ENVIRONMENTAL VARIATIONS AND IMPACTS ON FISH BIOLOGY: NEW THREATS TO AQUATIC SUSTAINABILITY

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Session –Fishery Biology, Toxicology, Environment

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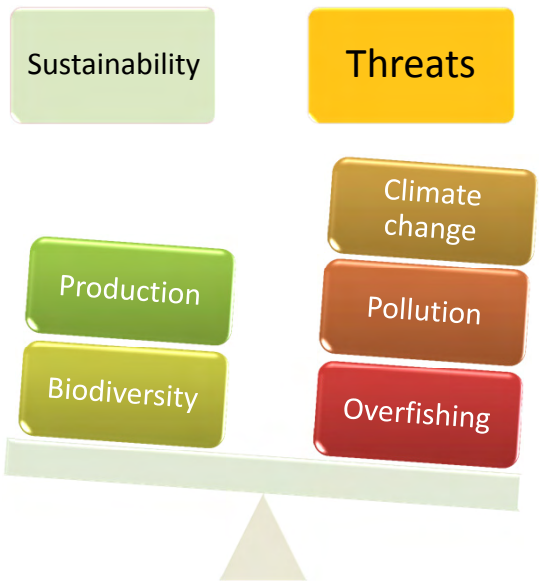

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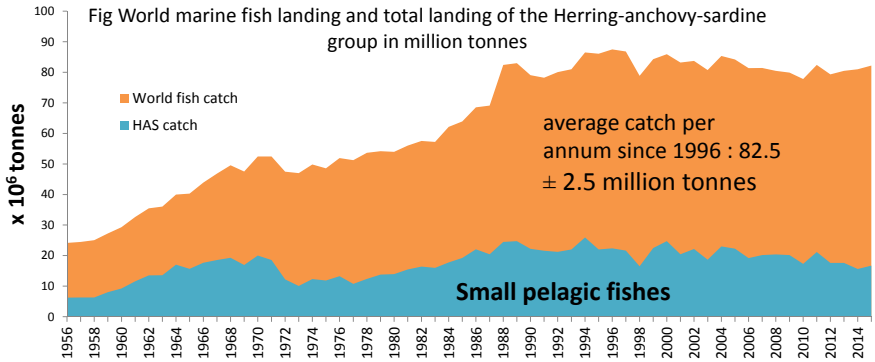
Impacts on small pelagics –Case study of Indian oil sardine collapse

CHANGING SEASONS AND MORE FREQUENT EPISODES OF EXTREME EVENTS (CLIMATE THREAT)

Significance of small pelagic fishes

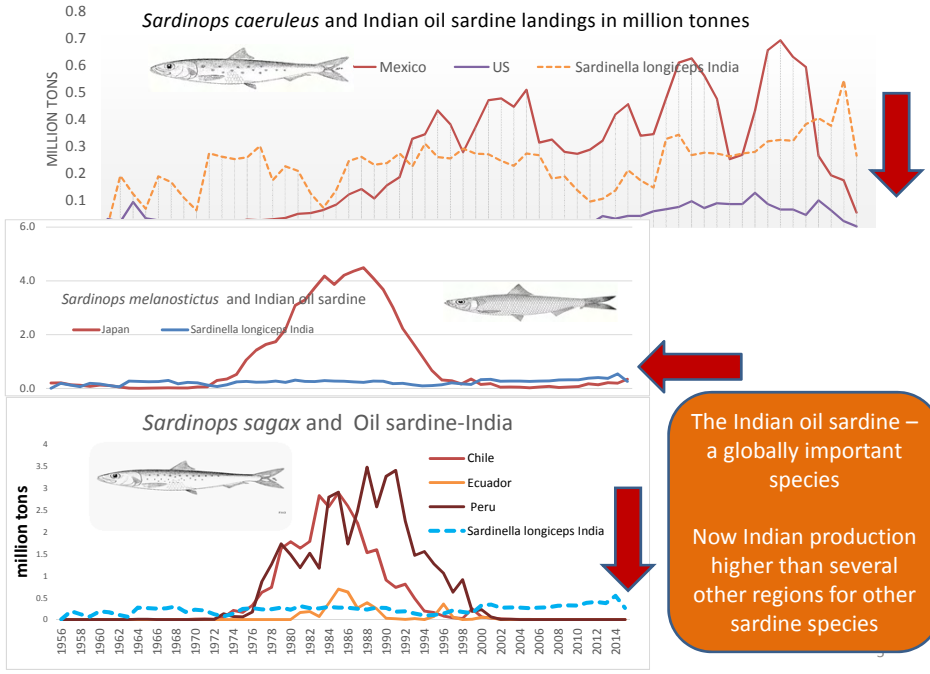
Fig World marine fish landing and total landing of the Herring-anchovy-sardine group in million tonnes



Small pelagic fishes : Herrings, Anchovies and Sardine (HAS) in FAO contributed to world fish landings highest - **42.7 %** of the world marine fish production in 1964 lowest **19%** in 2014.

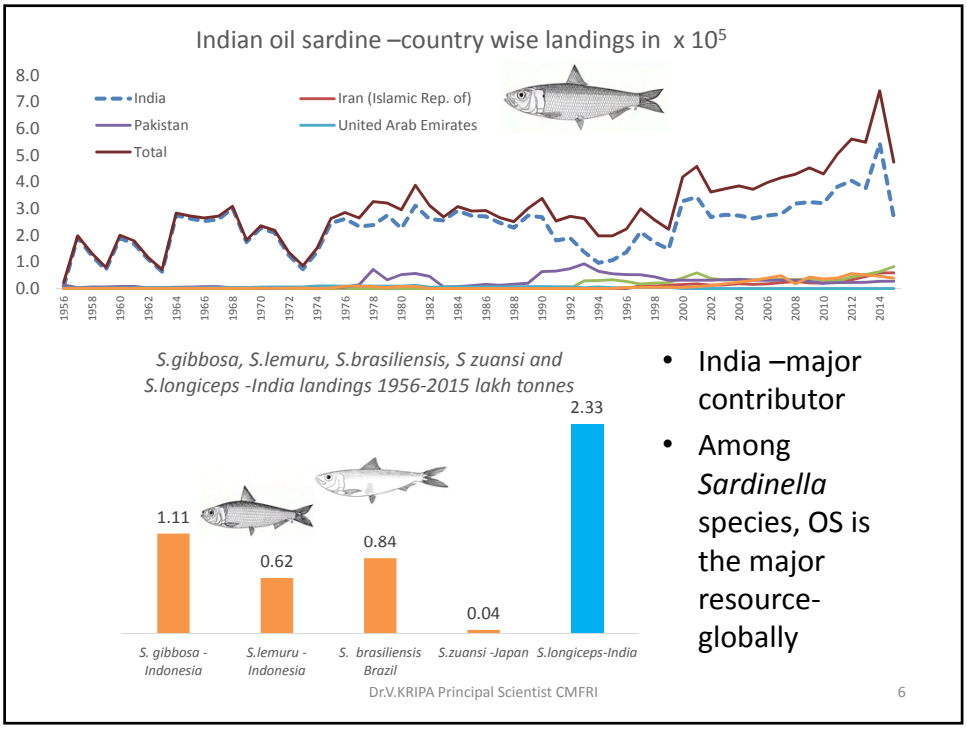
large fluctuations in abundance related either to environmental variations or due to fishing or a combination of both.

- Significance of Indian oil sardine ; southwest coast



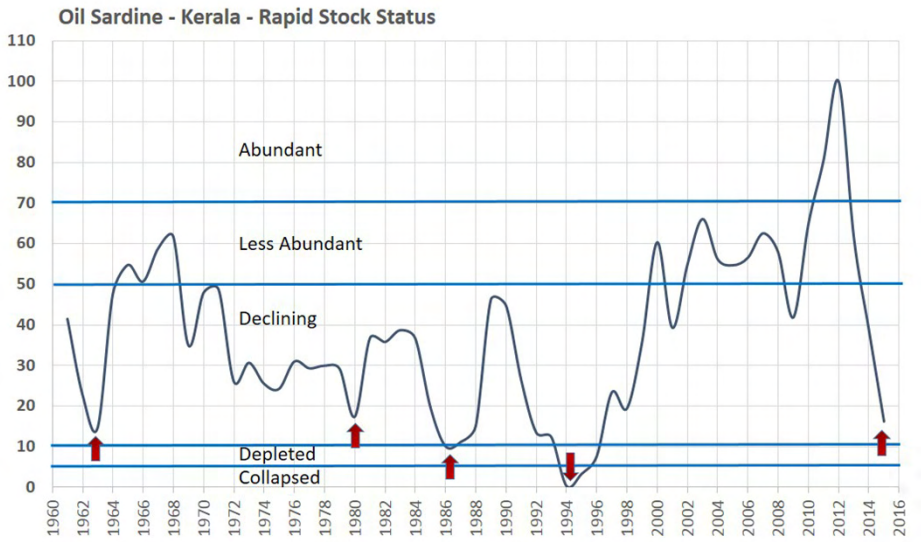
The Indian oil sardine – a globally important species

Now Indian production higher than several other regions for other sardine species

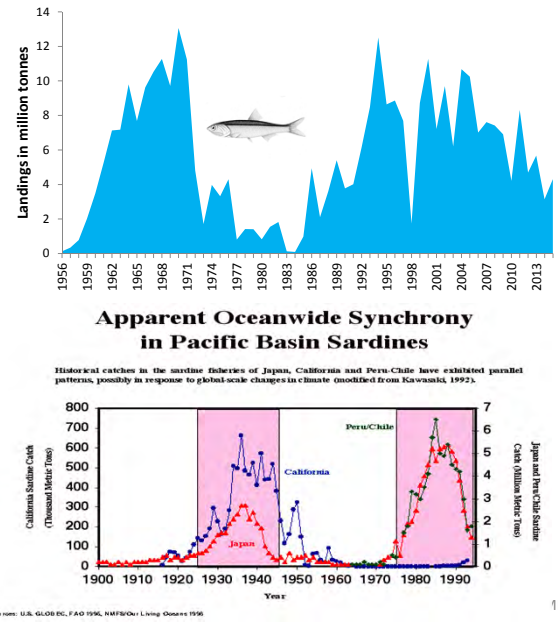


- India –major contributor
- Among *Sardinella* species, OS is the major resource-globally

Sardine fishery collapse -2015-2016



El Nino and Peruvian anchovy *Engraulis ringens*



- huge schools within 80 km, longevity3 years, reaching 20 cm Lm at about one year age and 10 cm
- 13.1 million tonnes in 1971; severely impacted by
- El Niño of 1982–1983, the 1997–1998 El Niño
- **In October 2015**, an El Niño year, of **3.38** mmt was estimated surveyed by The Peruvian Marine Research Institute, only 2 million metric tons were of reproductive age; 5 million metric tons are needed to open fisheries,

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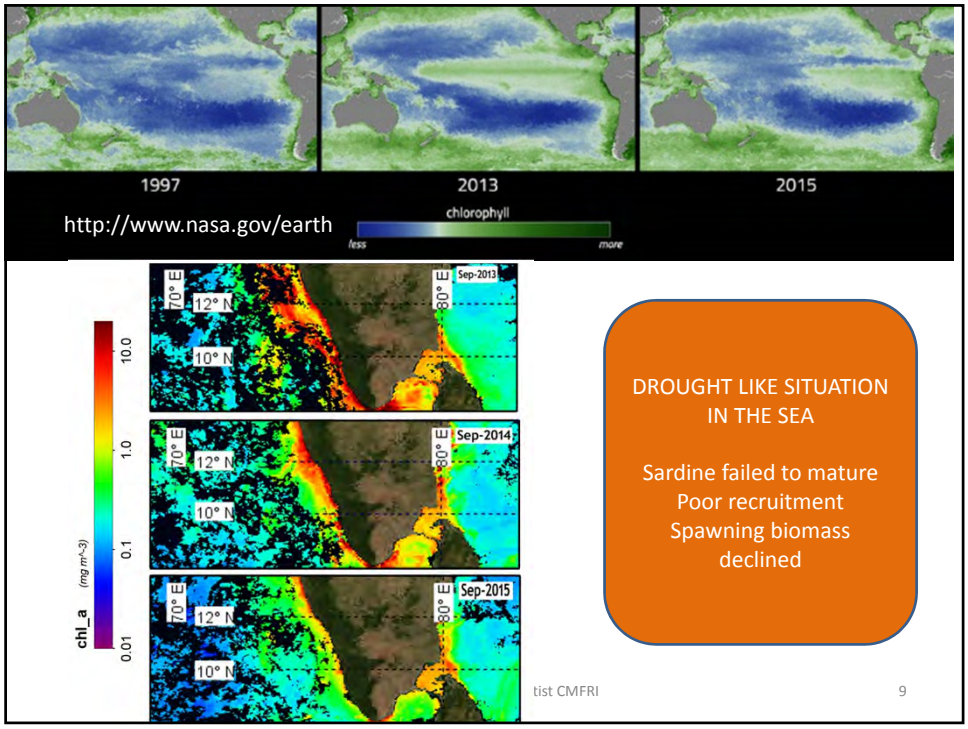
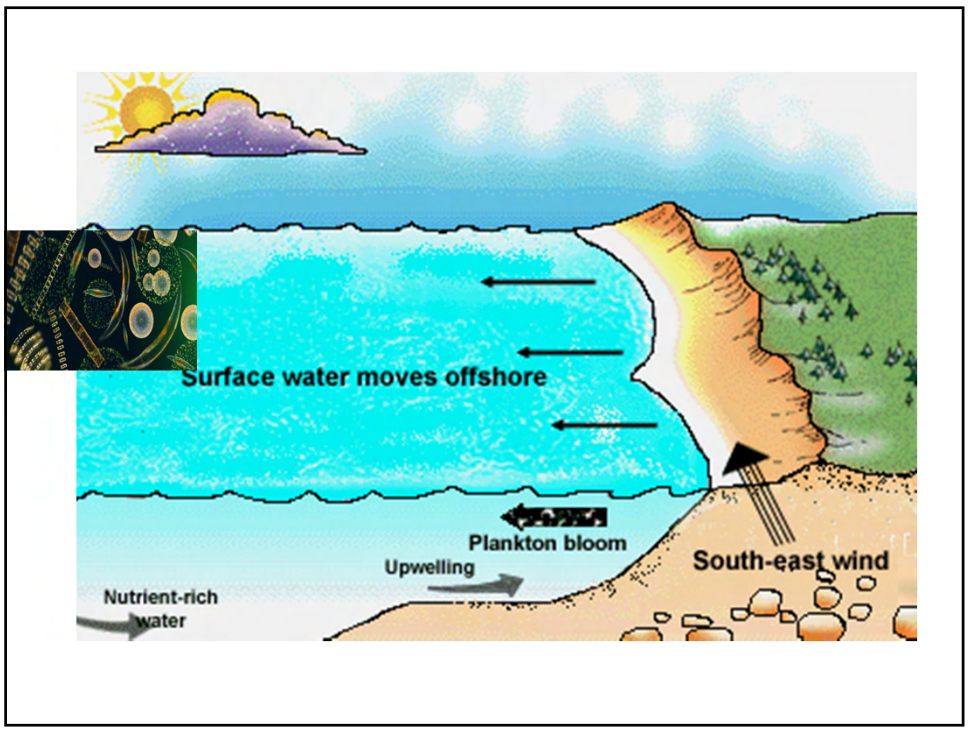
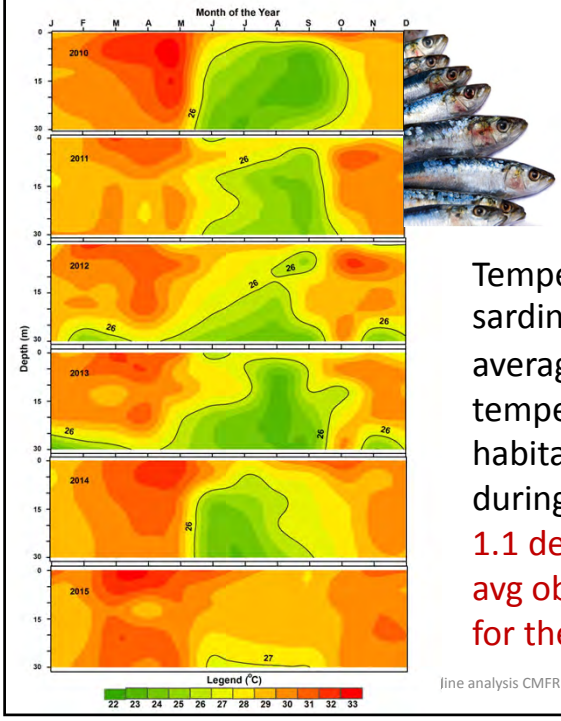


DROUGHT LIKE SITUATION IN THE SEA

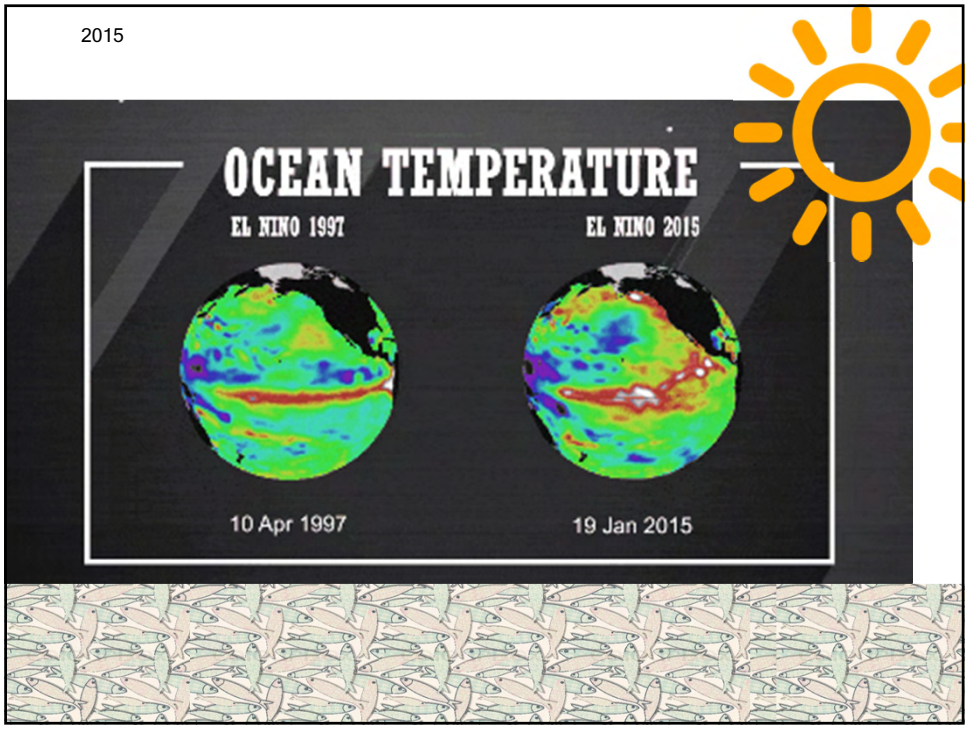
Sardine failed to mature
Poor recruitment
Spawning biomass declined



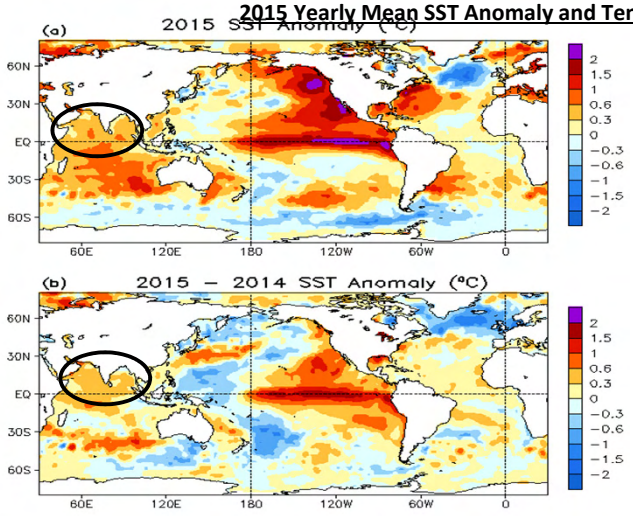


Upwelling -

Temperature variation in sardine habitat. The average seawater temperature in sardine habitat **was 29.8 deg C** during 2015, which is nearly 1.1 deg C higher than the avg observed (28.6 deg C) for the last 5 years



2015 Yearly Mean SST Anomaly and Tendency



- Positive **SSTA exceeding 0.6°C** dominated in the tropical Indian Ocean.

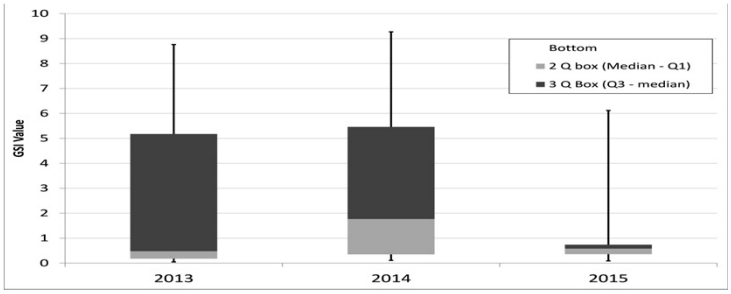
- There was a substantial warming in the tropical Indian Ocean, **partially due to influences of the 2015 El Nino.**

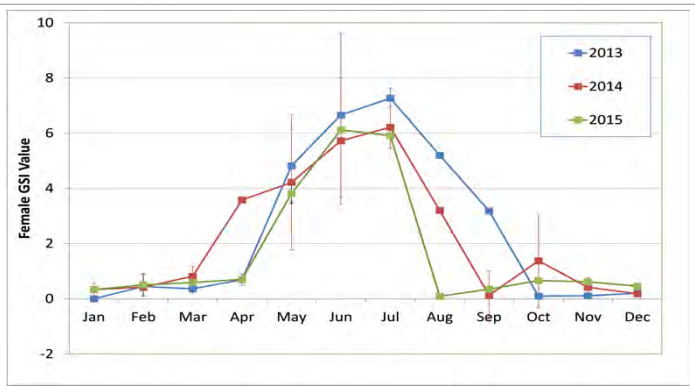
Global SST Section in the BAMS State of the Climate in 2015 by Xue et al.

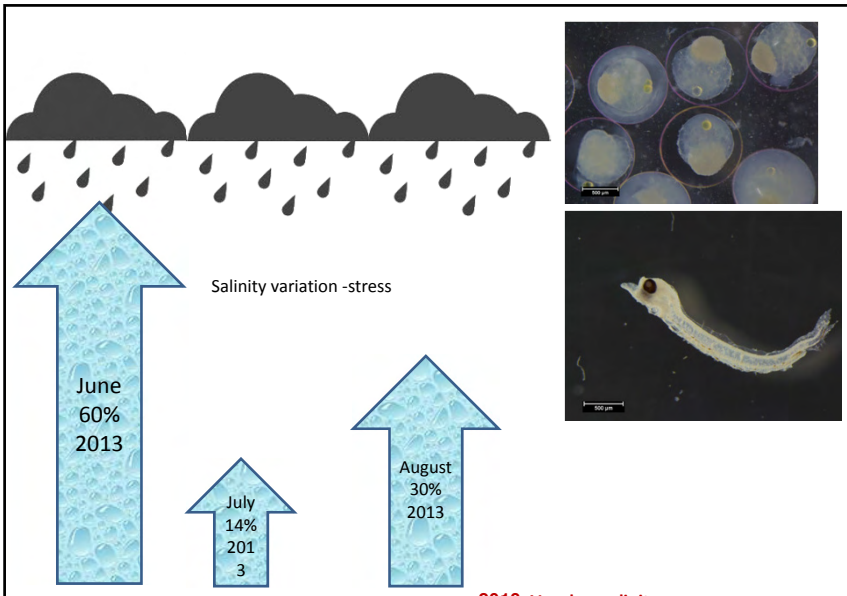
Fig. 3.1. (a) Yearly mean OISST anomaly (°C, relative to 1981-2010 average) in 2015, (b) 2015 minus 2014 OISST anomaly.

http://www.cpc.ncep.noaa.gov/products/GODAS/

13

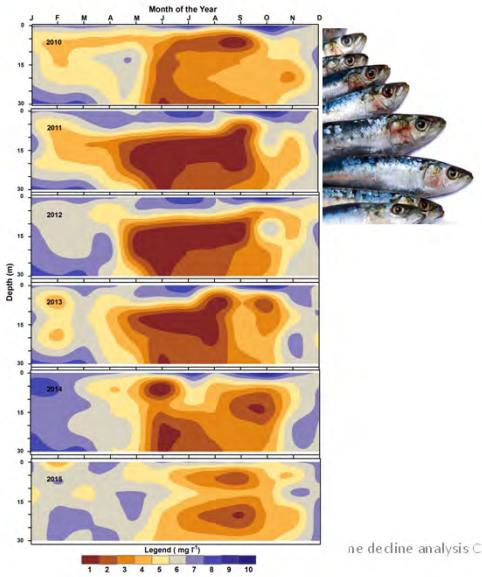






2013 Very low salinity

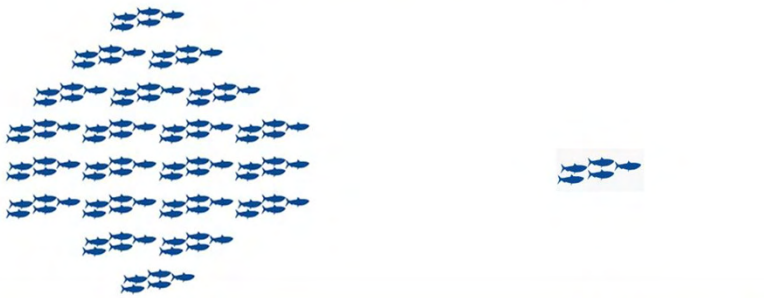
Hypoxic condition extending from near shore area up to 20 to 30 m depth



Second upwelling

- Negative aspect of upwelling is low oxygen condition which can lead to "stressed environment" and lead to **avoidance** of the area. The intensity of hypoxia has been found to vary

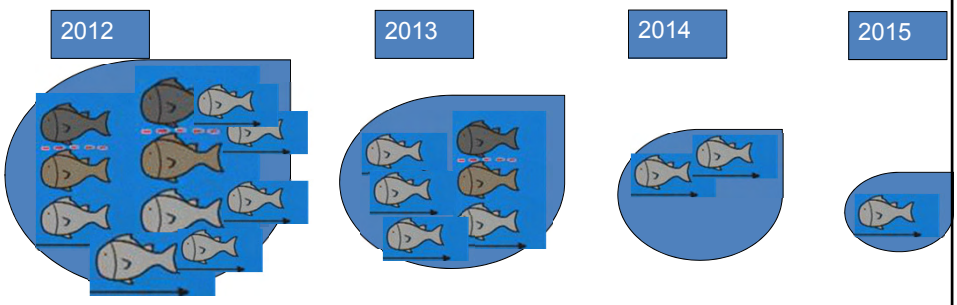
PACIFIC SARDINE POPULATION IN COLLAPSE



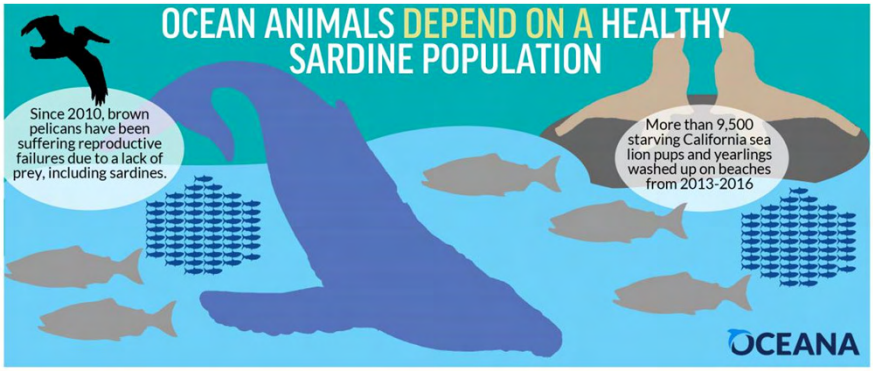
2006
~ 1.8 million metric tons

2017
~ 86,000 metric tons

Decrease in spawning population from 2012 to 2016



Cascading effect in the trophic chain



Fleshfooted Shearwater flock feeds Oil sardine *Sardinella longiceps during 2014*

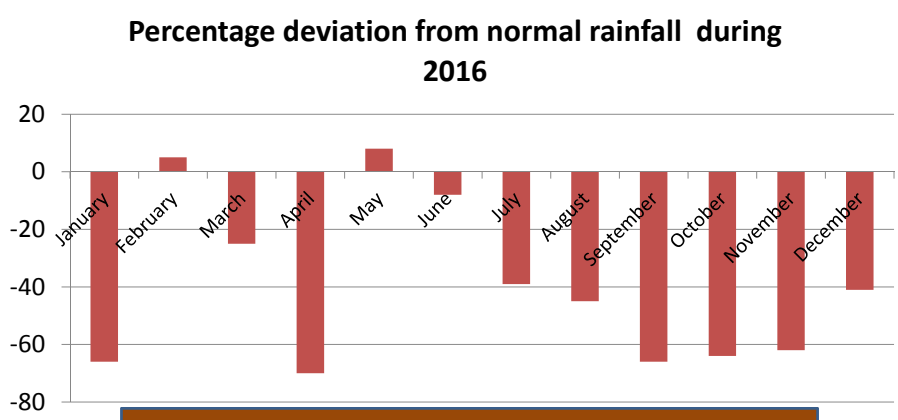
Pic courtesy- Dr R Jeyabaskarn

The way forward

Present	What can be done
• Only limited fisheries management programs and governance • No preparedness to face fishery collapses • MLS implemented in Kerala; but yet to be implemented in other states	• Very effective FMP (especially good governance) in all maritime states • Effective predictions to be developed on climatic factors and eggs and larval studies • International research collaborations for capacity building on these themes • Develop schemes to financially support small scale fishers during fish biomass decline due to natural calamities like in agriculture

Impacts of extreme events on other resources

2016-Rainfall- deficit year



Extremely low rainfall-----led to poor water flow, river discharges
Affected planton production and even intrusion of jellyfishes in estuaries during March April it self…threat to estuarine fauna recruitment

Jelly fishes in backwaters

- Usually seen during peak summer, but now even during late post monsoon
- A threat to fish larvae
- low fish catch, economic loss
- Menace to farmers

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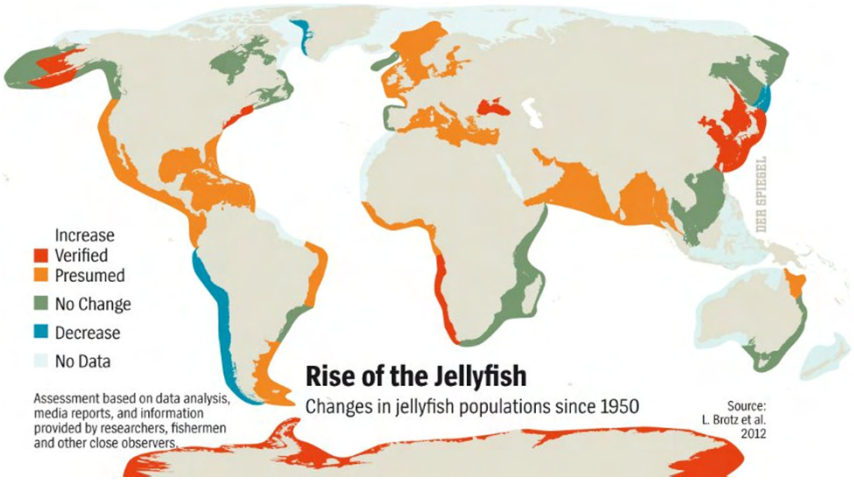
Jelly fish blooms in coastal /inshore fishing areas

JELLY FISH MENACE

Changes in jellyfish populations



A global regime shift from a **fish** **to a jellyfish ocean**

Why blooms occur

- **Ecological imbalance** due to removal of top predators
- **Eutrophication** of coastal waters due to urbanization
- **low oxygen**
- **New structure** where polps can attach

What happens during blooms

- **Endanger fish stocks** : high impact on fish eggs and larvae, either directly or by competing for the same food sources
- Further **reduce resilience** of already affected fish stocks

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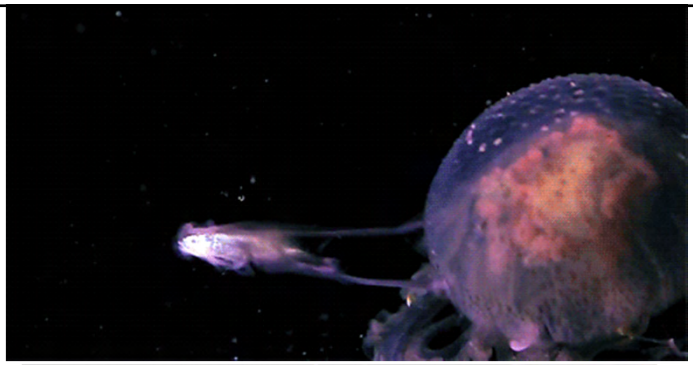
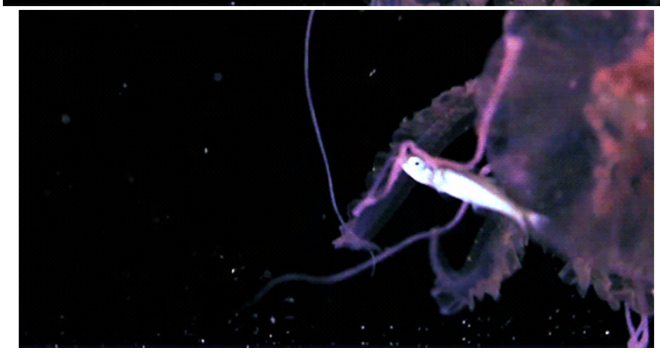




How jellyfish blooms affect fish resources

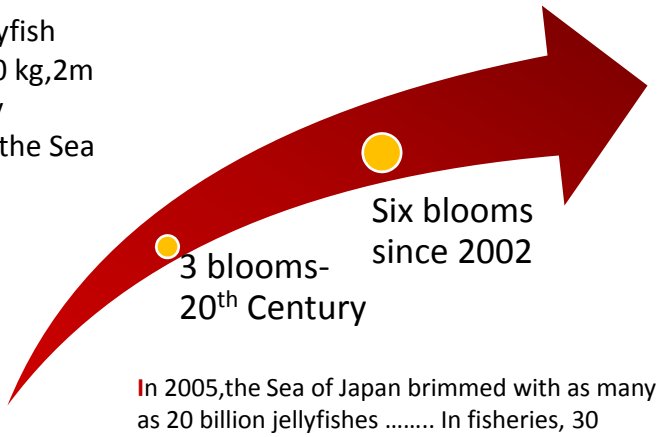
- Salmon production vs *Chrysaora fuscescens*, off the Pacific Northwest coast.
- There was a significant, negative correlation between jellyfish biomass and the **strength of adult salmon returning to the Columbia River**
- **Low feeding** : feeding incidence showed that salmon stomachs were less full at locations with higher sea nettle biomass.

Ref : Evidence that summer jellyfish blooms impact Pacific Northwest salmon production et al.,Ecosphere 2016 DOI: 10.1002/ecs2.1324

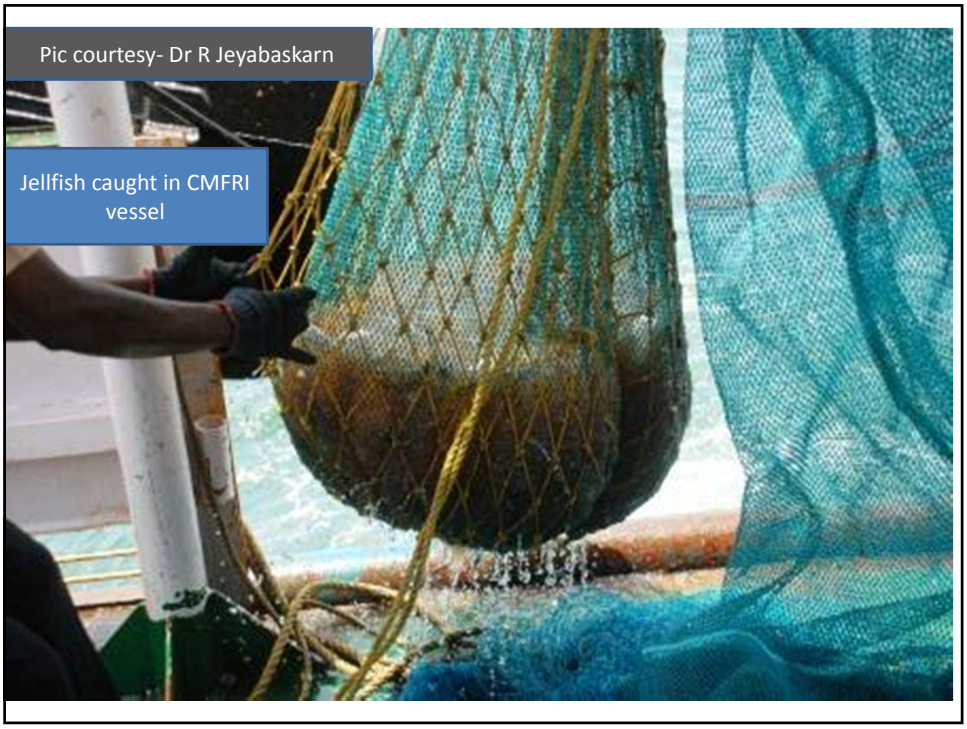
•James J. Ruzicka

Seas of Japan under jellyfish threat

Nomura's jellyfish (weighing 220 kg,2m dia was rarely encountered the Sea of Japan.



In 2005,the Sea of Japan brimmed with as many as 20 billion jellyfishes …….. In fisheries, 30 billion yen was estimated as loss



Jelly fishes in inshore waters this year also

Jellyfish blooms creating oceans of slime

In the last decade enormous plagues of jellyfish have been taking over the seas. And it is our fault.

By Gaia Vince
5 April 2012

Fisheries Centre Research Reports
2011 Volume 19 Number 5

CHANGING JELLYFISH POPULATIONS: TRENDS IN LARGE MARINE ECOSYSTEMS

After brief lull, jellyfish blooms resurface along N Goa coastline

Paul Fernandes | TNN | Updated: Nov 6, 2016, 02.34 PM IST

(Representative image)

THE HINDU

Jellyfish blooms pose threat to State

T. Nandakumar

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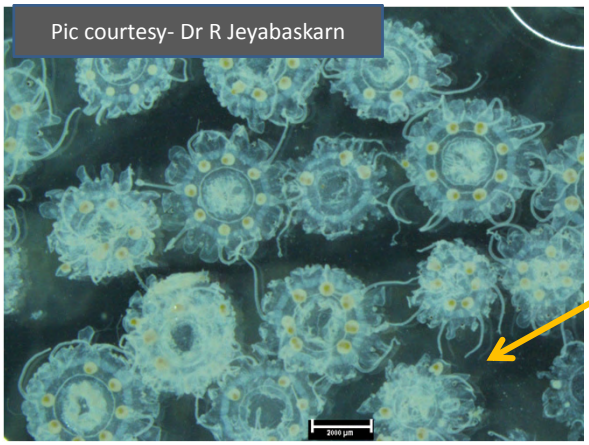
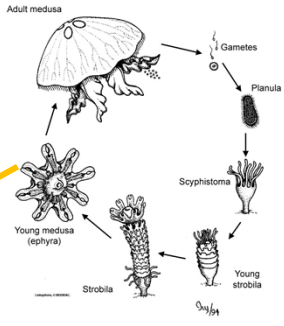
Ephyrae of *Chrysaura* sp.

First Report on Ephyrae

Pic courtesy- Dr R Jeyabaskarn





The ephyrae of the jellyfish *Chrysaura* sp was identified on 22.5.2015; just 2 months before the bloom. Bloom observed on end of July, 2015

TROPHIC CONTROL

- In East China Sea -Forty-five functional groups were defined in the model including 32 fish (19 single species and 10 multispecies.
- The average trophic level of fishery catch was 2.71 while the mean value for all groups was 2.87.
- Study indicated trophic mutual competition and predation between large jellyfish and Stromateoidae. So utilize this information for ecosystem based management

Trophic controls of jellyfish blooms and links with fisheries in the East China Sea Jiang Honga et al ecological modelling 212 (2008) 492–503

The way forward

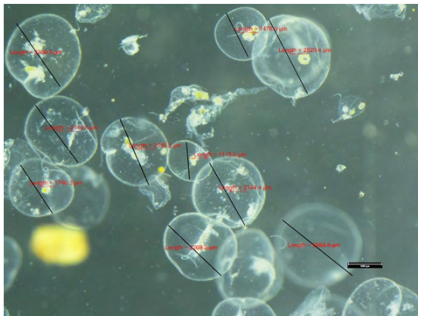
- Include jellyfish research into fisheries research.
- Develop early warning systems for bloom forming species
- Utilize jelly fish in (in collagen preparations; treat rheumatoid arthritis eg), have rich biomedical properties
- As food- dried and chopped into noodle-like strips to be added to soups, entrepreneurial Japanese are even making vanilla-and-jellyfish ice cream.
- 80% protein and very low in fat, although the high sodium content probably outweighs their health benefits.
- Reduce eutrophication through proper control measures

3

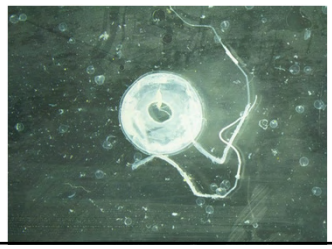
Anthropogenic impacts

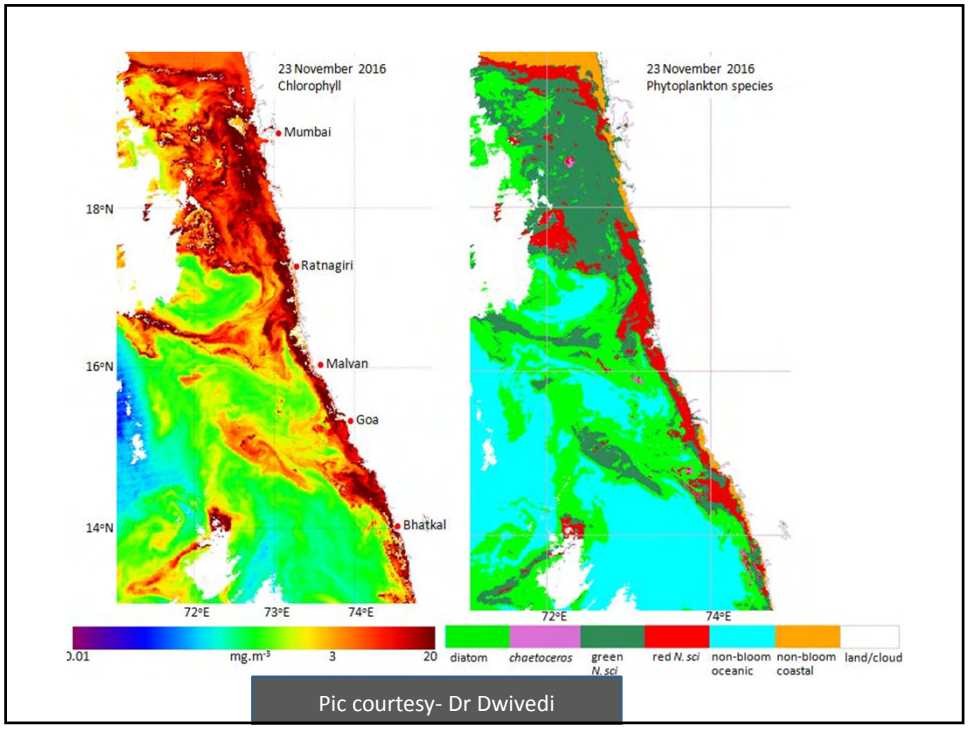
HARMFUL ALGAL BLOOMS

Noctiluca scintillans blooms

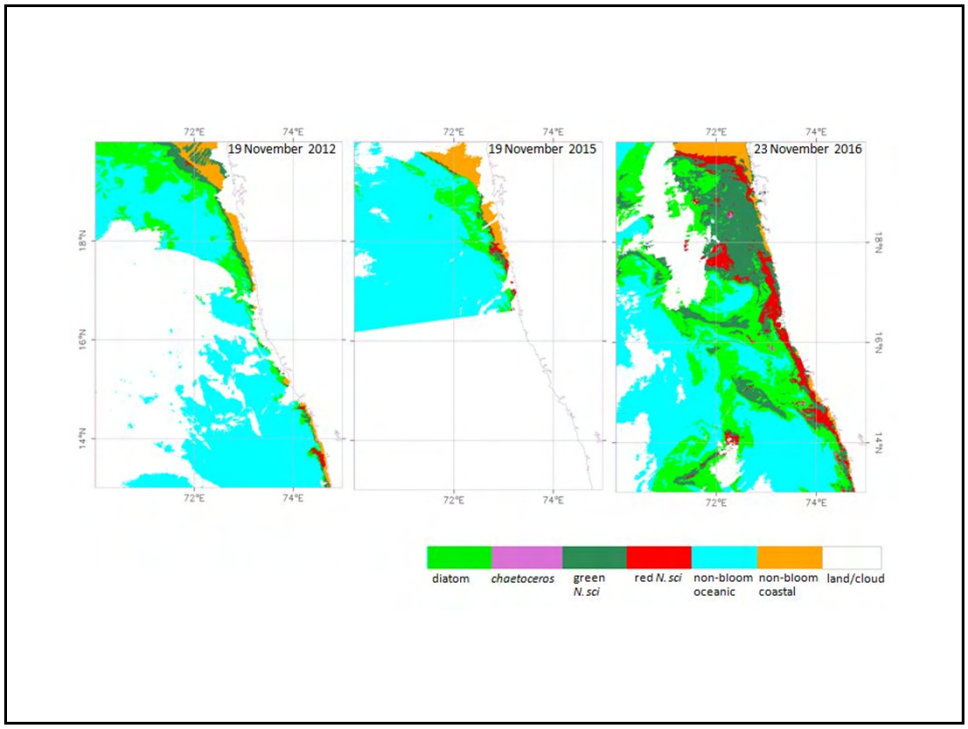


Pic courtesy- Ms Lavanya





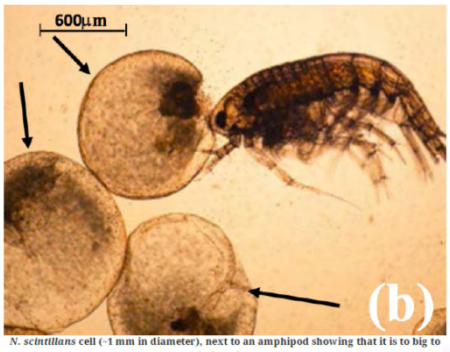
Pic courtesy- Dr Dwivedi



The HAB menace

The issue

- Complete disruption of normal food chain



N. scintillans cell (~1 mm in diameter), next to an amphipod showing that it is to big to be eaten by a similar sized zooplankton.
Image: SGP Matondkar

Way forward

- Develop prediction and early warning systems
- More important ---reduce eutrophication and coastal pollution which promote such HABs

4

Anthropogenic impacts

LITTER IN AQUATIC SYSTEMS

4.8 and 12.7 million MT enter the oceans.

The UNEP has recently initiated a special program ***'Global Initiative on Marine Litter'***. Three main industries which are affected by **marine debris are fisheries, shipping and tourism** and the estimated damage to these sectors in **APEC region is US$1.265 million annually**.

Annual production is about 50,000 tonnes

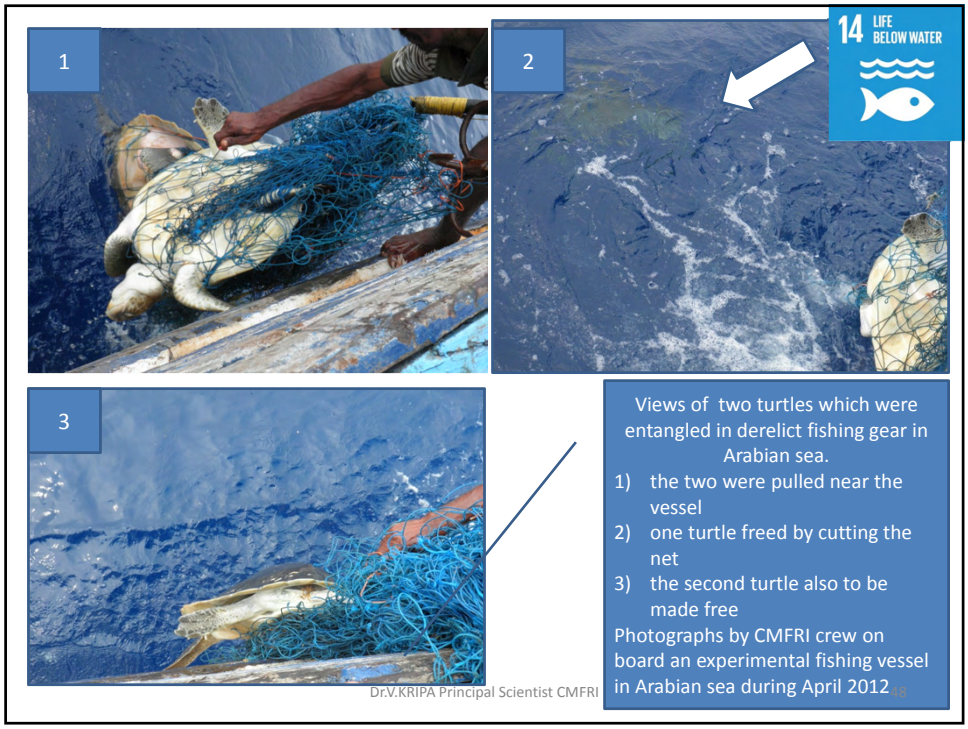
14 LIFE BELOW WATER

Some of the poorest fishers of India

Decrease in bivalve population can affect ecology of the whole system

Benthic habitat

- Flat fish habitat
- Egg laying habitat of gastropods, octopuses and fishes



Views of two turtles which were entangled in derelict fishing gear in Arabian sea.

1) the two were pulled near the vessel
2) one turtle freed by cutting the net
3) the second turtle also to be made free

Photographs by CMFRI crew on board an experimental fishing vessel in Arabian sea during April 2012

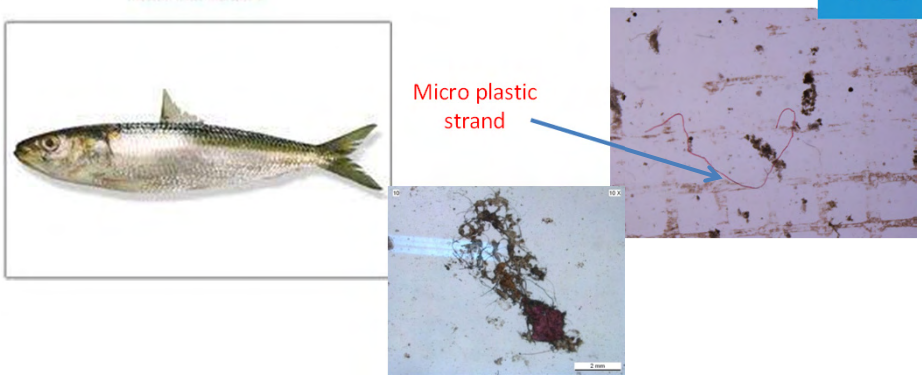
Danger—chemicals leaching from plastics

The **fragmentation of plastics increases** leaching of these chemicals and enable more surface area for adsorption of toxic chemicals from environment

- The toxicity of additive chemicals (default in manufacture) eg: **phthalates** (endocrine disrupting and carcinogenic), **bisphenol A** (endocrine disruption and cytotoxicity), **brominated flame** retardants (immunotoxicity, cytotoxicity, neurotoxicity, endocrine disruption), **triclosan, bisphenone** and **organotins** which can leach from the polymer into the surroundings as the bond weakly with the polymer.

Micro-plastic contamination in fish

Indian Oil Sardine



The abundance of MPs recorded from the sediment samples is in the range of 96–496 particles m^{-2} with a mean abundance of 252.80 ± 25.76 particles m^{-2}.

Macro-plastic contamination in fish

Pic courtesy- Dr Bindu Sulochanan CMFRI

Pic courtesy- Dr VV Singh/Mumbai RC CMFRI

Way forward

1. Awareness campaigns----student blue/green brigades
2. Collection Mechanism
3. Segregation
4. Efficient Transportation
5. Treatment facilities
6. For fishermen -Incentives – for litter reduction
7. Implementation of Rules and regulations

The way forward

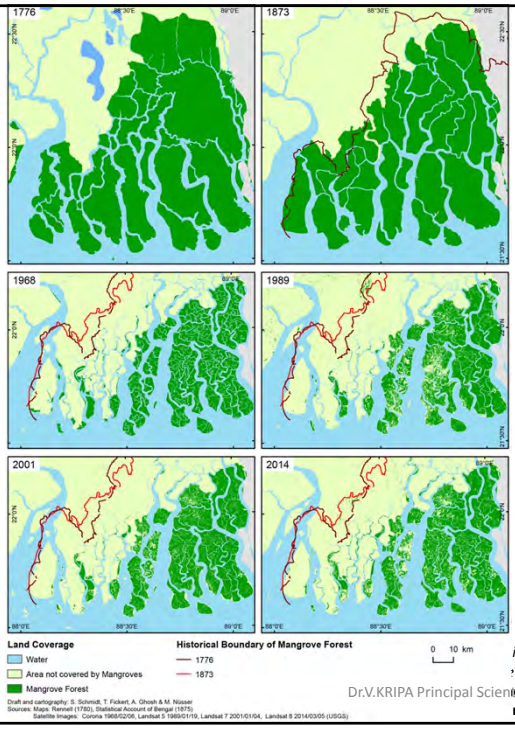
- CRZ – not targeting marine litter
- The Ministry of Environment and Forest (MoEF) has issued MSW management and handling rules for scientific MSWM –but this has not targeted marine debris.
- Hence –there should be a

National Marine Debris Management Strategy

5

Anthropogenic impacts

HABITAT ALTERATION



14 LIFE BELOW WATER

- policies may be designed, employing instruments such as REDD+ (Reducing Emissions from Deforestation and Forest Degradation) and the CDM (Clean Development Mechanism)

Ghosh Susanne Schmidt , Thomas Fickert and Marcus Nüsser

ity **2015**, *7*(2), 149-169; doi:10.3390/d7020149

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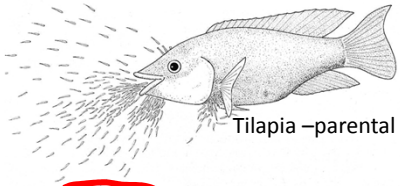
dian Sundarban Mangrove Forests: History, Utilization,

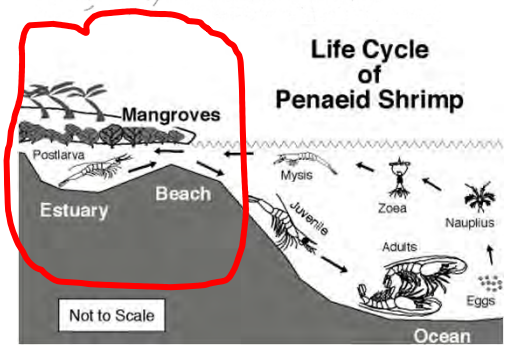
rvation Strategies and Local Perception

Important breeding ground and nursery of valuable biota



Tilapia –parental care

Karimeen-Pearl spot



Eggs of Pearl spot

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Many species have already become extinct, particularly in **tropical** areas. This loss of biodiversity impacts food resources, such as fish stocks

In Canada

- 625 Canadian scientists signed a letter protesting 2012 changes to the Fisheries Act stating: Habitat destruction is the most common reason for species decline
- NO HABITAT, NO FISH, THE SCIENCE IS CLEAR

What can be done in India

- Clear enforceable habitat protection provisions will help protect fish and fisheries

6

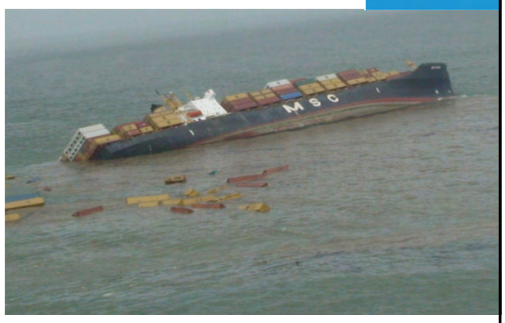
Oil and Grease

Global crude oil flows

- 2nd LARGEST CONSUMER IN ASIA-PACIFIC REGION
- 70% OF WORLD OIL DEMAND FERRIED ALONG INDIAN COASTLINE
- INDIGENOUS PRODUCTION ≈35 MMTPA
- IMPORT ≈200 MMPTA

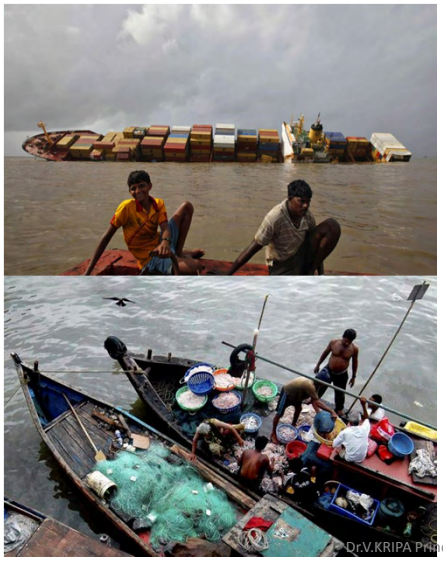
Credit : Former DIG ANISH A HEBBAR, TM

MSC Chitra

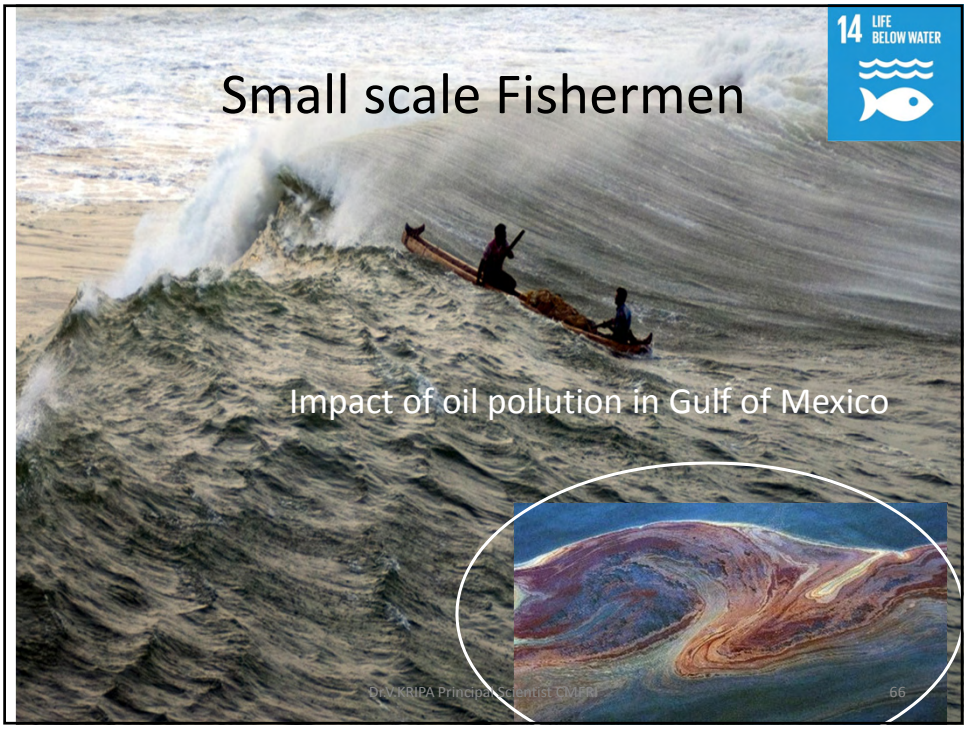


- Collision on 07 Aug 2010
- Off Mumbai
- 800 tons

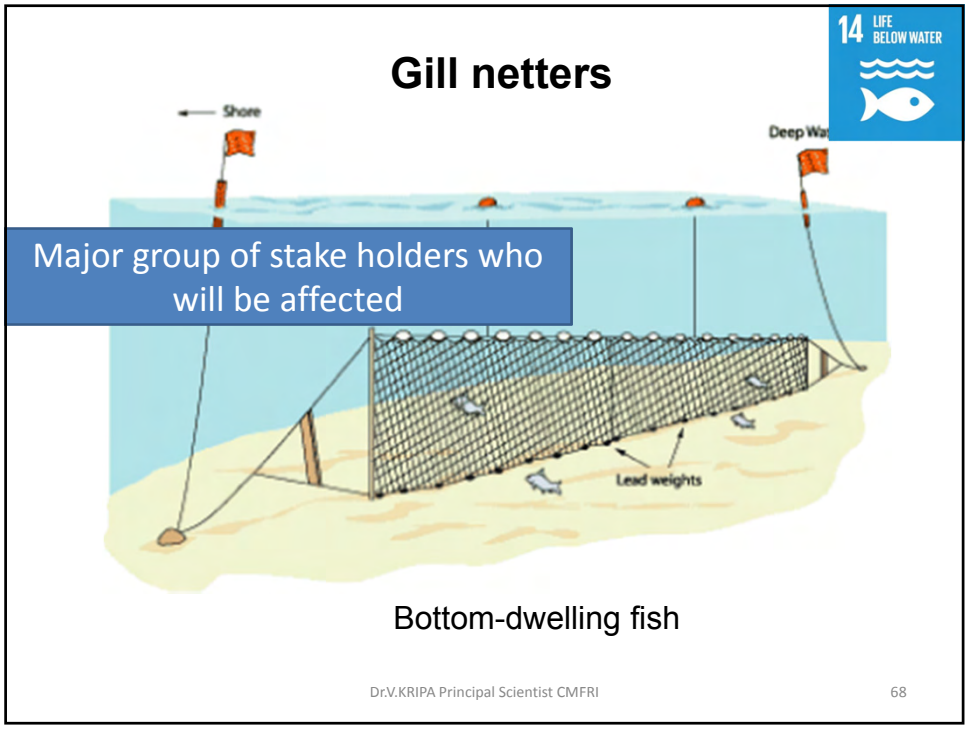
MSC Chitra

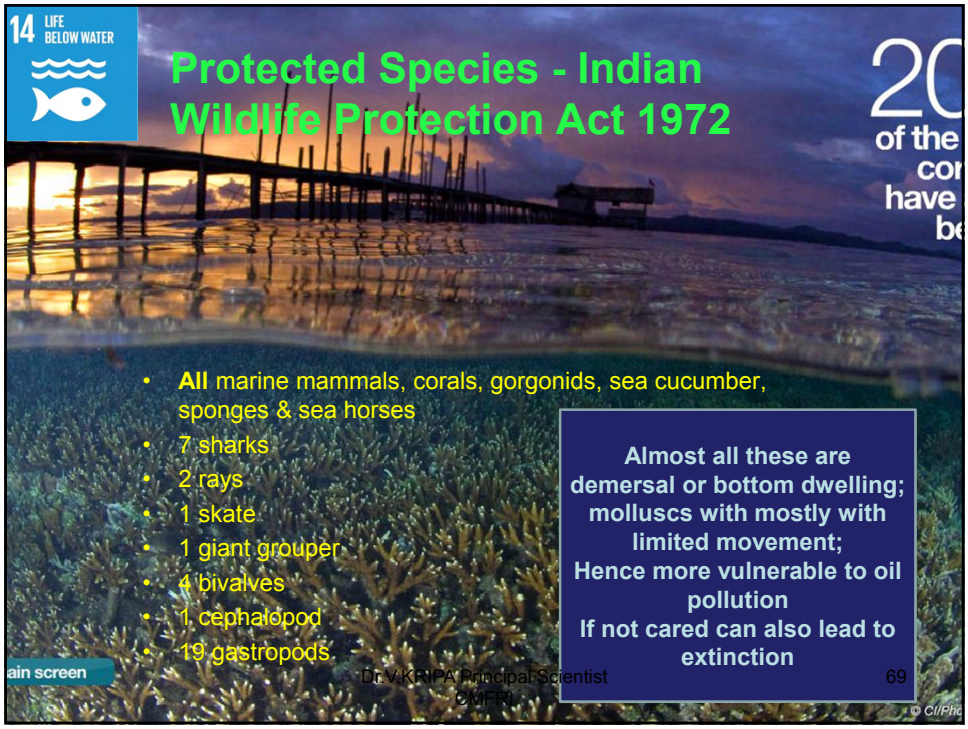


- Affected 33 Fishing villages in 3 districts
- **Prohibition on landing of contaminated fish by Mumbai Municipal Corporation**
- Fishing effort by mechanized vessels for August 2010 decreased by 29% and landings declined by 6% while the non-mechanized fishing recorded 49% decline in landings
- 60 fish markets across Mumbai empty for the week consequent to the spill
- Fisheries loss rupees 60-80 crore
- Fish from other states not allowed to enter Mumbai
- Stocked frozen fish sold at low price to clear the stock




14 LIFE BELOW WATER
Landing centers 1332
Non-motorised vessels 104,270
BEACH CLOSED
DUE TO
OIL SPILL
CAUTION

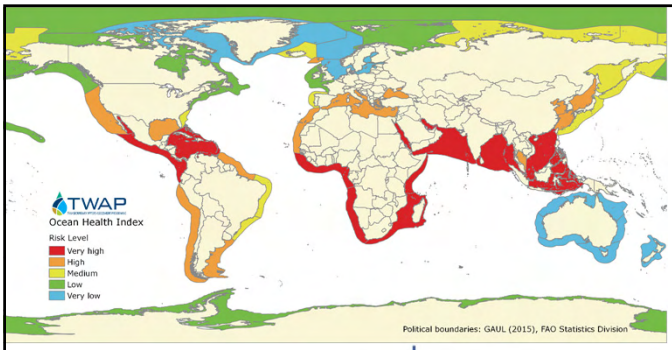

14 LIFE BELOW WATER
Gill netters
Shore
Deep Wa
Major group of stake holders who will be affected
Lead weights
Bottom-dwelling fish



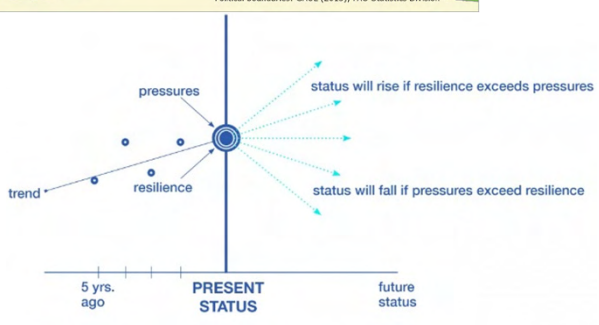
The way forward

- **Spatial Maps** of critical habitats along the Indian coasts and the route of oil tankers.-So that precaution can be taken
- **Map of vulnerable resource** abundance and make it available to oil tankers
- More research on the **impacts** of resources and ecosystem
- How plankton and benthos are affected

To conclude……

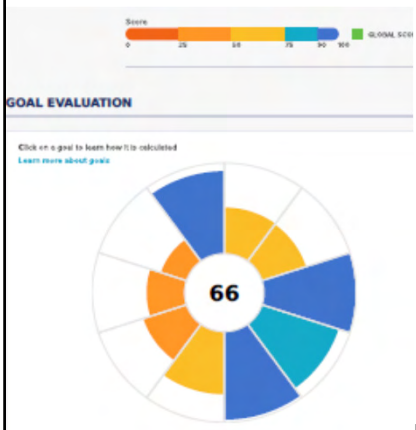


OCEAN HEALTH INDEX



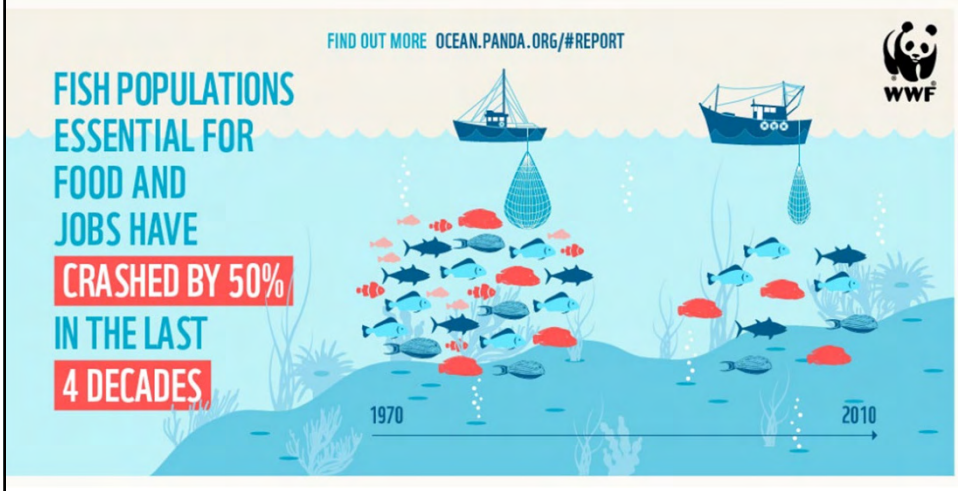
Ocean Health Index –India 2016

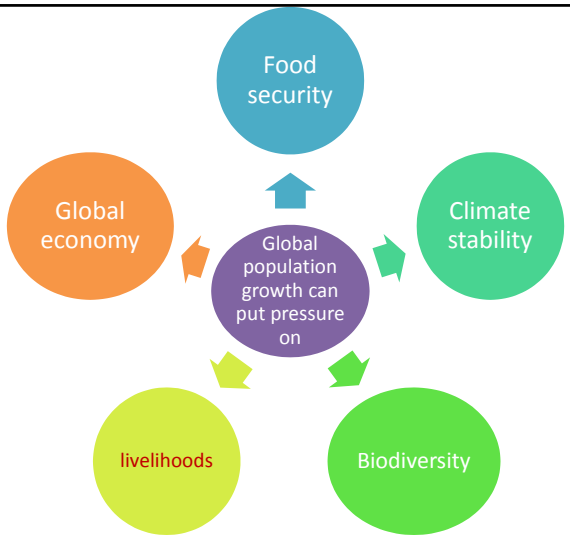
Score 66; 130th rank out of 221 EEZ



Score	Parameter
51	Food provision
50	Artisanal fishing opportunity
99	Natural products
87	Carbon storage
97	Coastal protection
69	Coastal livelihoods and economy
49	Tourism and recreation
41	Sense of place
29	Clean waters
91	Biodiversity
66.3	

There should be good FMP and governance





So…the way forward : Each nation should chart out specific plans to improve their OHI

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