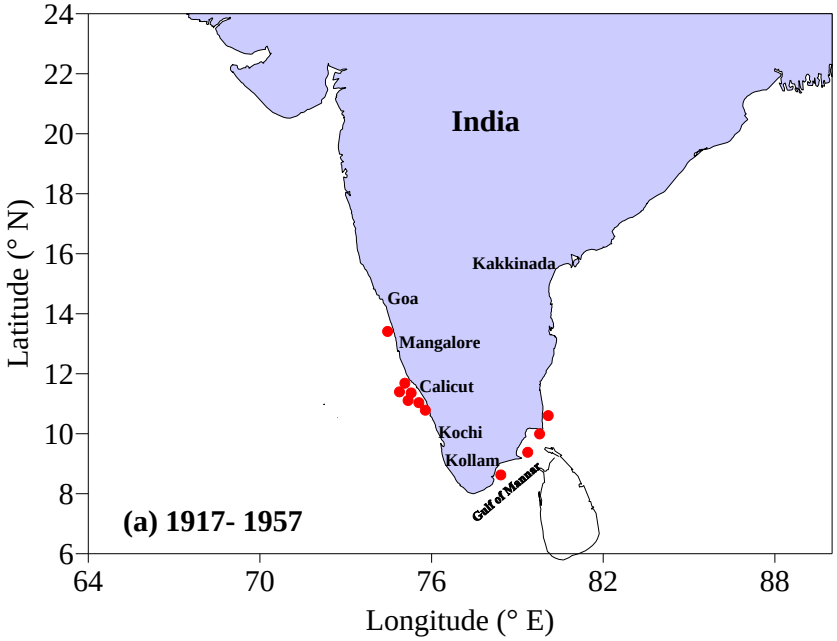
HAB Hotspots

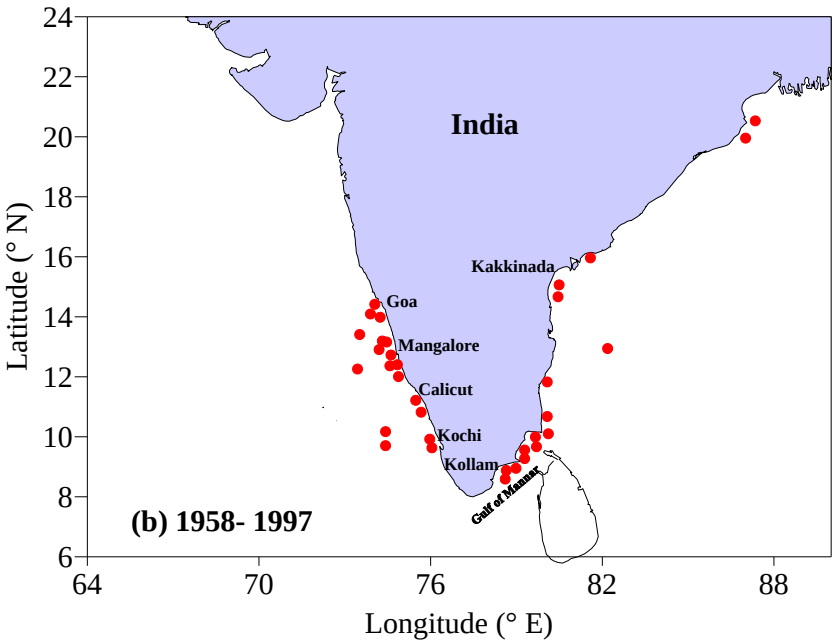


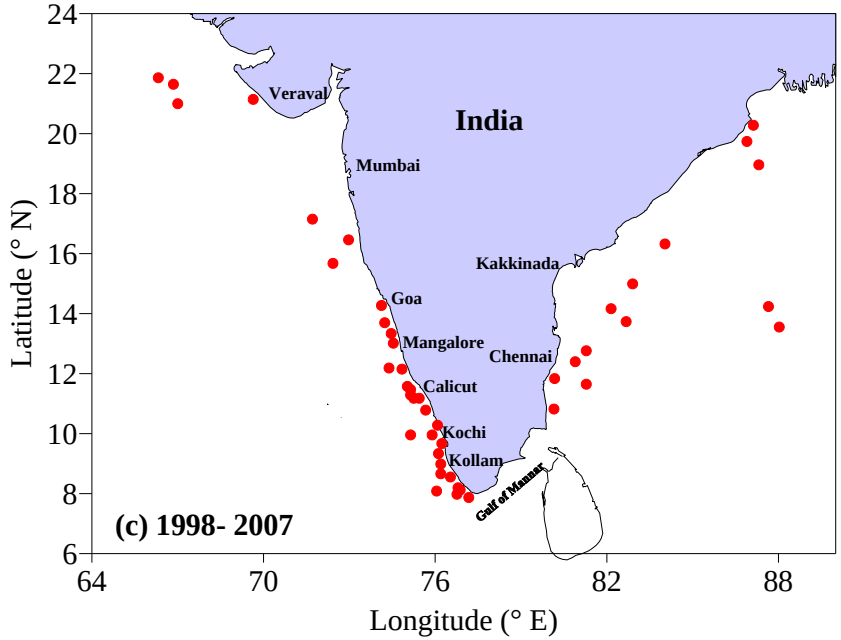
Seasonal occurrences

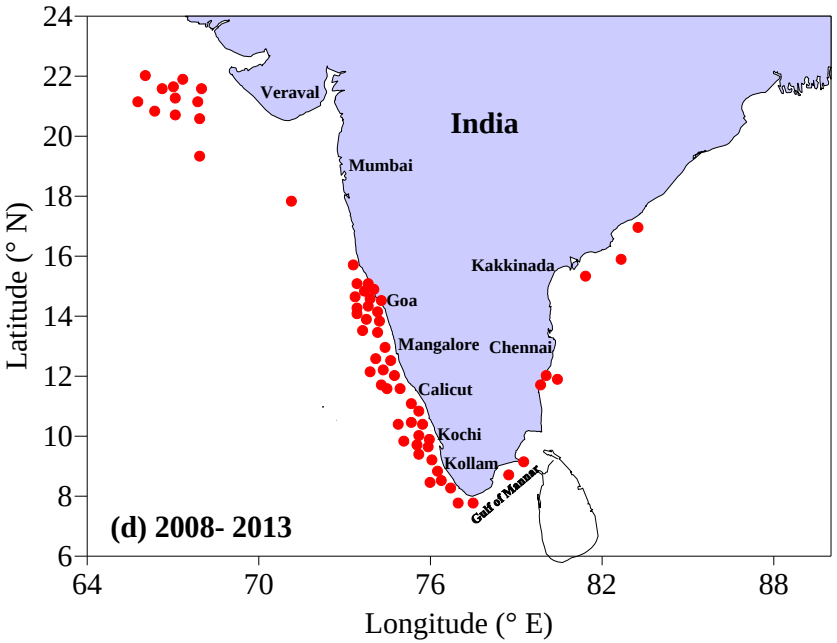


Centennial changes



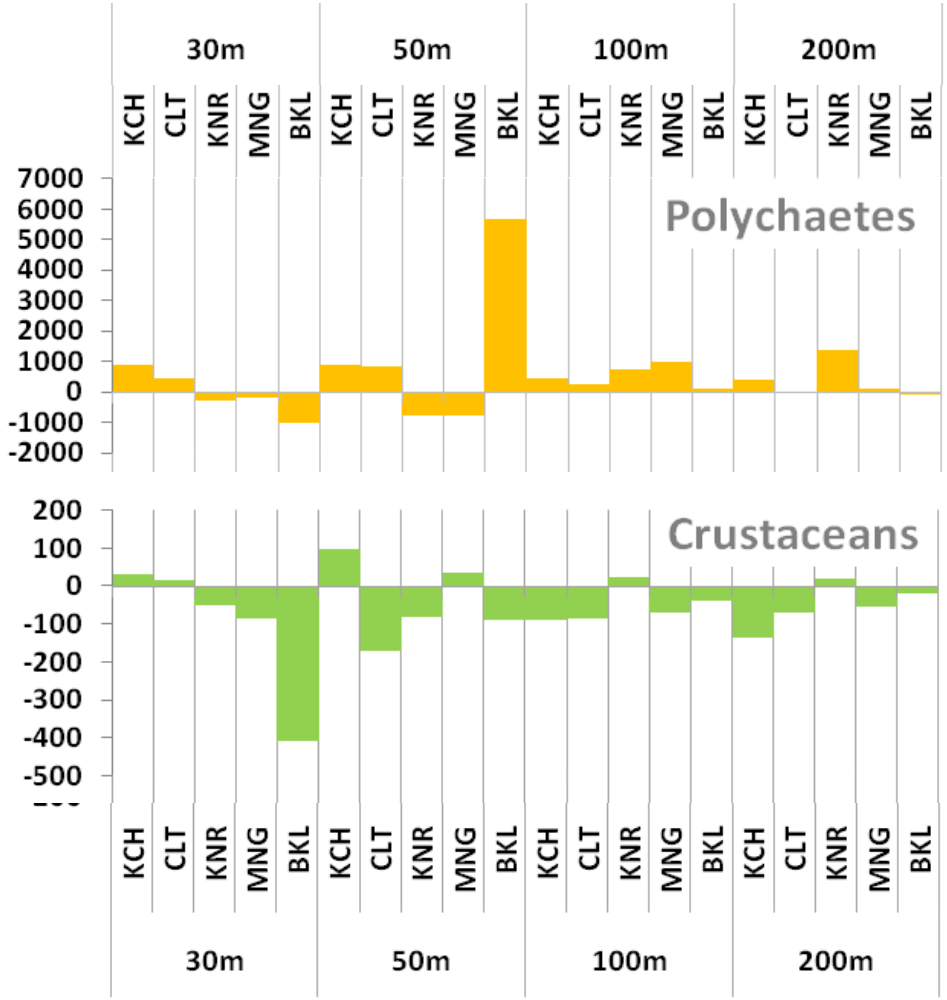






Decadal changes in Marine Benthos

Comparison between 1998 and 2012



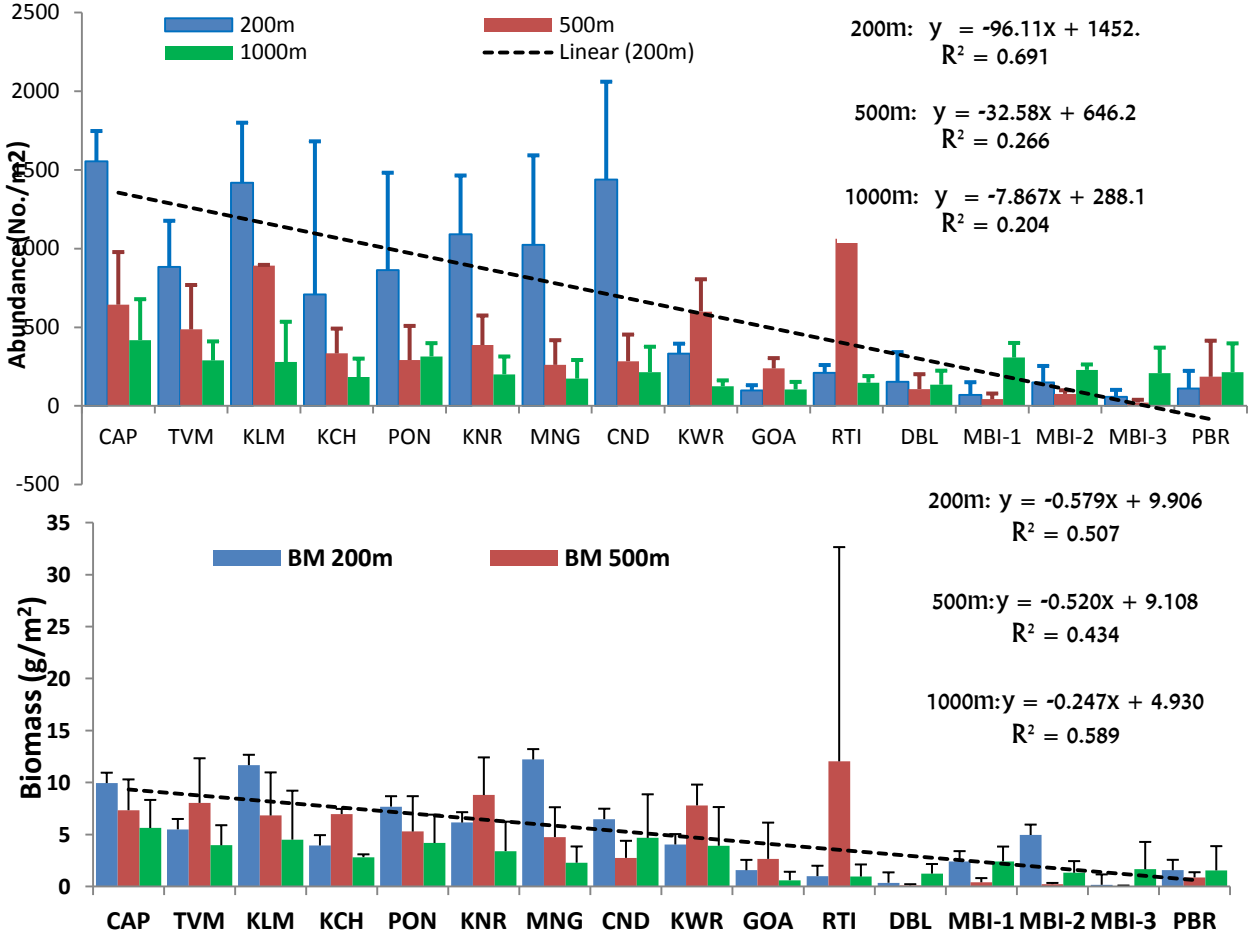
Environmental conditions were more or less unchanged and the bathymetric variations were prominent

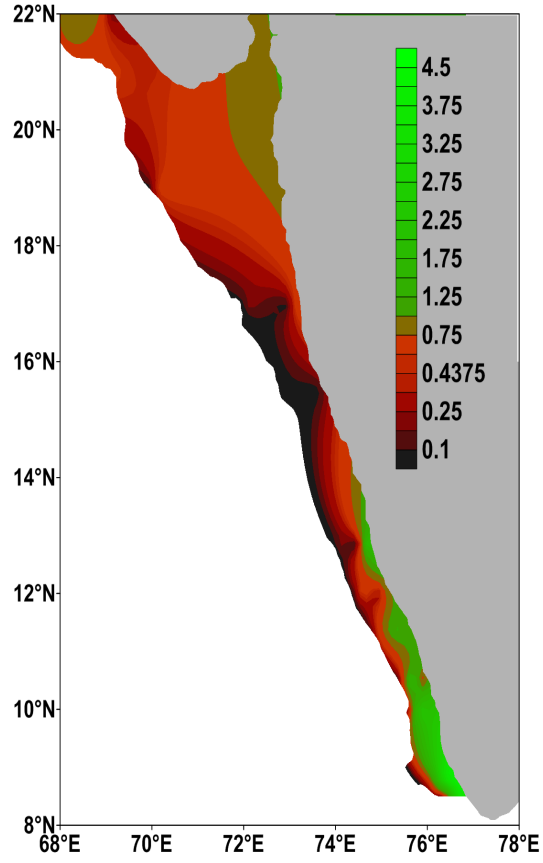
Density of polychaetes increased and crustaceans decreased at most sites – increase in total density

Total biomass decreased, indicating an overall reduction in size of fauna

Increase in dominance of opportunists (polychaetes) in 2012, and decline in crustacean density – not a good trend in healthy ecosystem

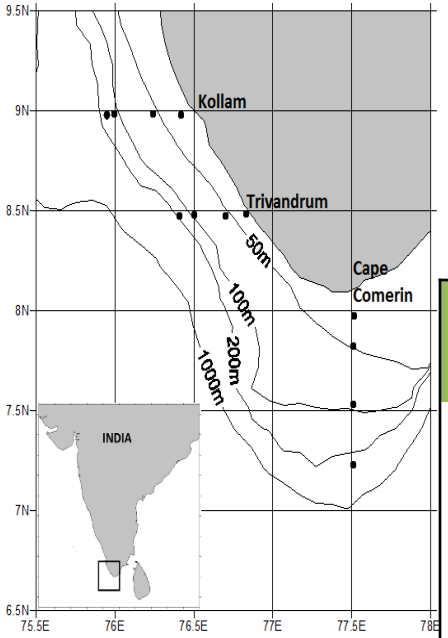
Benthos in Arabian Sea shelf (200-1000m)





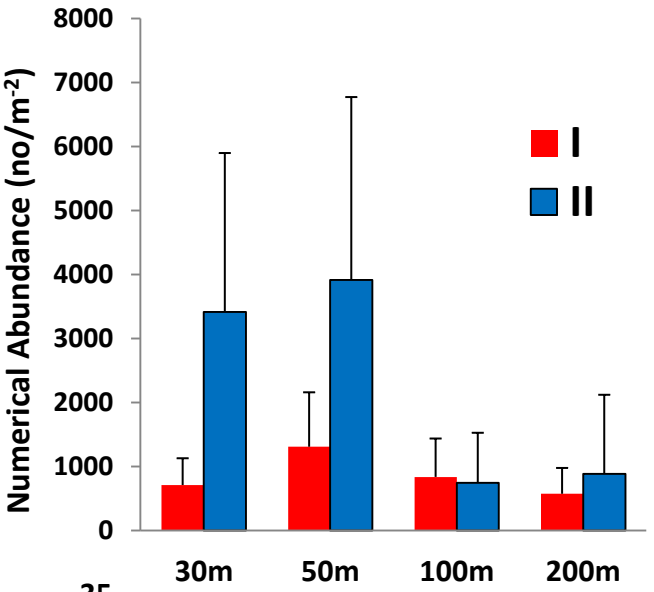
Abundance & biomass of macrofauna decreased towards north, where the influence of Arabian Sea OMZ is strong, particularly at 200m & 500m depth (OMZ core)

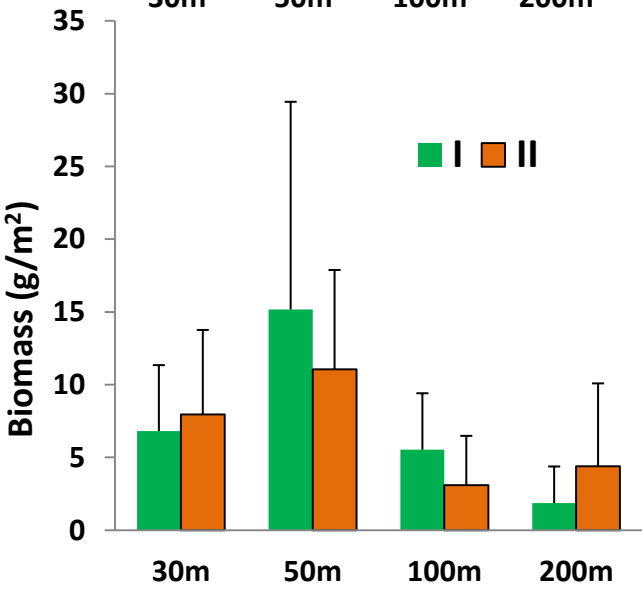
Trawl ban effect on Marine Benthos



Pre-Ban (I): 30th May-5th June 2009
Post-Ban (II): 14th-19th Aug 2009

Density	Pre Ban	Post Ban
30m	711 ± 419 ind. m^{-2}	3418 ± 2482 ind. m^{-2}
50m	1310 ± 850 ind. m^{-2}	3917 ± 2856 ind. m^{-2}

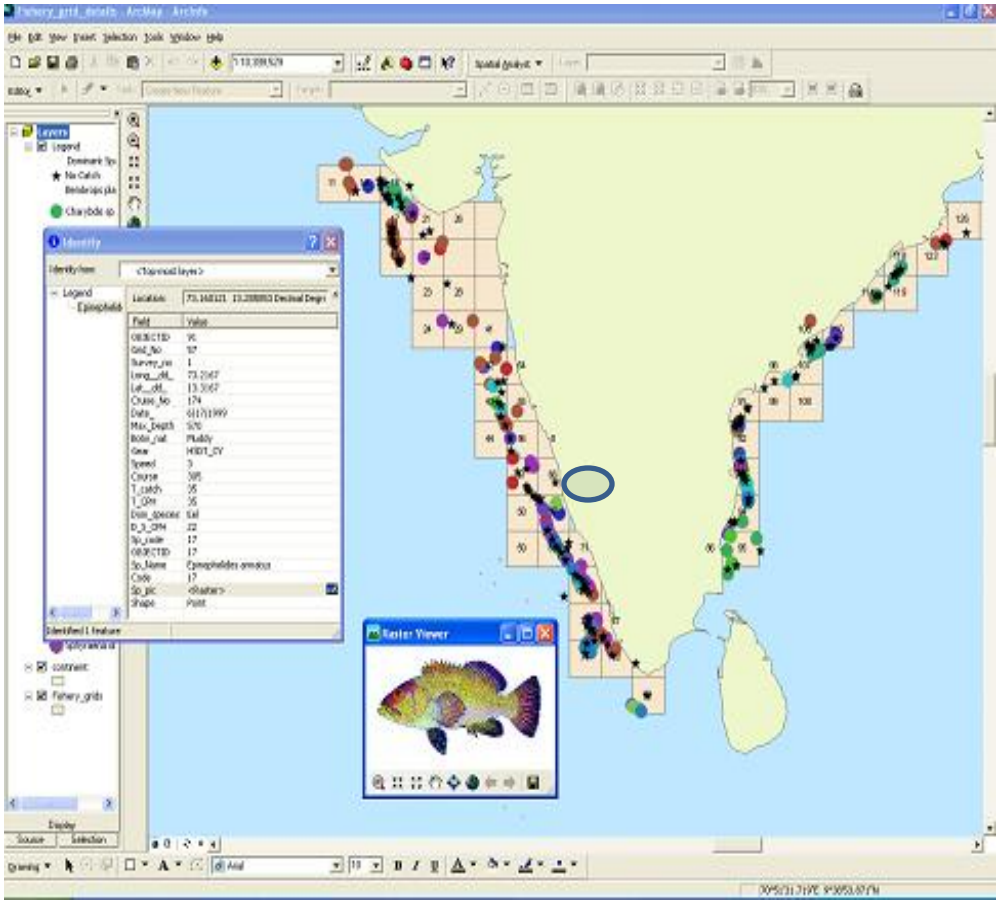


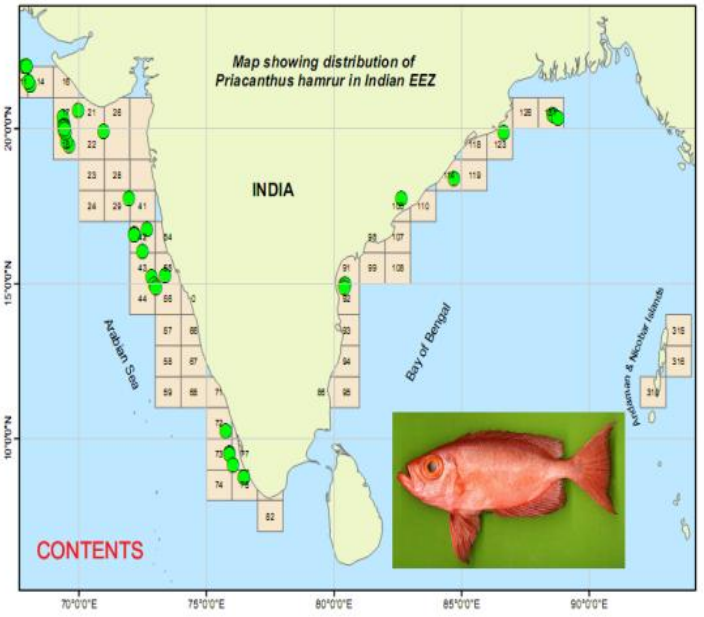


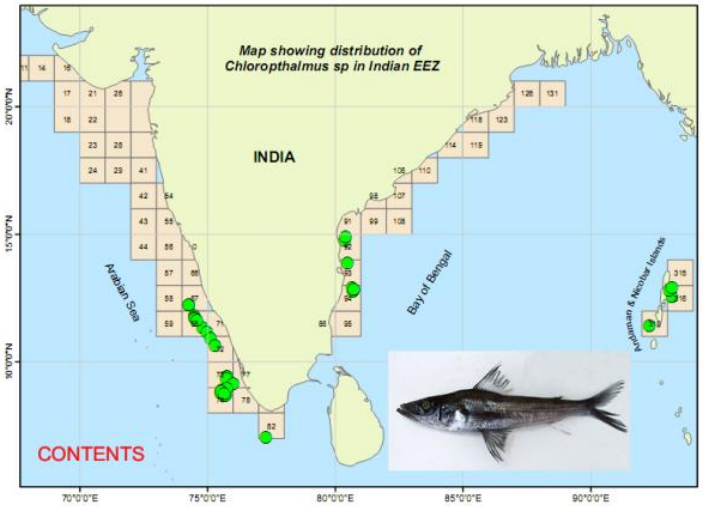
- Southwest monsoon - breeding season for many polychaetes
- High abundance of larvae and juveniles in post ban.
- **Monsoon ban has a positive impact on spawning success, larval development and settling**

Jaleel *et al.* (2015)

Deep-sea fishery resources in Indian EEZ

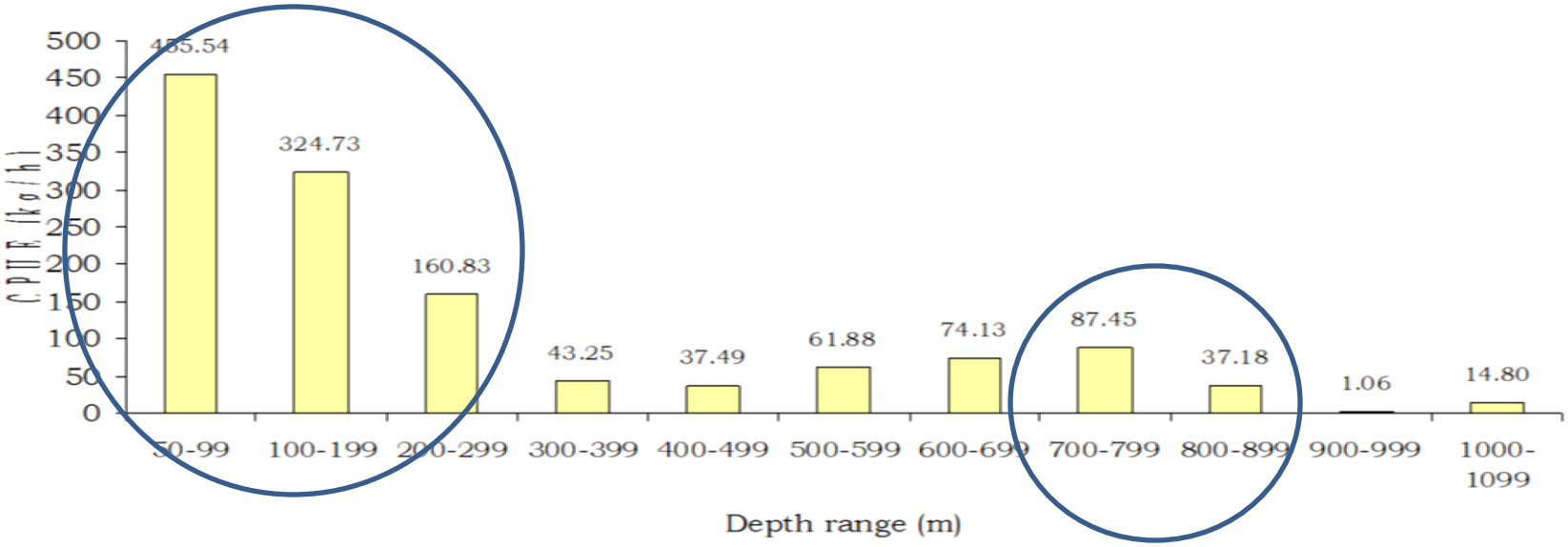






Delineated distribution pattern of about 536 species which are available in the shelf and slope regions of Indian EEZ area.

Figure 5: CPUE of deep-sea fish catch from different depth zones along the India EEZ during the study period



Deep sea and distant water fishery

CMLRE

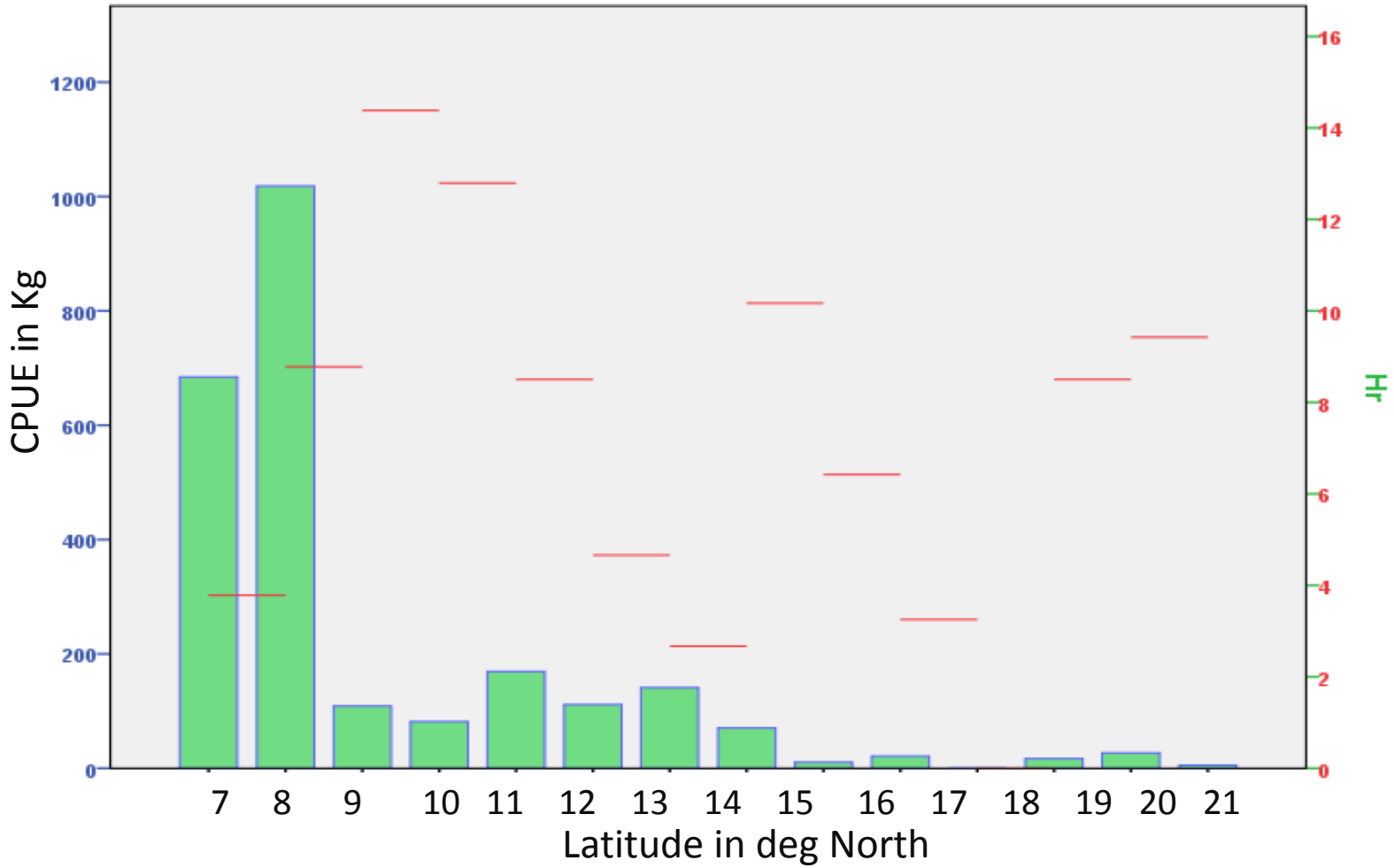
Initiatives

Region wise catch-effort data for demersal fishery (200-1000m depth)

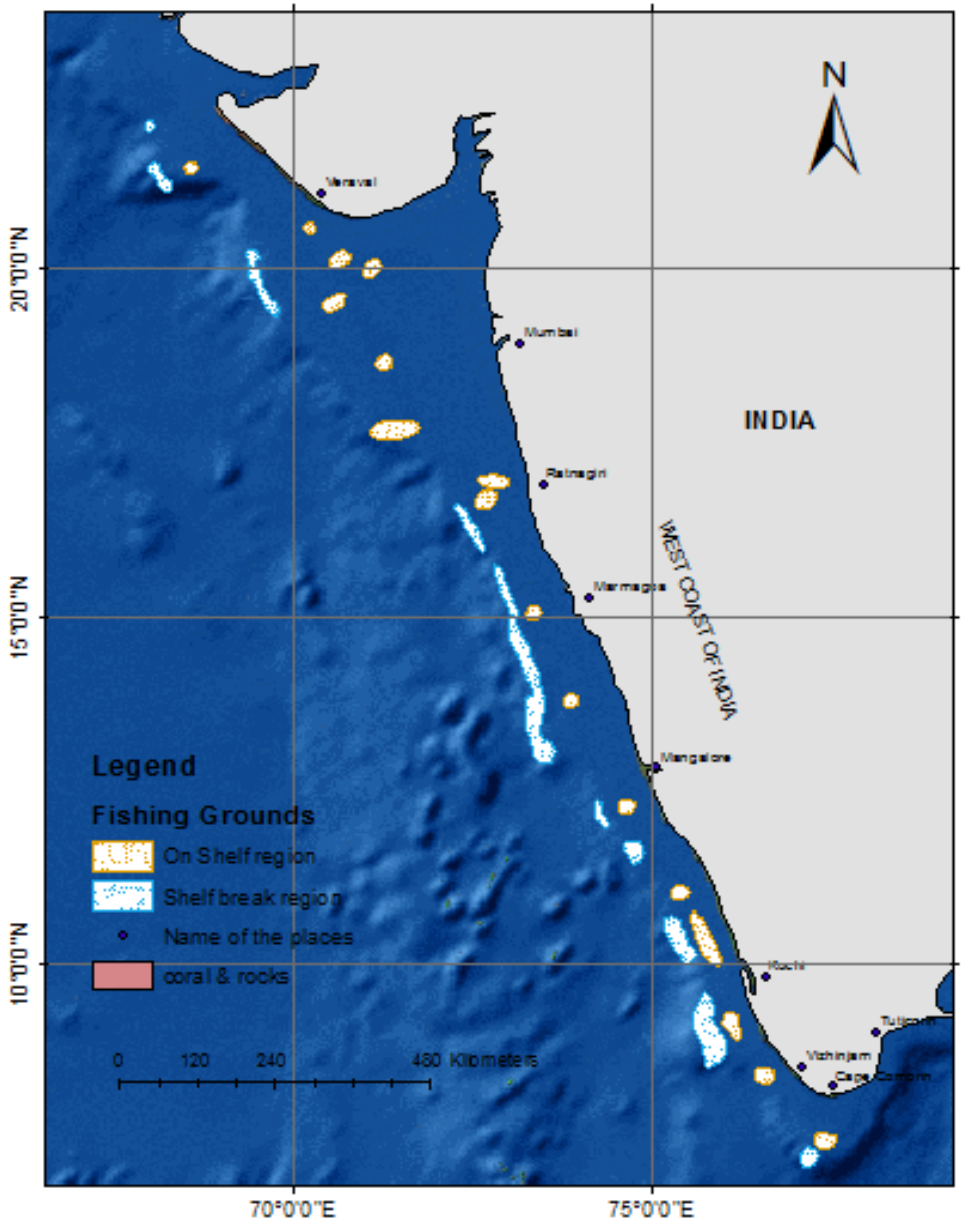
Region	No. of hauls	Effort (hrs)	Total catch (Kg)	CPUE (kg/hr)
NW coast	38	32.9	555.7	16.9
SW coast	100	97.4	23328.3	239.5
SE coast	55	54.1	5515.7	102.0
NE coast	53	49.2	4148.0	84.4
A & N waters	35	31.8	4189.8	131.9
Total	281	265.3	37737.5	142.23

Latitudinal variation in demersal fishery resources along west coast of India

(Catch/Hr along 200-1000m depth)

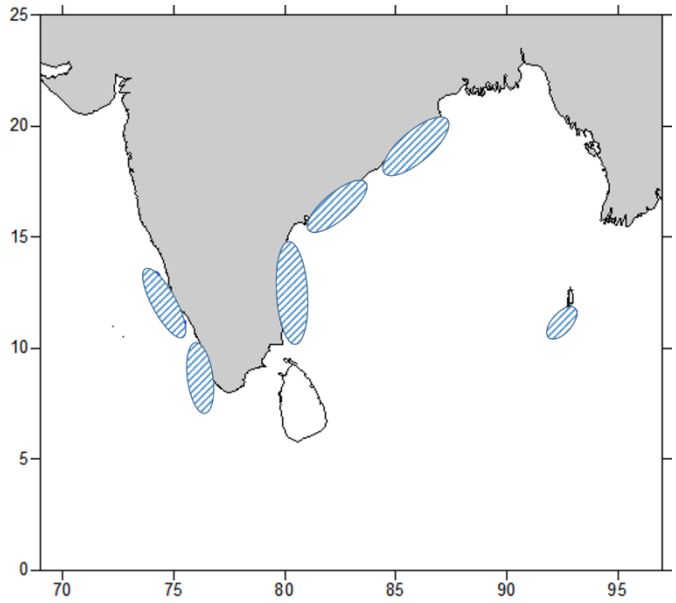


Trawlable fishing grounds along the West coast of India



17 on shelf and 11 on slope

Spatial database on trawling grounds along West coast of India



Potential fishing grounds identified along the Indian EEZ

Landing of deep sea shrimp *Plesionika sp*

Area : Kochi (10°02.418’N; 75°36.443' E)
Season : Summer monsoon (Aug 2010)
Depth : 235m
Trawl : HSDT (CV)
Effort : 1 hr
Catch : 950 kg
Bottom : Muddy

DEEP-SEA CRUSTACEAN RESOURCES

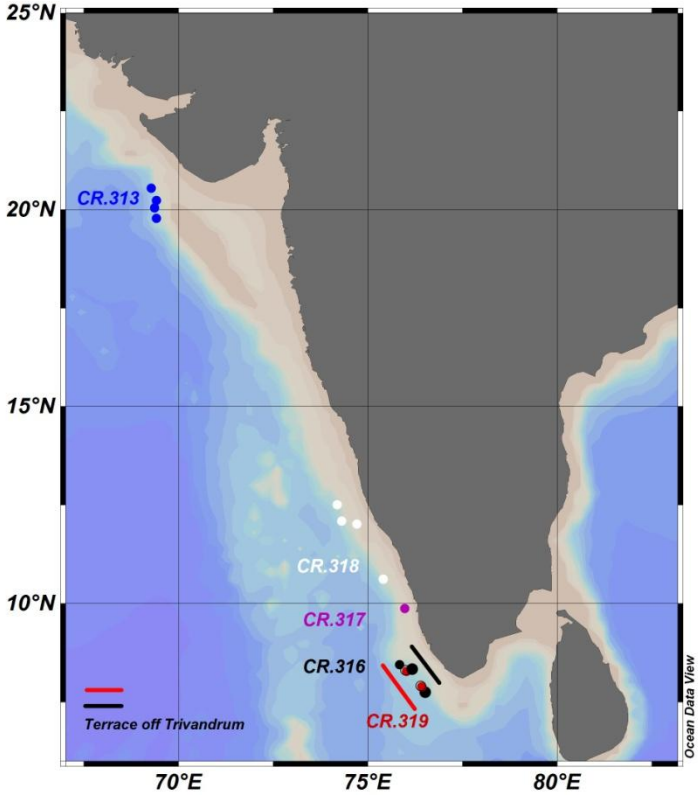
- Record catch of Deep-sea prawn, *Aristaeopsis edwardsianus* (Johnson, 1867) and *Metapenaeopsis andamanensis* (Wood-Mason, 1891)

Aristaeopsis (Plesiopenaeus) edwardsianus
Off Trivandrum, Lat 8◦ 18.60”N, 76 ◦ 13.72”E
at a depth -995m , CPUE- 14 kg/hr

Mixed catch of *M. andamenensis* and *S.hextii*
off Karwar, Lat 14 ◦ 17.34 N, 73 ◦ 15.00”E
at a depth-214m , CPUE- 100 kg/hr

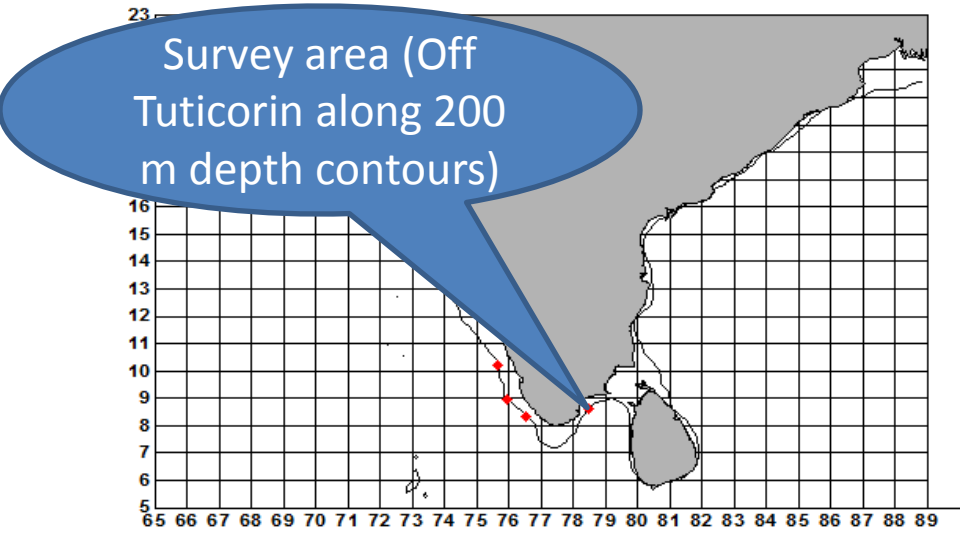
Bulk catch of
Lamprogammus niger (Cr.319)

Neohariotta pinneta &
Echinorhinus. Brucus (Cr.318)

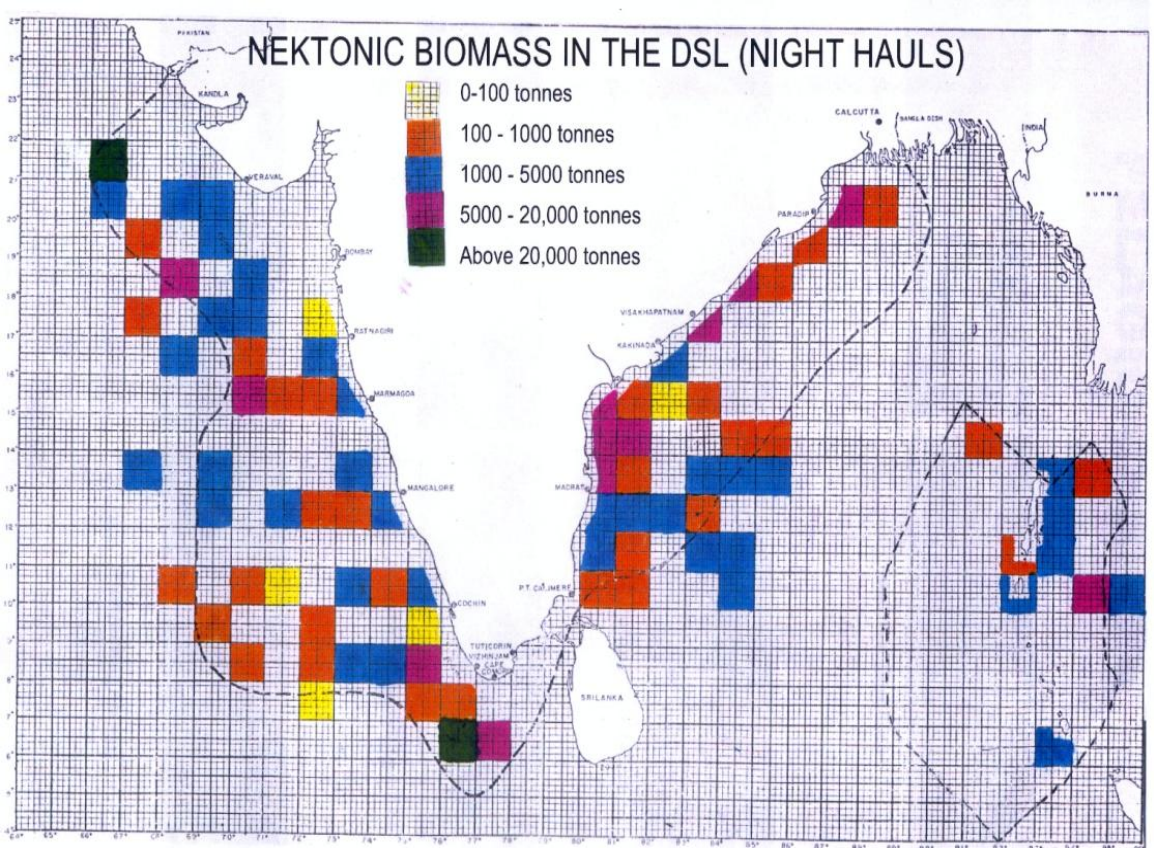


A total of 80 species were recorded from the bathyal region of the Terrace off Trivandrum. CPUE recorded as 198 kg/ hr

Record catch of pelagic crab *Charybdis smithii* by FORV Sagar Sampada in its entire service of past 34 years



Myctophid Resources of Arabian Sea



MYCTOPHIDS

Bolinichthys longipes

Myctophum spinosum

Diaphus fragilis

Cerotoscopelus warmingii

Benthosema pterotum

Hygophum proximum

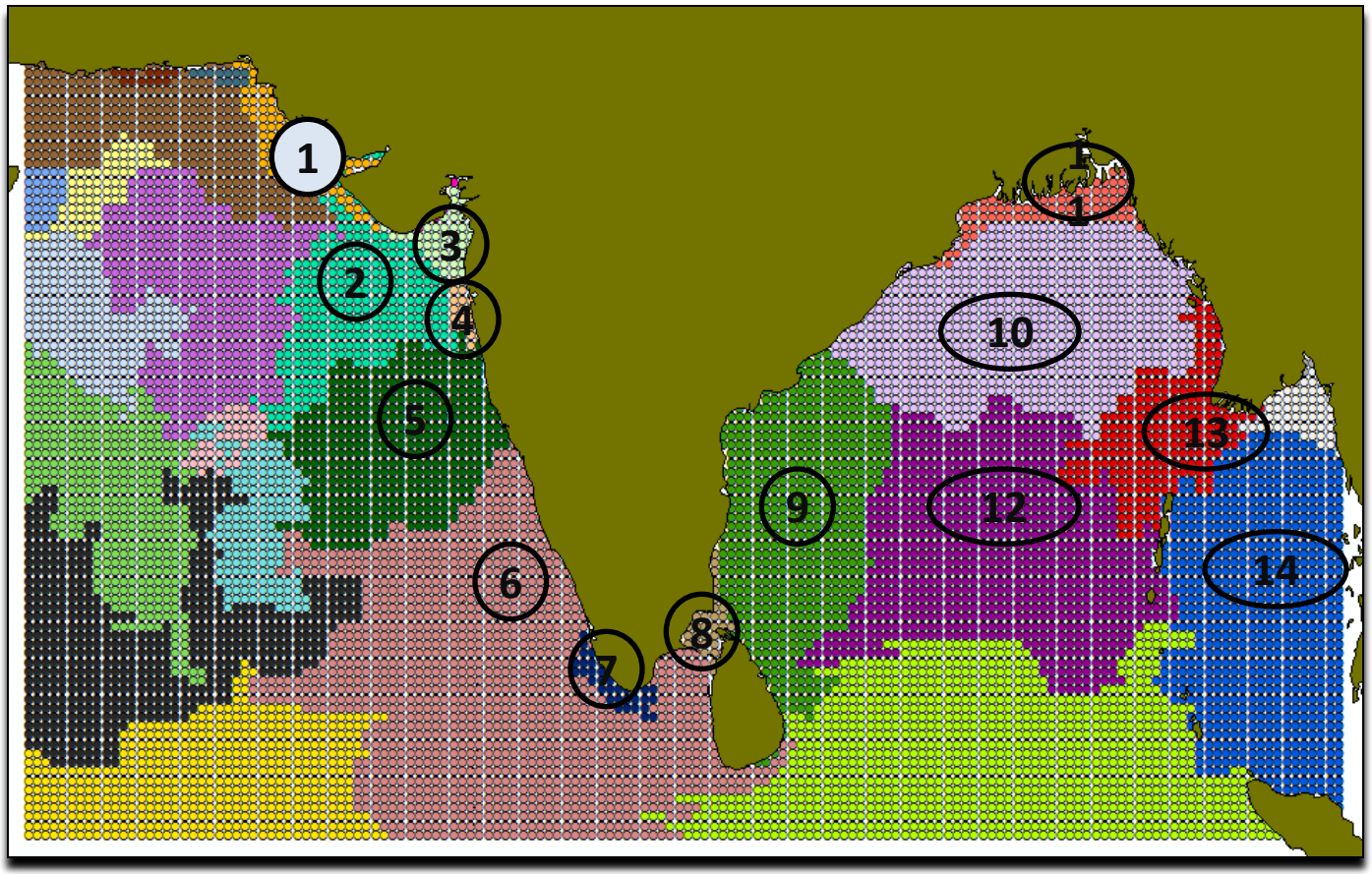
Lampanyctus turneri

Symbolophorus evermanni

- **Biocomposition of DSL species established**
- **Biomass of DSL Plankton and nekton worked out.**
- **Trophic relations established**
- **DSL Atlas prepared**

Benthosema pterotum

Data products - Delineation of different eco-bioregions



14 major eco-regions have been identified within the Indian EEZ

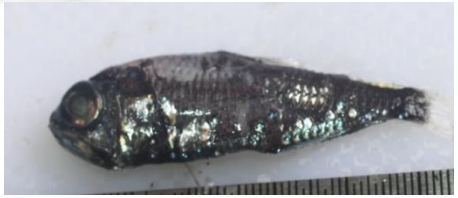
"geographically or oceanographically discrete areas that provide important services to one or more species/populations of an ecosystem or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics, or otherwise meet the [EBSA] criteria" – CBD definition of EBSA

Intensification of OMZ;

- Pushing out of Mid water Pelagic species from their natural habitat.
- Occupation of this niche by Myctophids??

Electrona sp

Diaphus sp



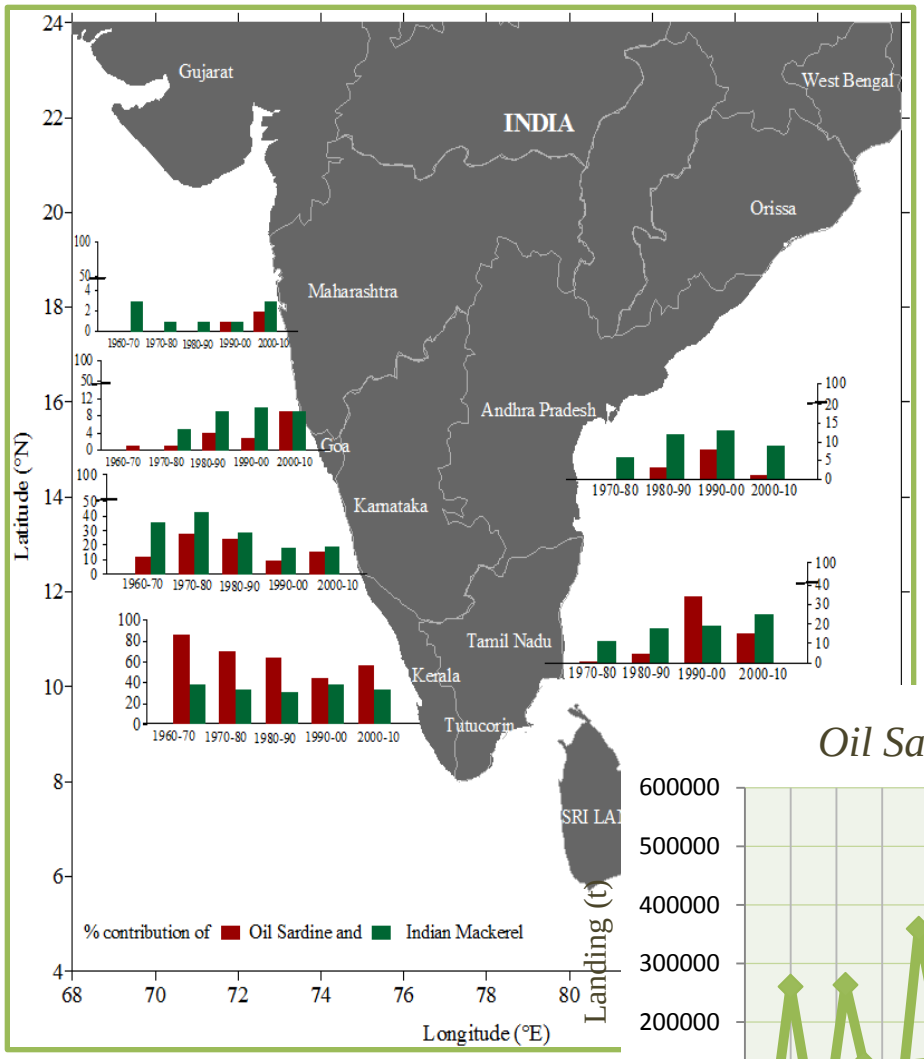
Hygophum sp

Bolinichthys sp

Lampanyctus sp

Myctophum sp

Regime shift and expansion in geographic range of oil sardine

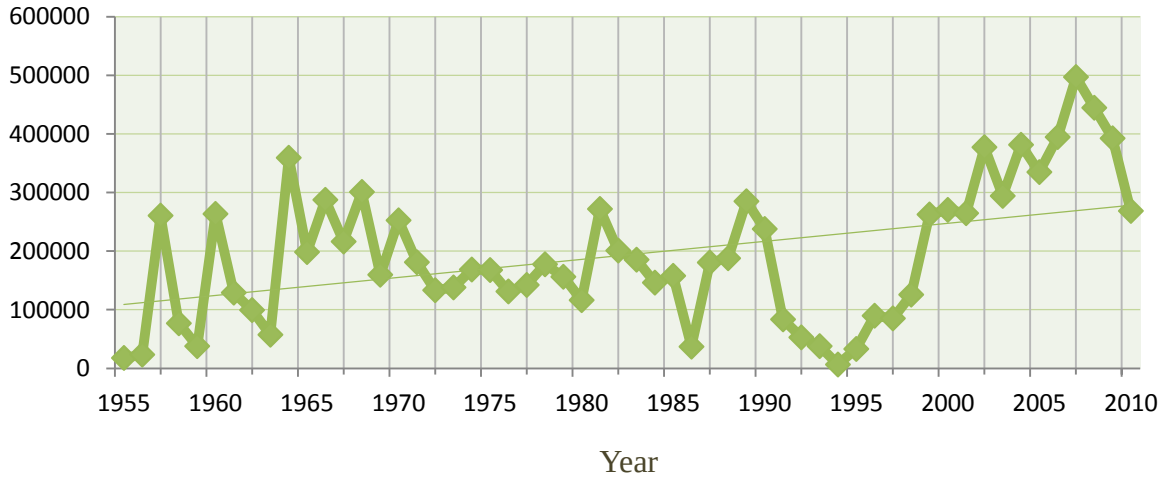


Expansion in the geographical range of Oil-sardine and Indian Mackerel in recent decades along the Indian coast

Until 1985, almost the entire catch was from the Malabar upwelling zone and the catch was either very low or there was no catch from latitudes north of 14oN along the west coast.

In the last two decades, however, the catches from latitude 14oN - 20oN and along the east coast are consistently increasing

Oil Sardine Landing (tons) for West Coast of India



Jelly fishes/Gelatinous zooplankton

Off Trivandrum showing Dead Jelly fish washed ashore

Swarms of Salpa sp. observed during February-March 2012 in NEAS

Increase in Jelly fish population in the Indian waters???

Plausible Causes in rise

- ❖Climate change causing waters to warm and stratify
- ❖Eutrophication leading to hypoxia which jelly fish can tolerate more readily than fish

The jellyfish explosion is alarming for coastal fishery as it consumes the food of the bigger fish

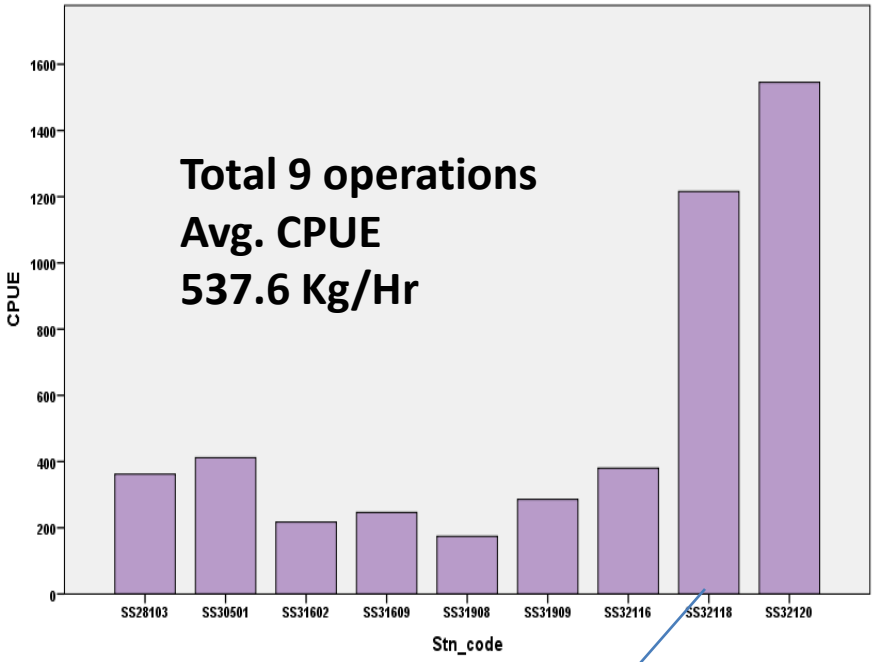
Climate change and Cephalopod Resources

India's squid fishing fleet accounted for 3% of the global squid production and makes up approximately 5–7% of U.S. squid imports

The proposed changes responded quickly in the squids and act as ecosystem indicators of environmental change by minimum growth rate and maximum production since, the increase in ocean temperatures can cause faster growth and shorter life spans of squid.

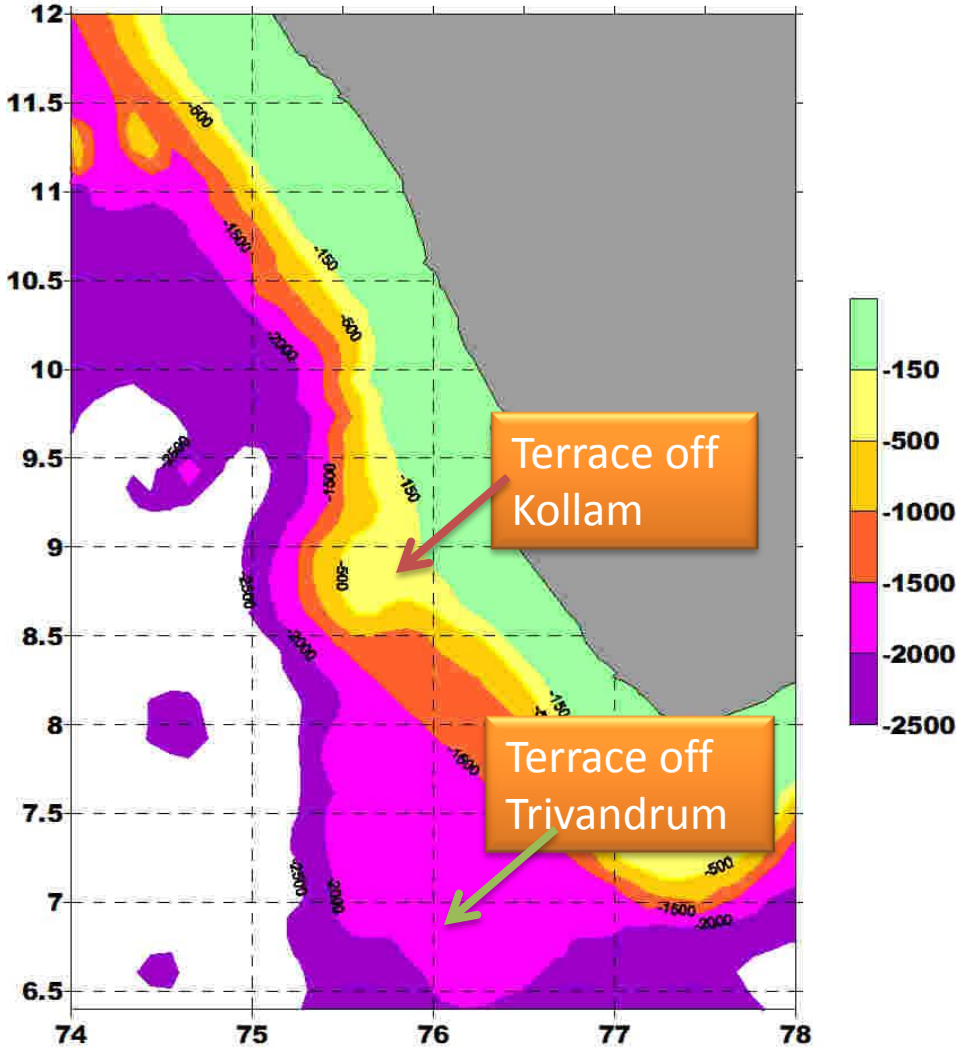
The Indian squid (*Loligo duvaucelii*) is the dominant species, landing about 97% all over the country per year.

Deep Sea and Distant Water Fishery – Survey near Terrace of Trivandrum

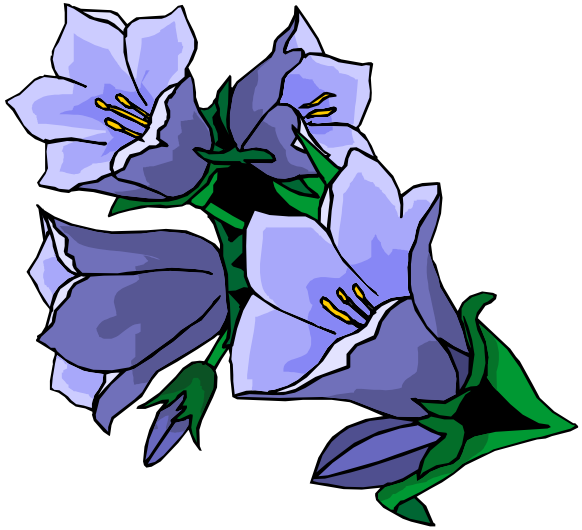


Unusual catch was due to this species

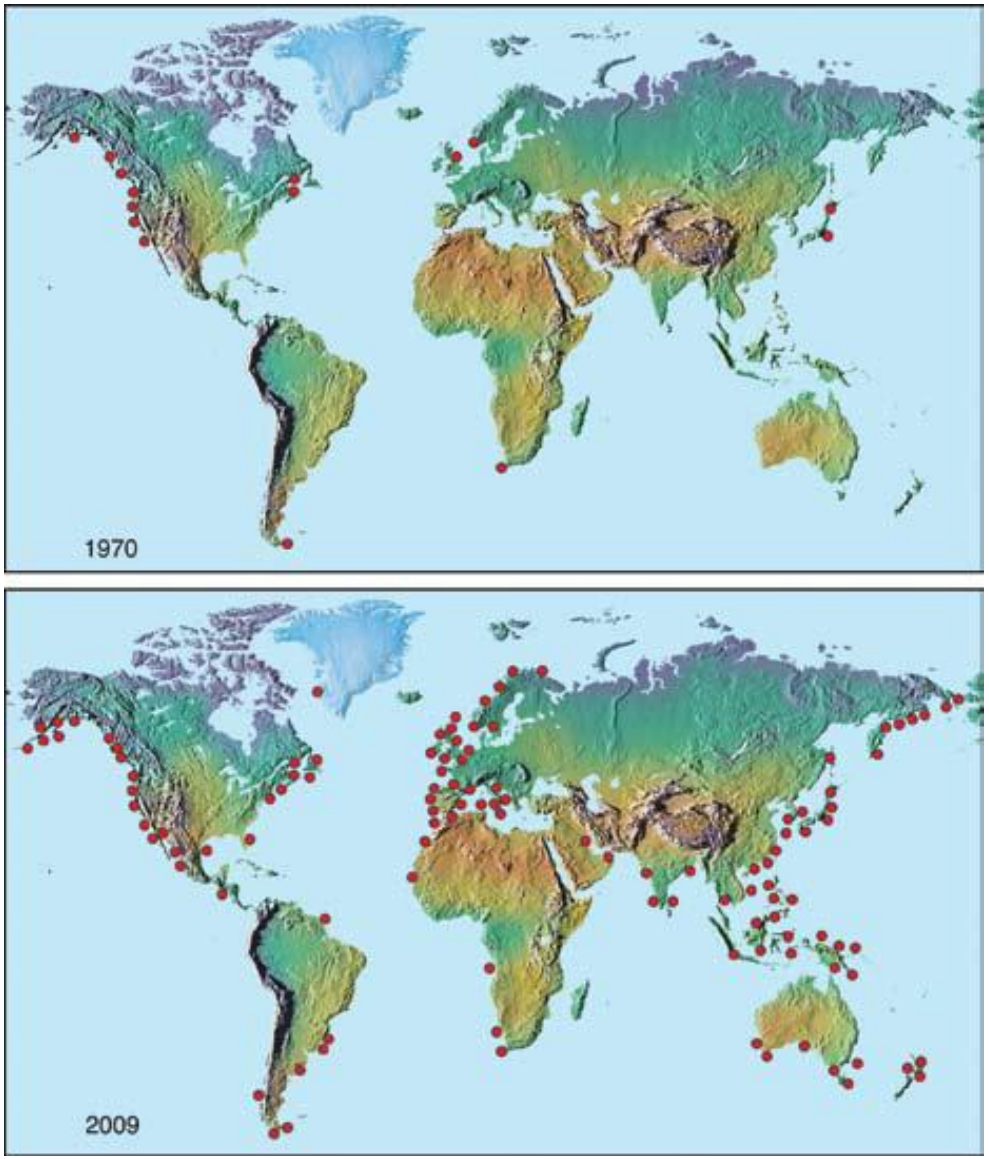
Lamprogrammus brunswigi



Thanks for patience



HAB incidence growing world wide

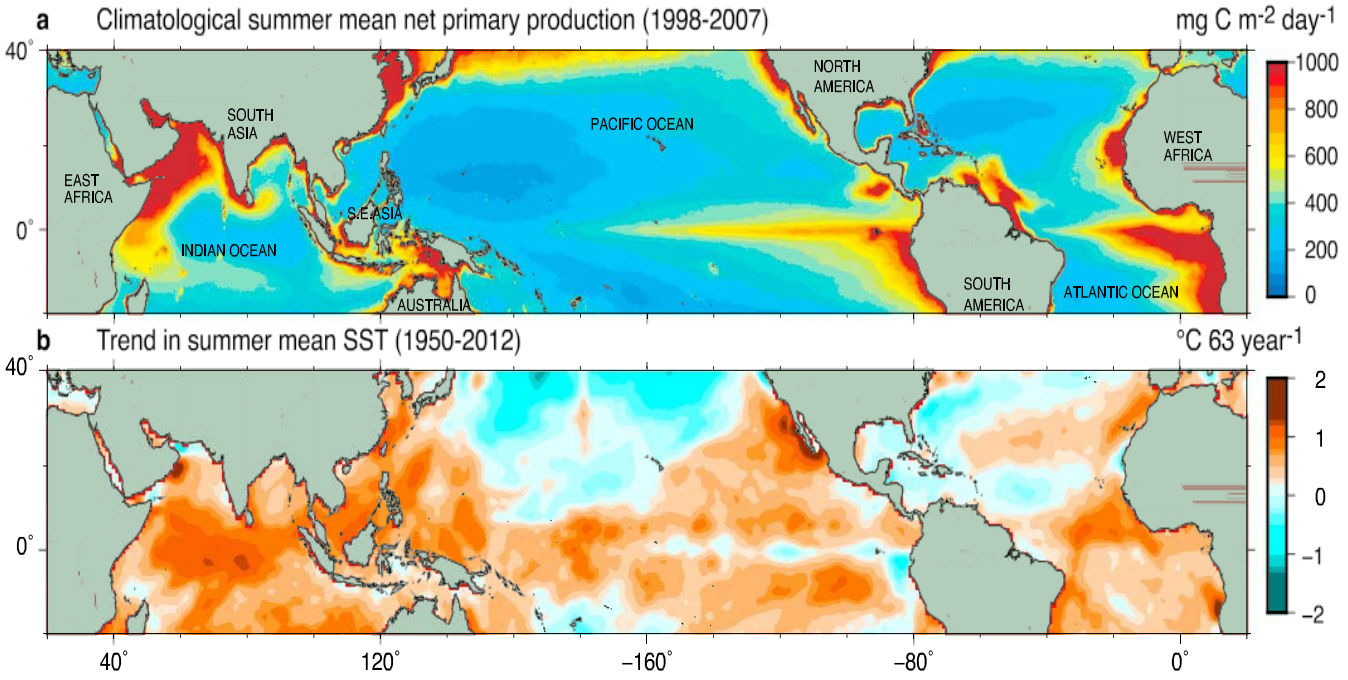


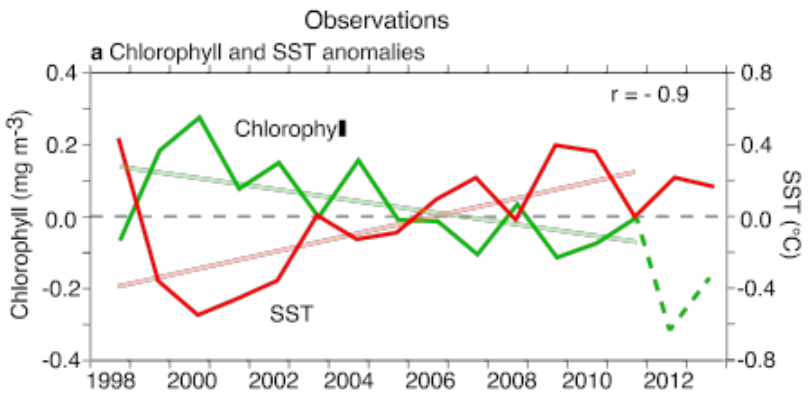
Global expansion in the distribution of PSP toxins- 1970 compared to 2009.

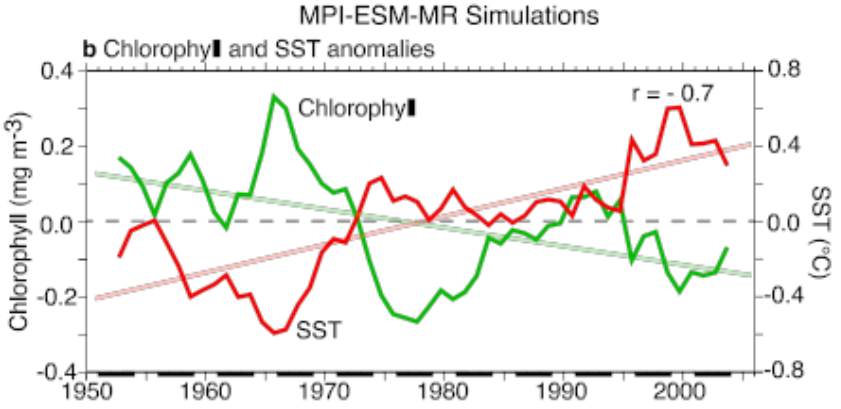
Red circles denote locations with documented measurements of PSP toxins in shellfish, fish, or plankton samples.

Data:
US National Office for Harmful Algal Blooms, Woods Hole Oceanographic Institution, Woods Hole, MA

Long-term changes in surface chlorophyll in western Arabian Sea



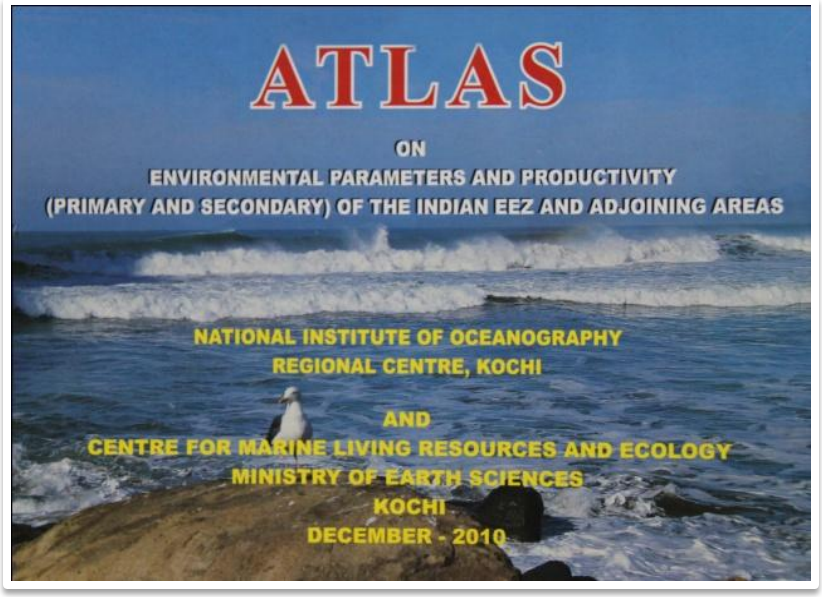




Roxy *et al.* (2016)

Decrease in Chlorophyll – what will be fate of OMZ and Fishery?

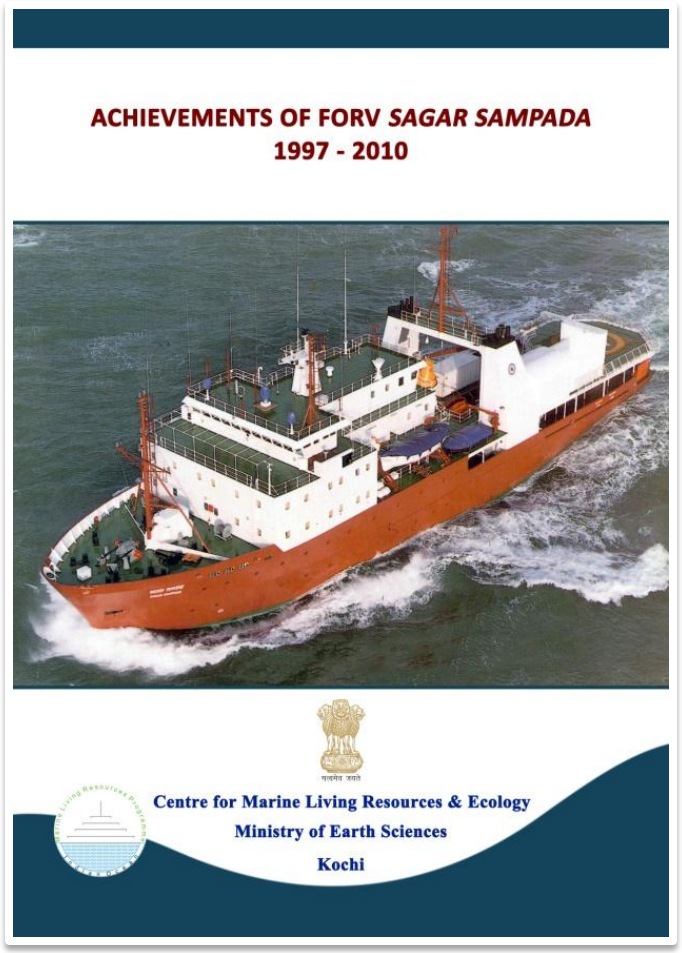
ATLAS ON ENVIRONMENT & PRODUCTIVITY PATTERNS OF INDIAN EEZ



INFORMATION ON THE PHYSICAL CHEMICAL AND BIOLOGICAL ATTRIBUTES OF THE INDIAN EEZ SURFACE TO 1000M DEPTH COVERING THE SM, FIM, WM AND SIM SEASONS

DATE OF RELEASE : 02.12.2010
TOTAL PAGES : 305
PRICE : RS 2500/-

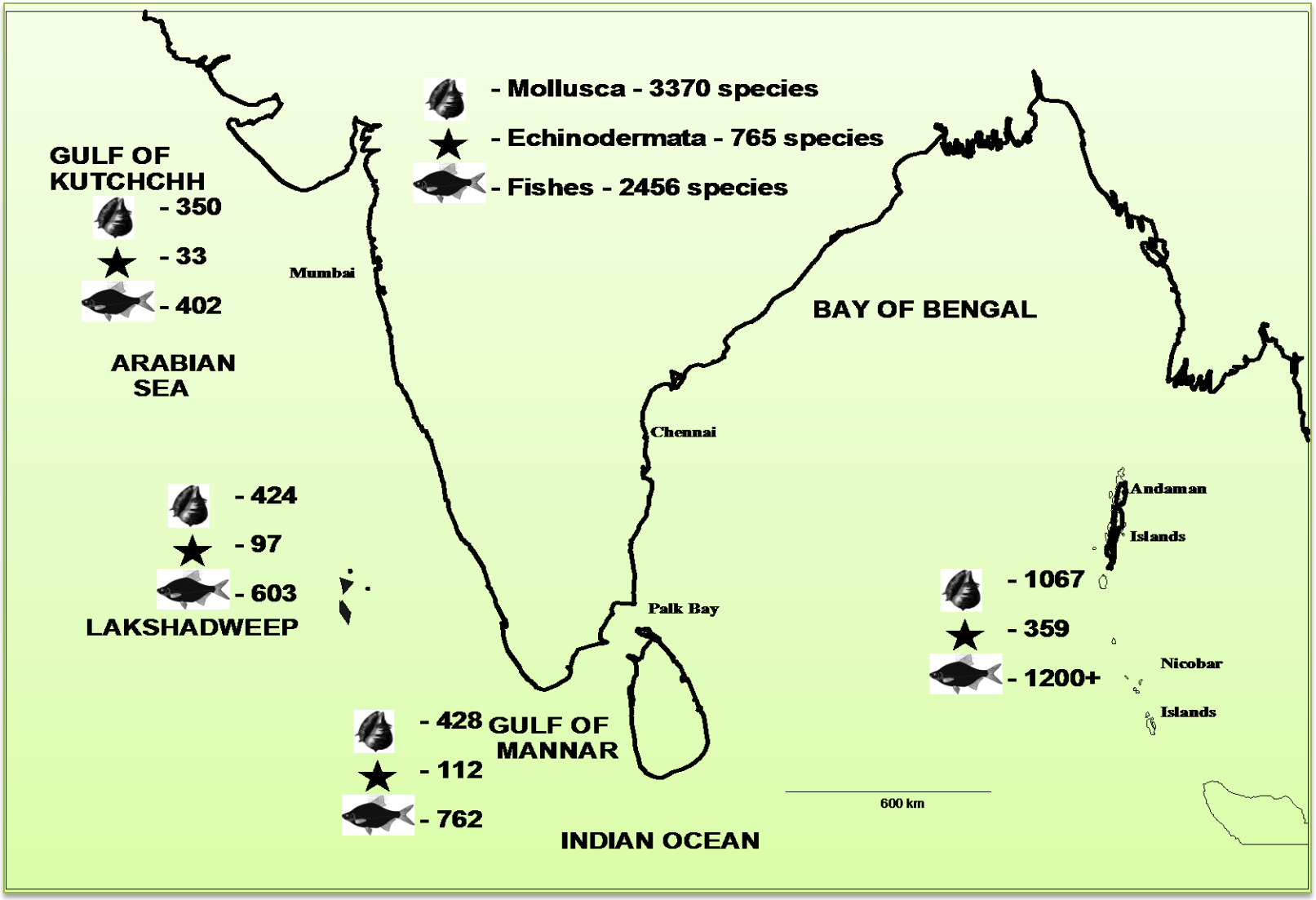
MLR – Achievements of FORV-*Sagar Sampada*



Has information of FORV cruises conducted between 1997 – 2010, HABs, Deep sea fishery, trawlable grounds, Marine Mammals, Marine Benthos, new records of species of Indian EEZ, list of publications under MLR and Human Resource Development under MLR

Date of Release : 02.12.2010

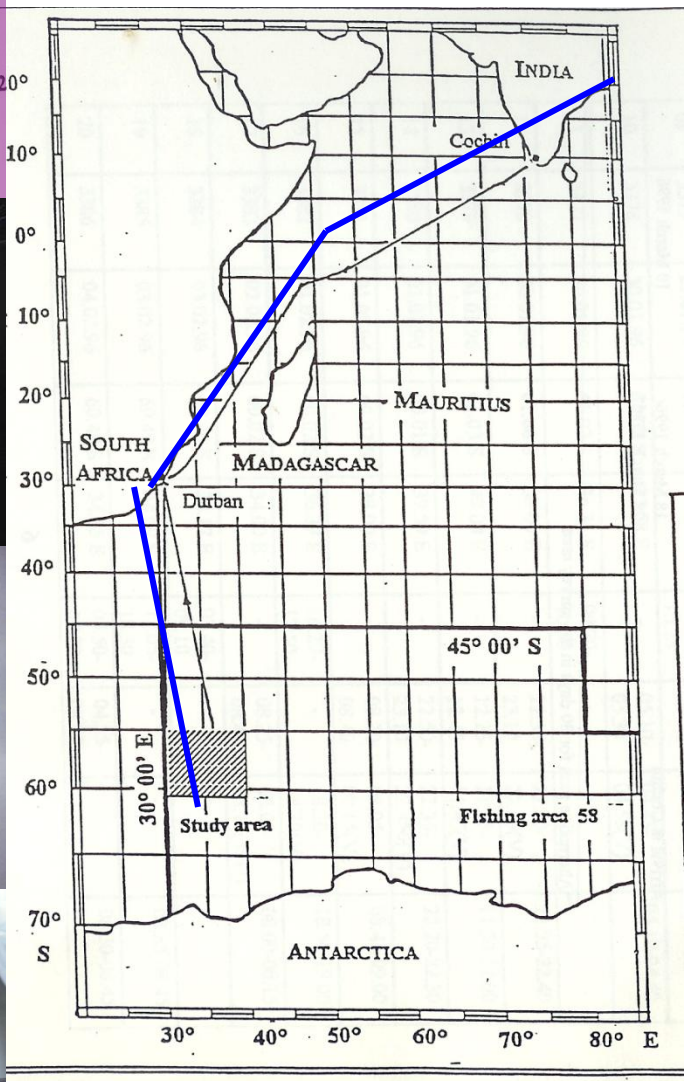
Diversity of Demersal fauna in the Indian EEZ

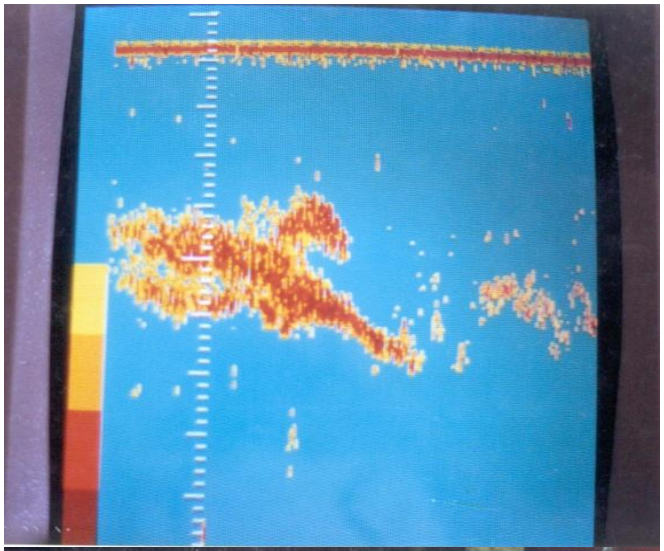


(Redrawn from Venkataraman and Wafer, 2005)

Southern Ocean MLR

FIKEX 1995





Total estimated krill = 850 million tonnes 1% allowed for harvest

Trawl catch onboard FORV Sagar Sampada

Potentially toxic micro algae of the Indian EEZ

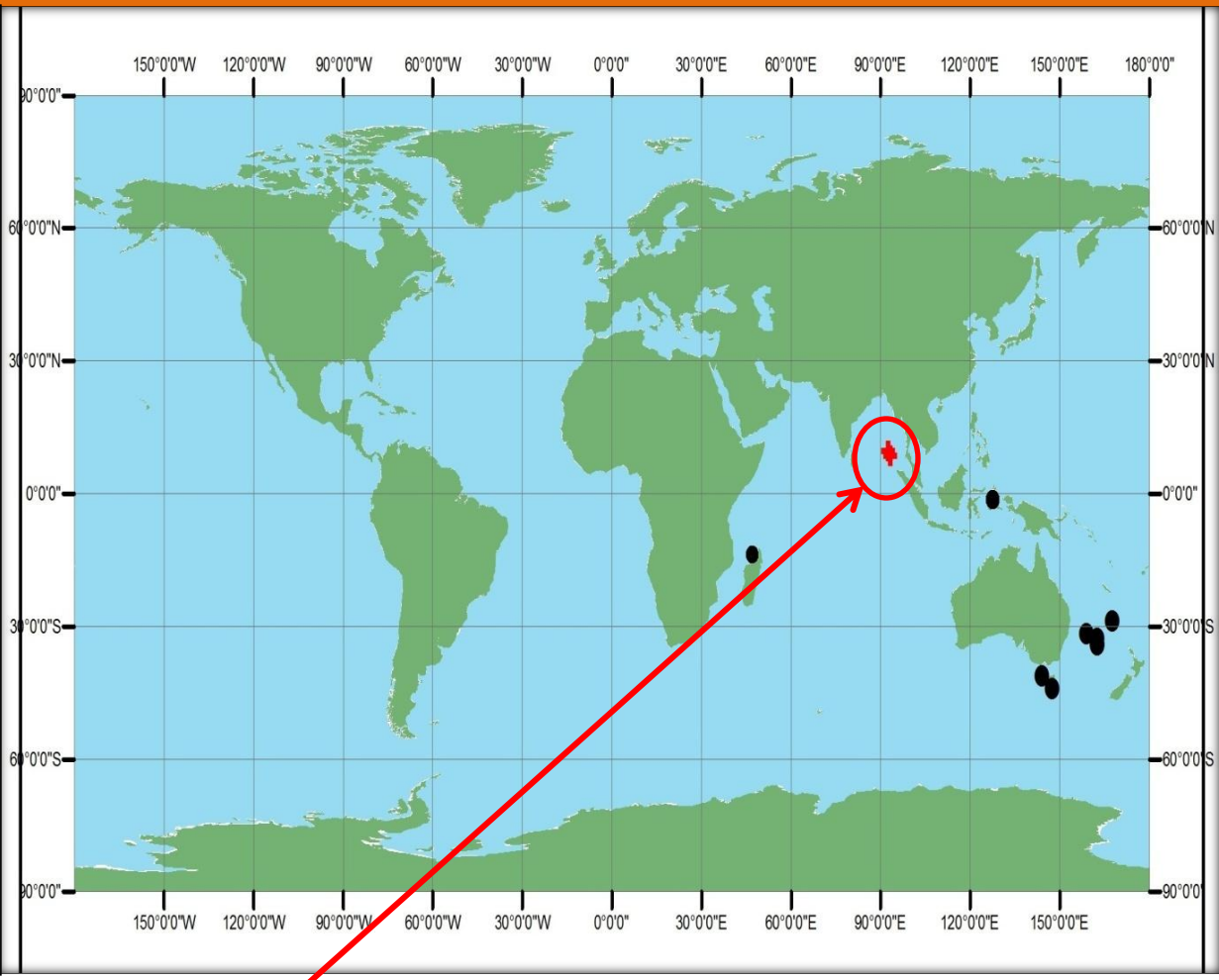
Alexandrium sp.
Amphidinium carterae
Coolia monotis
Chattonella marina
Dinophysis acuminata
Dinophysis caudata
Dinophysis fortii
Dinophysis miles
Dinophysis rotundata
Gymnodinium catenatum
Karenia mikimotoi
Phaeocystis globosa
Prorocentrum micans
Prorocentrum lima
Prymnesium parvum
Pseudonitzschia multiseries
Pseudonitzschia seriata


Green *Noctiluca* bloom


Red *Noctiluca* bloom


Trichodesmium bloom

ENIGMATIC SEA PEN - GYROPHYLLUM SIBOGAE- *NEW RECORD FROM NORTHERN INDIAN OCEAN*



Gyrophyllum sibogae Hickson, 1916

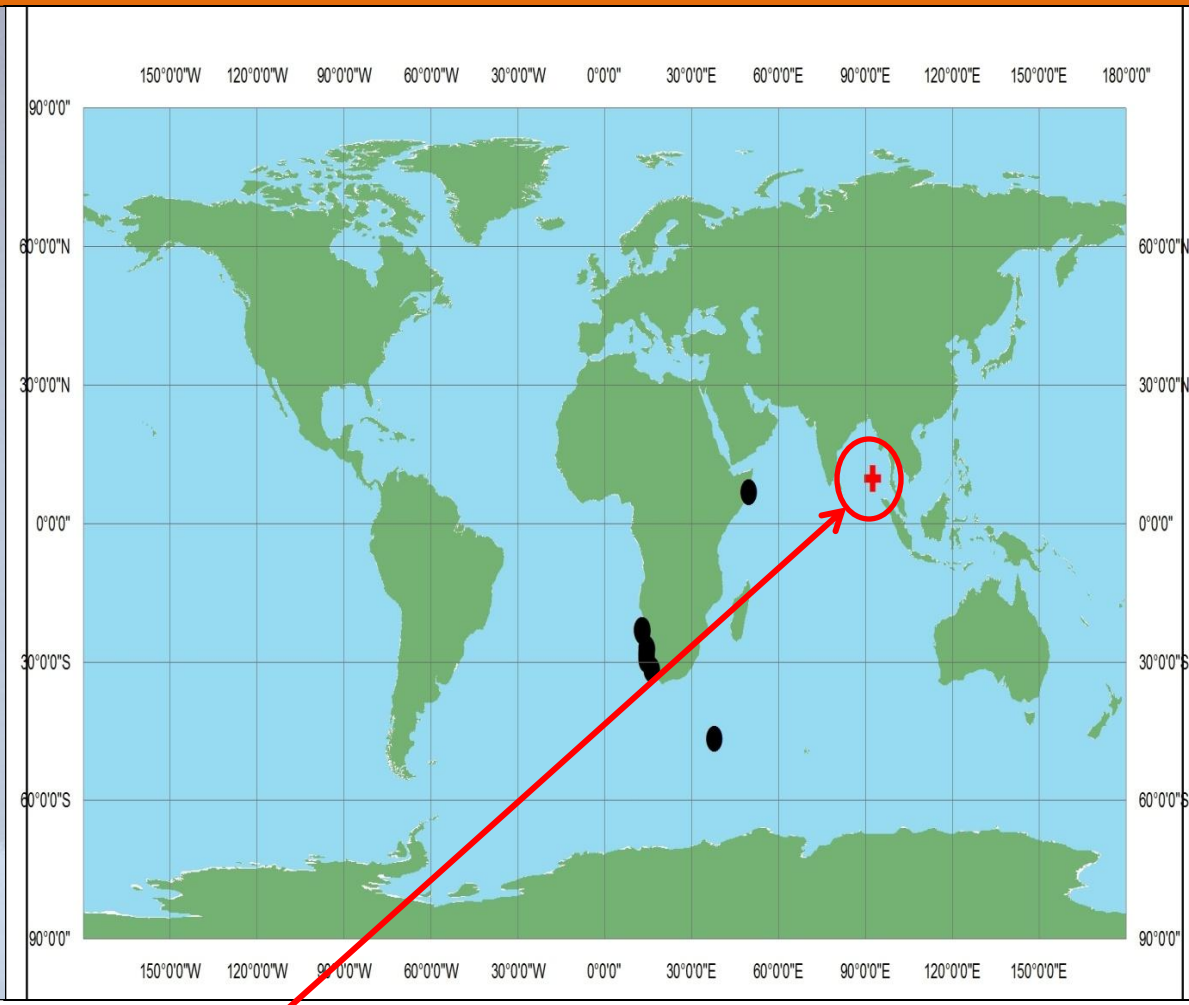
PHYLUM : CNIDARIA
CLASS : ANTHOZOA
ORDER :PENNATULACEA
FAMILY :PENNATULIDAE

\+ NEW COLLECTION SITES FROM ANDAMAN SEA,

Depth : 622-629 metres

•PREVIOUSLY REPORTED SITES

FEATHERY SEA PEN-PENNATULA INFLATA-
NEW RECORD FROM NORTHERN INDIAN OCEAN



Pennatula inflata **Kukenthal, 1910**

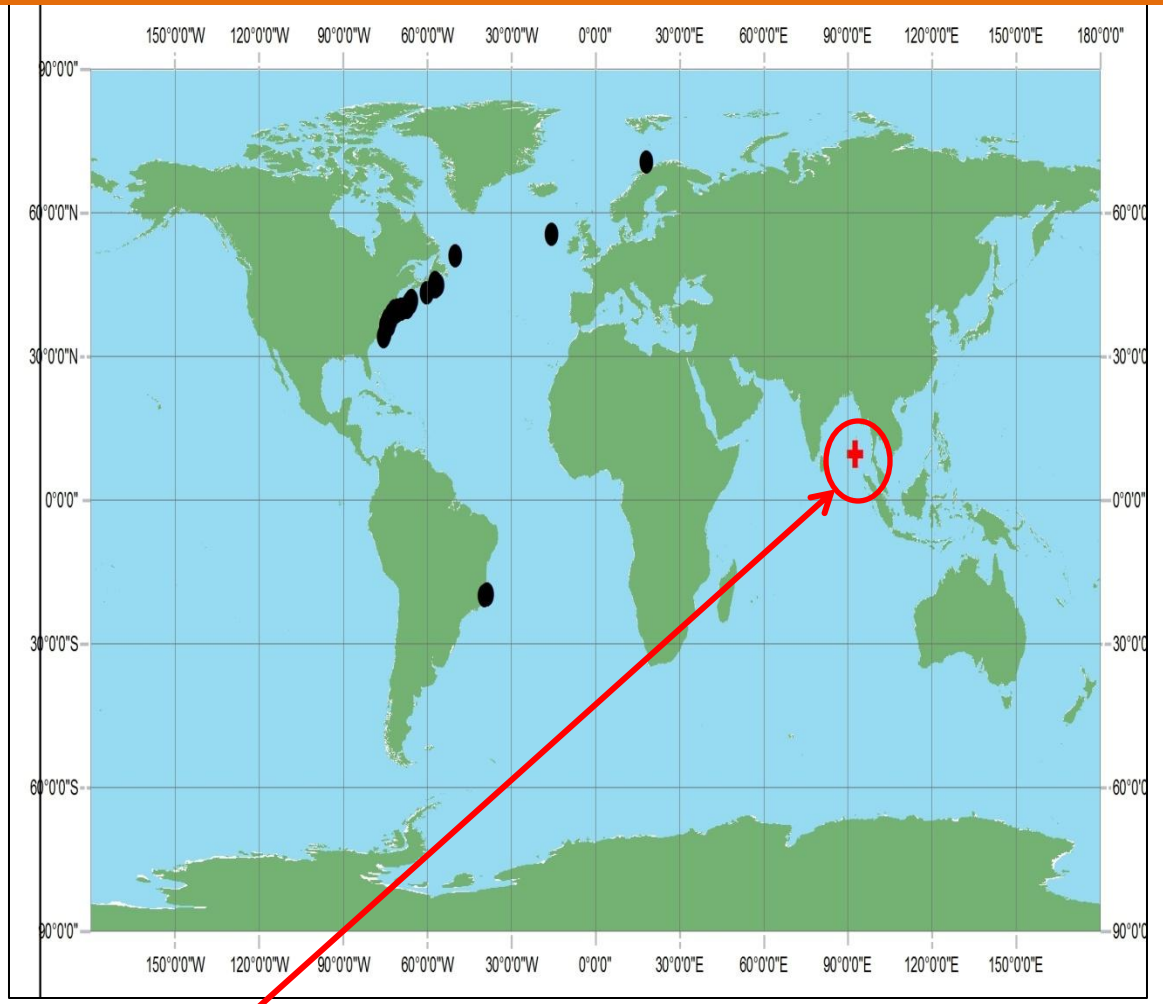
PHYLUM : CNIDARIA
CLASS : ANTHOZOA
ORDER :PENNATULACEA
FAMILY :PENNATULIDAE

NEW COLLECTION SITE FROM ANDAMAN SEA,

Depth : 629 metres

- **PREVIOUSLY REPORTED SITES**

MUSHROOM SOFT CORAL - ANTHOMASTUS GRANDIFLORUS- *NEW RECORD FROM INDIAN OCEAN*



Anthomastus grandiflorus Verrill, 1878

PHYLUM : CNIDARIA
CLASS : ANTHOZOA
ORDER :ALCYONACEA
FAMILY :ALYCYONIIDAE

NEW COLLECTION SITE FROM ANDAMAN SEA,

Depth : 629 metres

- **PREVIOUSLY REPORTED SITES**

PHYLUM ECHINODERMATA

VOUCHER SPECIMENS COLLECTED DURING CRUISE 334

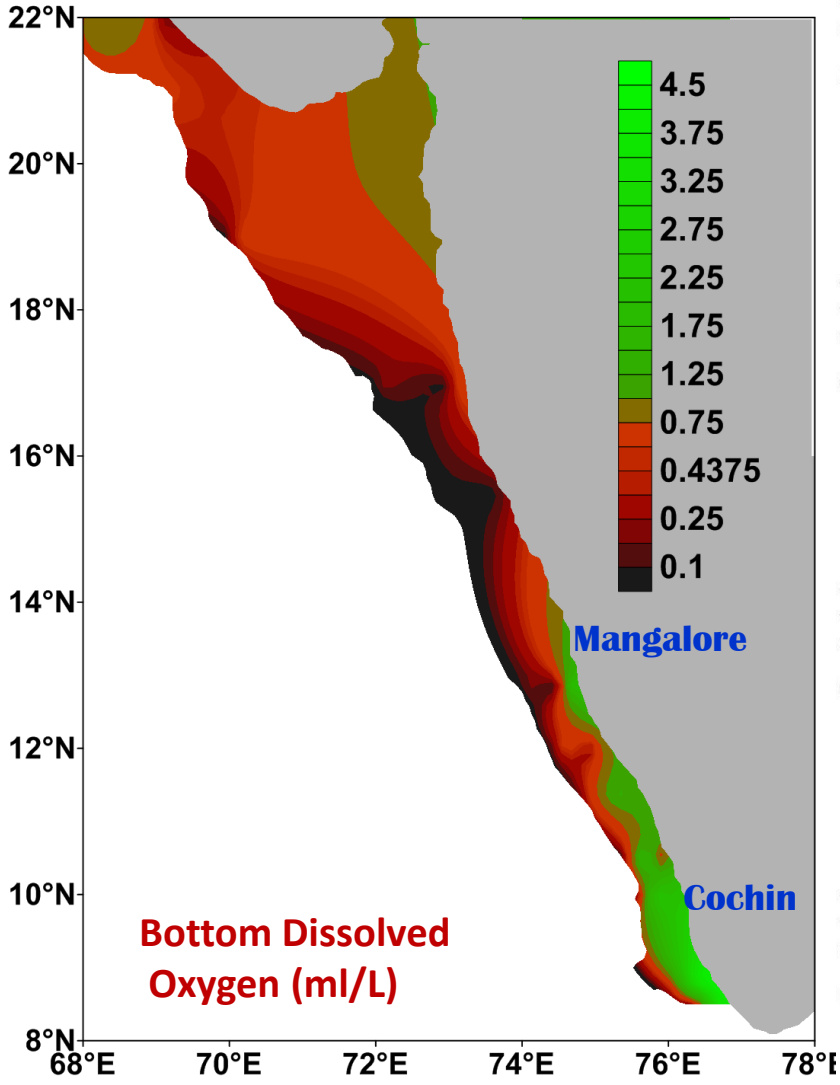
ASSOCIATION OF GORGONID & BRITTLE STAR- ASTEROSCHEMA SP.

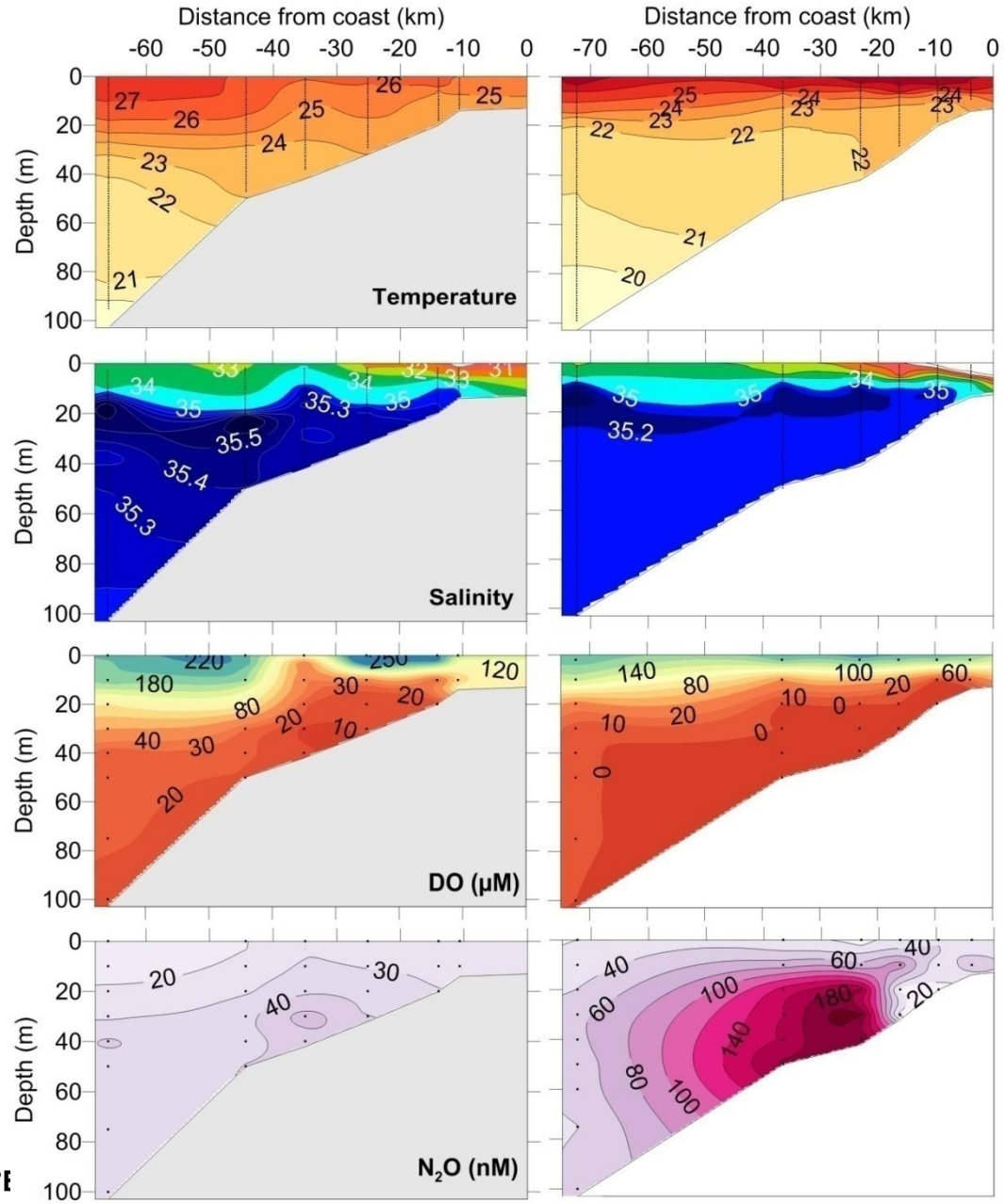
BRITTLE STAR

DEEP SEA CRINOID

BENTHODYTES SP.

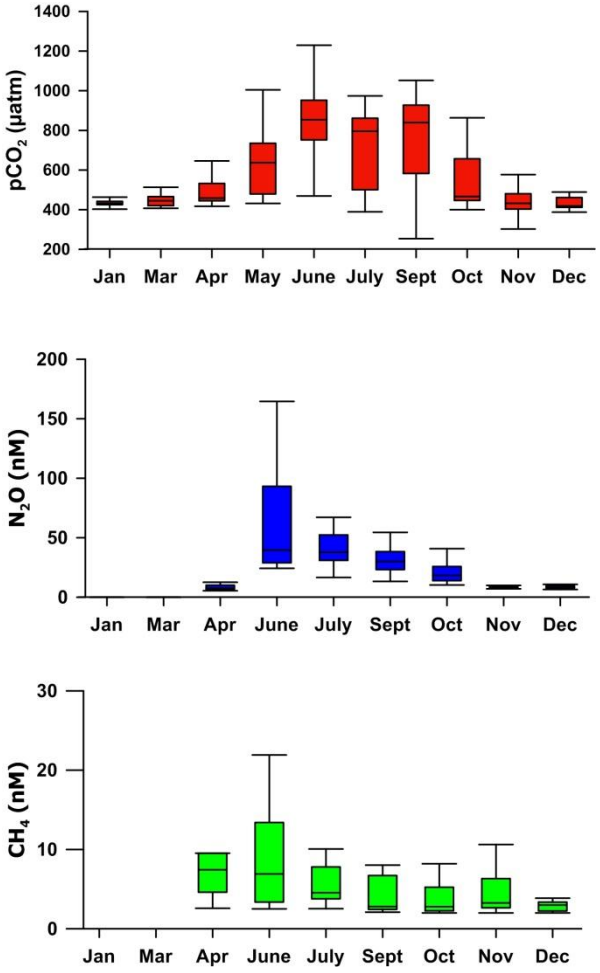
OMZ extension as coastal upwelling



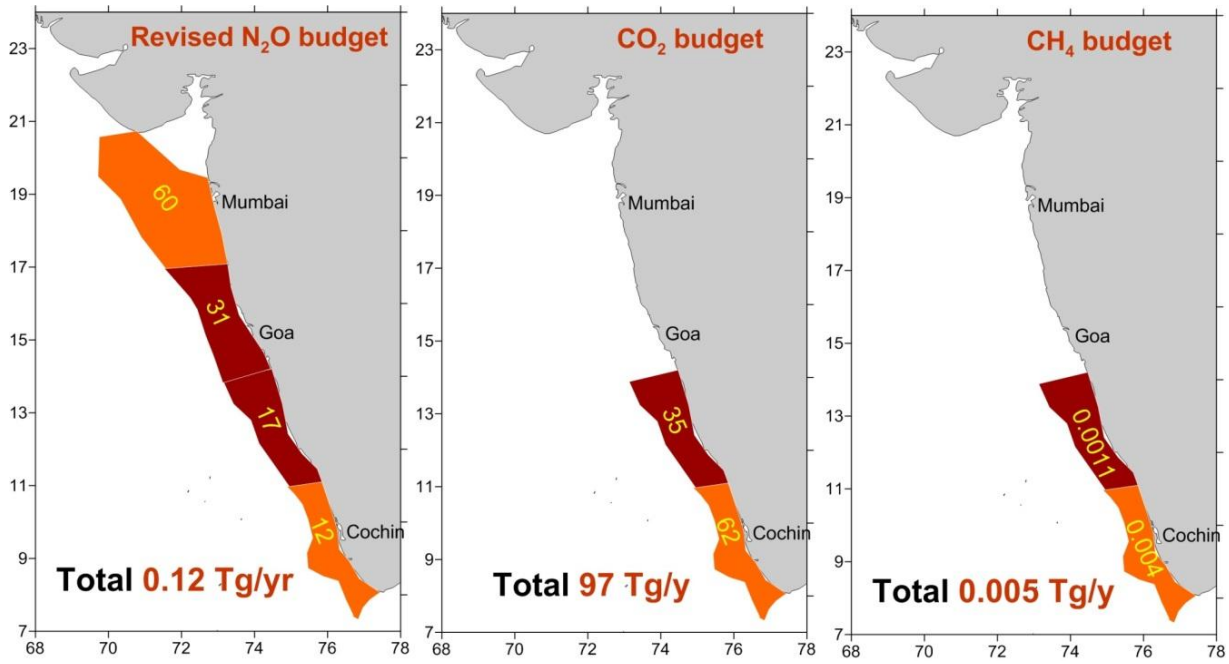


Anoxia driving fishery out of region

Greenhouse Gases Fluxes



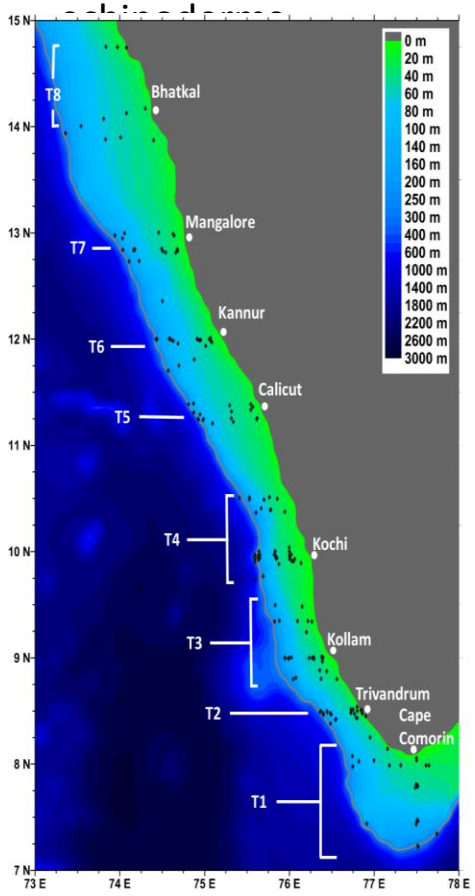
Monthly variation of GHGs off Cochin

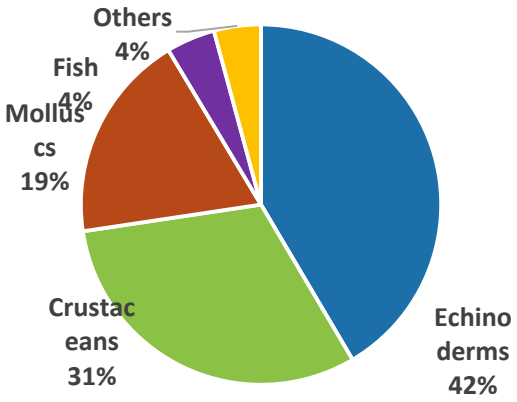


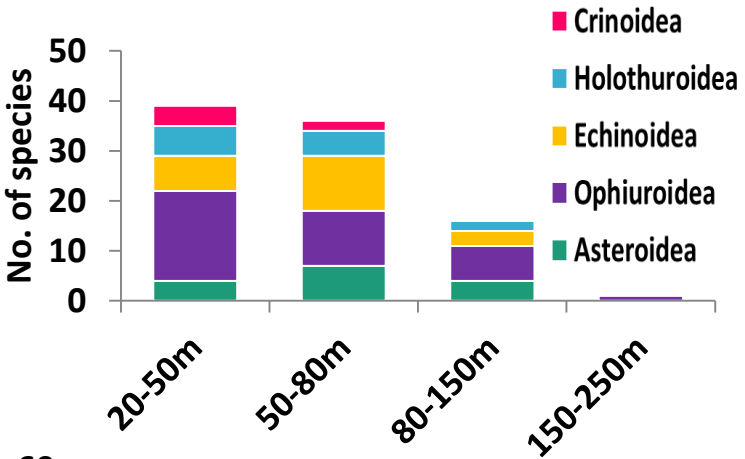
- N_2O budget along western shelf is revised.
- Gases production is maximum during southwest monsoon, more so in the eastcentral Arabian Sea (11-17° N) w.r.t N_2O due to anoxia.

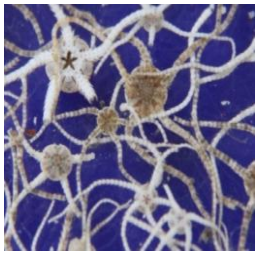
Echinoderms of the south eastern Arabian Sea (SEAS) shelf

Survey at 241 sites in the SEAS from 30-250m using grab and dredge to study diversity of



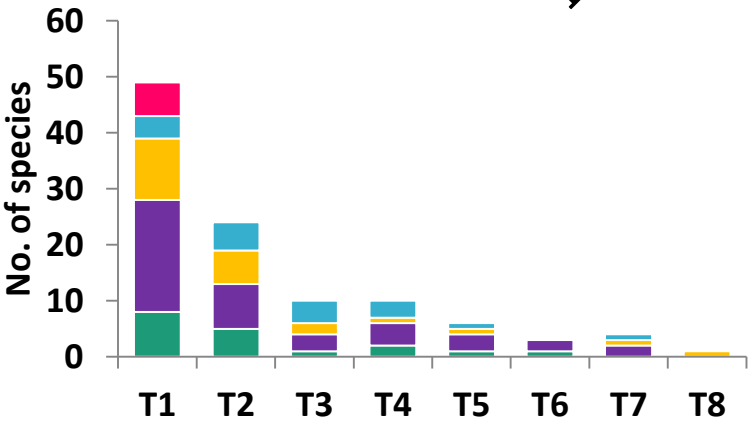




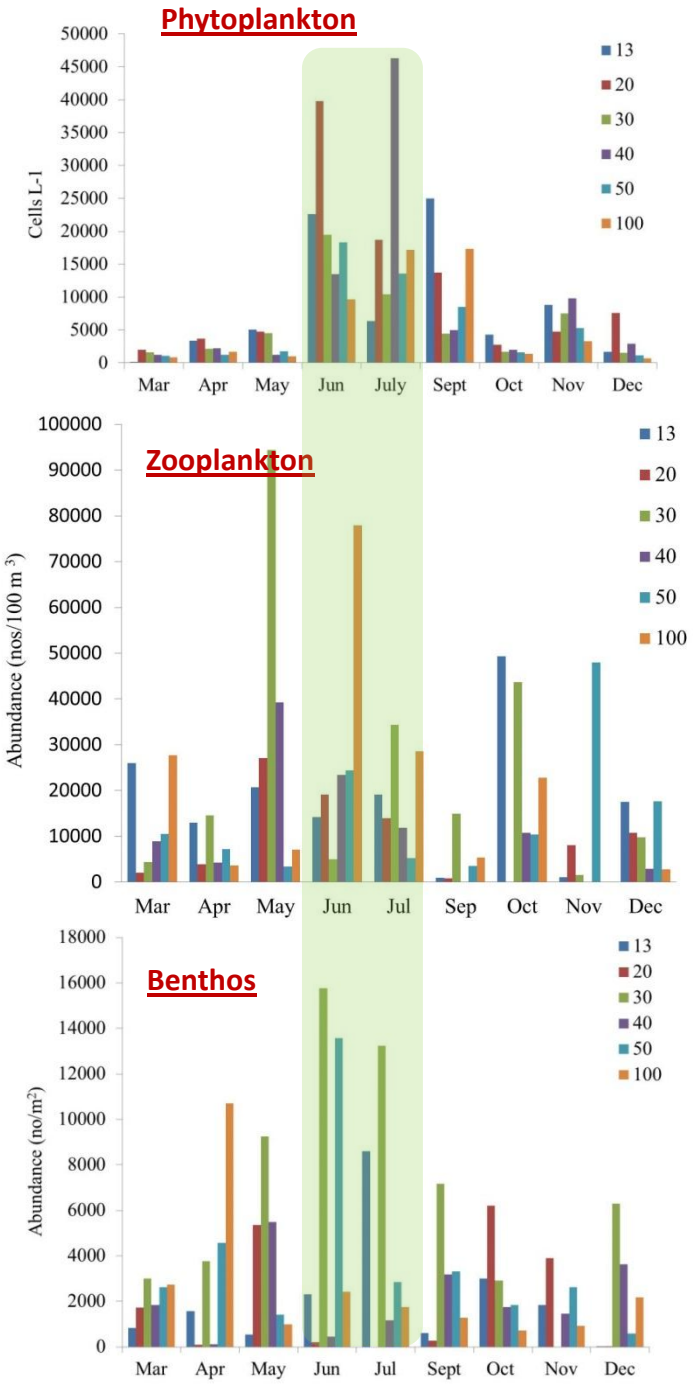


Ophiura kinbergi

Clypeaster rarispinus



- Echinoderms constituted 42% of epifauna in the continental shelf
- Highest diversity in southern transects, dominated by ophiuroidea and echinoidea
- Common species: *Ophiura kinbergi*, *clypeaster rarispinus*
- Near absence in the 150-250 m depth zone and low diversity in the north
- Distribution patterns influenced by sediment texture and DO availability



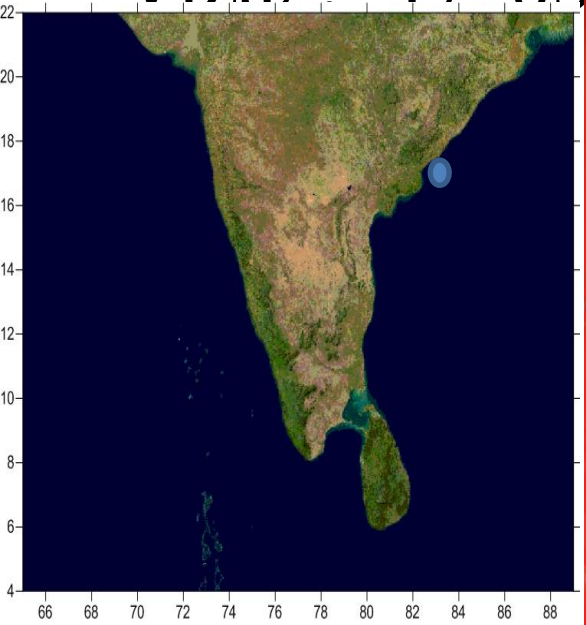
Pelagic-Benthic relationship & Fish trawl ban effect

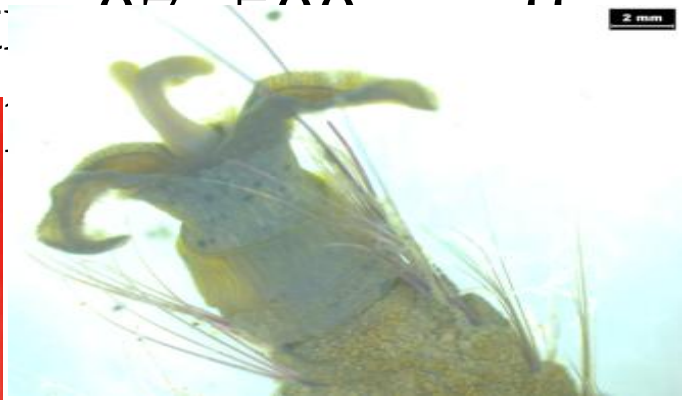
- Shelf region is highly productive during summer monsoon.
- Multi-fold increase in phytoplankton abundance during Jun-Sept due to injection of nutrient rich upwelled waters and terrestrial discharges.
- Zooplankton abundance also increased during May-July but not as clear as phytoplankton.
- Benthic abundance follows closely with their pelagic plankton and showed significant increase in June-July coinciding with fish trawl ban period.
- Increased supply of food from pelagic column coupled with trawl ban facilitated increase in benthic production during June-July.

An unusual occurrence of the deep-sea polychaete *Piromis bifidus* (Fauvel, 1932) from Bay of Bengal

(FORV SS Cr. 346 Leg-II , St[illegible]

Vizag 17°09[illegible]

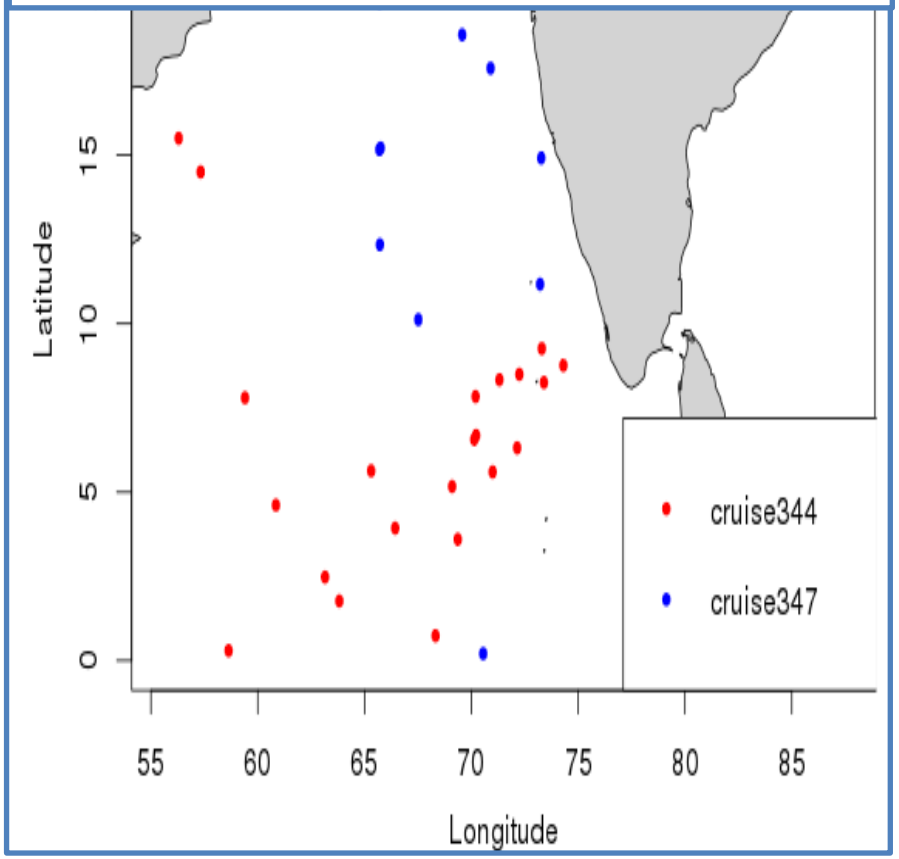




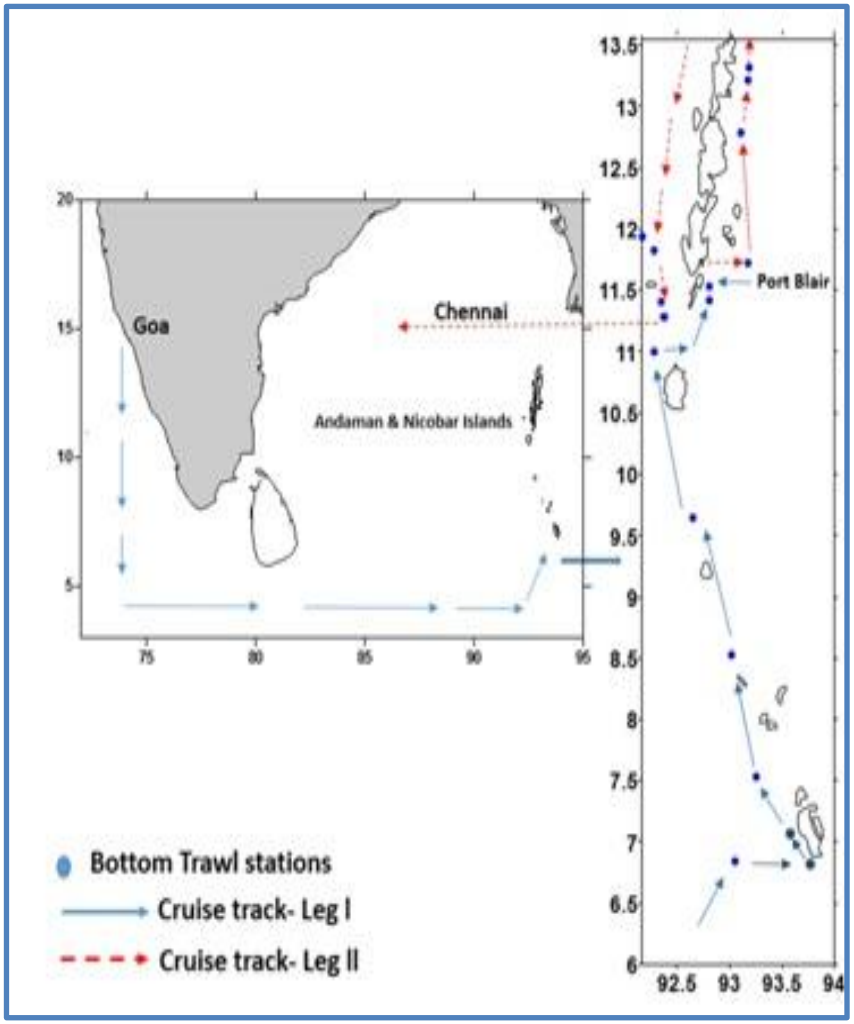
Piromis bifidus (Fauvel, 1932)

Scoloplos (Leodamas) latum (Chamberlin, 1919)

Stations covered during FORV Sagar sampada Cruise # 344 &347 at Northern Arabian Sea and Central Indian Ocean



Sampling locations : FORV Sagar sampada ongoing Cruis in the Andaman waters



Myctophids from Central Indian Ocean

Animal Discovery

- ✓ *Diaphus andamanensis* (new species) from Andaman Sea
- ✓ *Lampedna anomala* first findings from from Andaman Sea

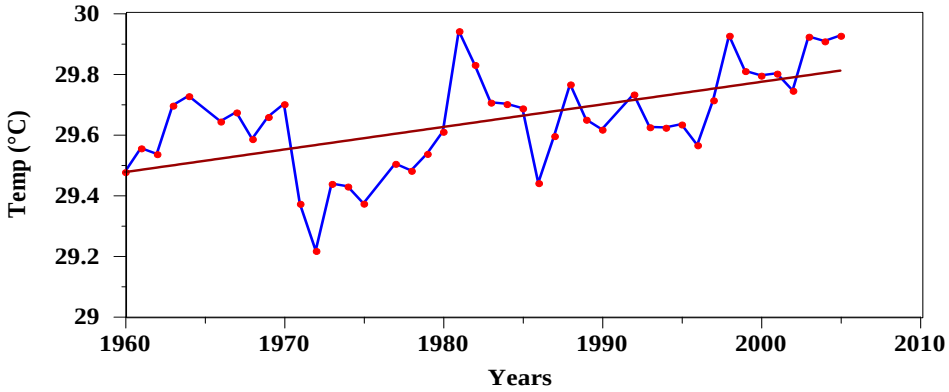
Diaphus andamanensis (new sp)

Lampedna anomala (new rec

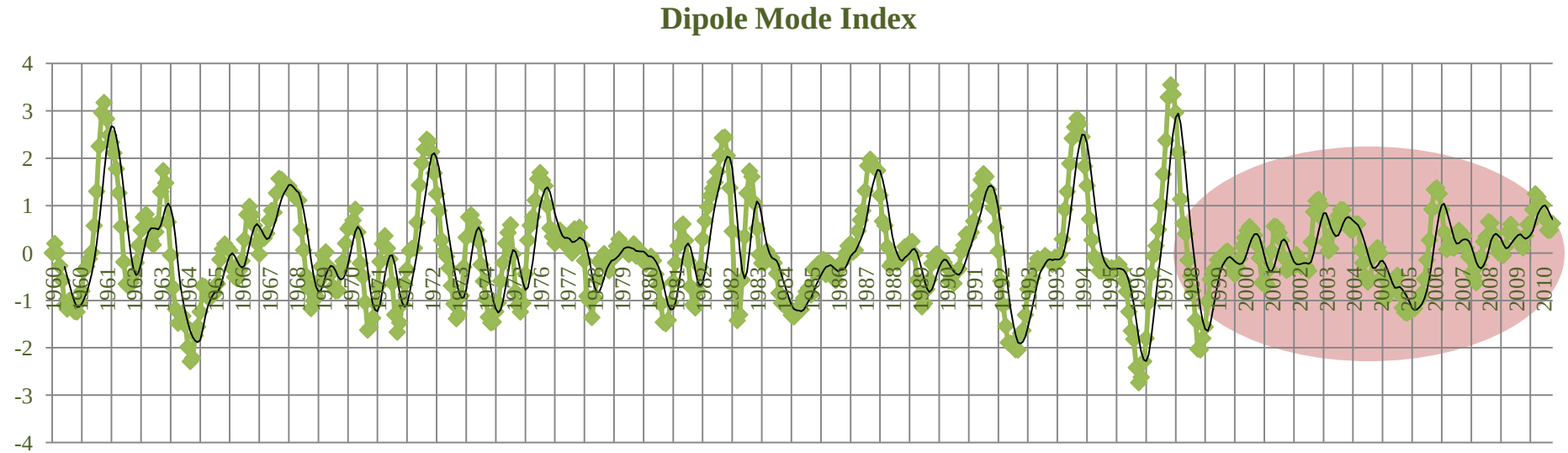
DSL organisms from Central Indian Ocea

Climate change and Tuna fishery

Spring average (March-May) of SST (°C) from ICOADS (1x1°)



❖Tuna (Yellow fin) distribution and IODs



Extension of northern boundary of oil sardine

(the colored lines indicate percentage of All India oil sardine production)