ISSN 0254-380 X

No. 213
July-September 2012

Marine Fisheries Information Service

Technical and Extension Series

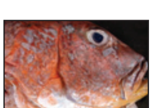
Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)
Post Box No. 1603, Cochin - 682 018
www.cmfri.org.in

Marine Fisheries Information Service

No. 213 * July-September, 2012

Abbreviation - *Mar. Fish. Infor. Serv., T & E Ser.*

Mud bank fishery



Lower jaw deformity in Malabar red snapper

Chelonia mydas

CONTENTS

The Marine Fisheries Information Service : Technical and Extension Series envisages dissemination of information on marine fishery resources based on research results to the planners, industry and fish farmers, and transfer of technology from laboratory to field.

Climate change impacts on coastal lakes: an evaluation of the impact on Vembanad, Chilka and Pulicat lakes and their resources

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Coastal lakes are important breeding grounds of fish/shellfish which support artisanal fisheries. The changes in the immediate offshore regions are important as these regions also form spawning and nursery grounds of several species of fishes. Hence it is presumed that changes in the immediate offshore regions or in the inshore critical habitats might influence the phenology and recruitment success of fish/shellfish by affecting their growth and survival.

Study locations

Three major coastal lakes of the country such as Vembanad (south-west coast), Pulicat (south-east coast) and Chilka (north-east coast) were selected for the study as these are regions of rich biodiversity. The services they offer by providing breeding habitat and/or nursery grounds for a large number of high value finfishes and shellfishes including some migrant species which spend only part of their life in the coastal regions. A typical example is the Indian shrimp *Fenneropenaeus indicus* which spawns in the sea and completes its early life cycle in the estuaries/coastal lakes. They are known to support the major commercial fishery worth several millions of dollars. The lakes also support the livelihood of several coastal fishers who use simple non-mechanised /traditional gear to fish the resources in the lakes. The geo-locations of the three lakes and the immediate offshore regions are given in Table 1.

Table. 1. Geo-locations of the study area

	Lake	Offshore
Vembanad (south- west region)	76^0 E 9^0 N	75^0 E 9^0 N
PulicatLake (south-east region)	80^0 E 13^0 N	81^0 E 13^0 N
Chilka Lake (north-east region)	85^0 E 19^0 N	86^0 E 19^0 N

Methodology

The monthly SST (sea surface temperature) for the period from 1960 to 2009 was downloaded from ICOADS (provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their web site at http://www.esrl.noaa.gov/psd/database) and analysed.

Comparison of monthly surface water temperature during the five decade period, 1960-69 and 2000-2009

The average monthly variations in the parameters pertaining to 1960-69 and 2000-2009 were compared. The trend in variation was inferred and instances where Δt (variation in monthly decadal mean surface water temperature, SWT of 1960-69 and 2000-2009) was more than 0.5, (increase or decrease) was considered as significantly impacted.

Comparison of decadal mean surface water temperature

The mean decadal SWT of the six regions were compared. When the values were equal to or above 0.5, the difference was considered significant. Moreover, the percentages of impacted months in the region were calculated and the values were graded as given in Table 2. These grades were also used to evaluate the intensity of climate change (CC) impact in the specific region.

Table 2. Grades used for evaluating intensity of climate change

Value/range of percentage	Grade
0	No impact
1 to 33 %	Mildly impacted
34 to 67 %	Moderately impacted
68 to 100 %	Strongly impacted

Comparison of seasonal surface water temperatures during the decades 1960-69 and 2000-09

From the monthly data, the variations in seasons such as summer monsoon (June to September), inter-monsoon fall (October), winter monsoon (November-February) and Inter-monsoon spring (March to May) were also analysed. Here also, when the Δt values were above 0.5, it was considered as significantly impacted.

Evaluation of likely impacts on spawning or survival/ growth of eggs, larvae, juveniles (recruitment success) and possible impact on fishery

Published information on the spawning period (months) and/or the months when the eggs and larvae were obtained in large numbers of commercially important resources like shrimps and finfishes were collected. The intensity of climate change in these months as obtained from the results under section A was used and the inferences were made based on the grades obtained as indicated in the case of mean decadal SWT.

Results

Comparison of monthly surface water temperature during the five decade period, 1960-69 and 2000-2009

Vembanad Lake and offshore region of Vembanad Lake

In general it was observed that, there is significant change in surface water temperature during February and April to September (Table 3). A shift in peak during summer from April to May has been observed in Vembanad Lake. In the open sea, off Vembanad Lake, during the months February, June-September and November, there is significant increase in temperature.

Pulicat Lake and offshore region of Pulicat Lake

In Pulicat Lake, the temperature was found to decrease significantly during April, May and June. During the period from August to October, though there was increase in temperature, the increase was not significant (Table 4). In the offshore region, the temperature was found to increase significantly in April, June, July, October and December. Moreover, the peak observed in May was found to shift to June.

Chilka Lake and offshore region of Chilka Lake

In Chilka Lake, temperature was found to significantly increase during January, March, April, July, September and November and found to significantly decrease during May and August (Table 5). The peak in May was found to shift to April and peak in August was found to shift to July. In the offshore areas of Chilka Lake, SWT was found to increase significantly during January, February, April, June and from October to December. The peak in May was found to shift to April.

Comparison of decadal mean surface water temperature

Based on the decadal ΔSWT, the Vembanad Lake and offshore region did not show significant

Table 3. Month-wise evaluation of Δt in Vembanad Lake and offshore region

Vembanad lake			Vembanad off shore region		
Month	Shift observed	Intensity of change / Δt	Month	Shift observed	Intensity of change / Δt
Jan	No	↑ NS	Jan	No	↑ NS
Feb	No	↑ S	Feb	No	↑ S
March	No	No change	March	No	No change
April	Peak shifted to May	↓ S	April	No	No change
May	No	↑ NS	May	No	Almost same
June	No	↑ S	June	No	↑ S
July	No	↑ S	July	No	↑ S
Aug	No	↑ S	Aug	No	↑ S
Sept	No	↑ S	Sept	No	↑ S
Oct	No	↓ NS	Oct	No	↑ NS
Nov	No	↑ NS	Nov	No	↑ S
Dec	No	↑ NS	Dec	No	↑ NS

↑ indicates increase; ↓ indicates decrease; S = Significant; NS = Not significant

Table 4. Monthwise evaluation of Δt in Pulicat Lake and offshore region

Pulicat Lake			Pulicat offshore region		
Month	Shift observed	Intensity of change / Δt	Month	Shift observed	Intensity of change / Δt
Jan	No	No change	Jan	No	↑ N S
Feb	No	↑ N S	Feb	No	No change
March	No	No change	March	No	↑ N S
April	No	↓ S	April	No	↑ S
May	No	↓ S	May	Peak shifted to June	No change
June	No	↓ S	June	No	↑ S
July	No	No change	July	No	↑ S
Aug	No	↑ N S	Aug	No	↑ N S
Sept	No	↑ N S	Sept	No	↓ N S
Oct	No	↑ N S	Oct	No	↑ S
Nov	No	No change	Nov	No	↓ N S
Dec	No	Almost same	Dec	No	↑ S

↑ indicates increase; ↓ indicates decrease; S = Significant; NS = Not significant

difference, though the offshore region showed a higher value (0.44) compared to the lake (0.4). Based on the percentage of significantly impacted months, it can be inferred that both Vembanad Lake and corresponding offshore region are moderately impacted (Table 6).

The offshore region of Pulicat Lake showed an increase of 0.14 °C in ΔSWT than that of the Pulicat Lake. The Pulicat Lake showed a decrease in ΔSWT. This may be indicative of a possible decrease in mean SWT in this lake, in majority of the months of the recent decade compared to its SWT of the months of the decade before 40 years. Based on the percentage of significantly impacted months, it can be inferred that Pulicat Lake is only mildly impacted while the offshore region is moderately impacted.

The offshore region of Chilka showed an increase of 0.1 °C than the ΔSWT of Chilka Lake. Significant increase in ΔSWT was shown only in Chilka Deep.

Table 5. Monthwise evaluation of Δt in Chilka Lake and offshore region

Chilka Lake			Chilka offshore region		
Month	Shift observed	Intensity of change /Δt	Month	Shift observed	Intensity of change / Δt
Jan	No	↑ S	Jan	No	↑ S
Feb	No	↓ N S	Feb	No	↑ S
March	No	↑ S	March	No	↑ N S
April	No	↑ S	April	No	↑ S
May	Peak shifted to April	↓ S	May	Peak shifted to April	↓ N S
June	No	↑ N S	June	No	↑ S
July	No	↑ S	July	No	↑ NS
Aug	Peak shifted to July	↓ S	Aug	No	No change
Sept	No	↑ S	Sept	No	↑ N S
Oct	No	No change	Oct	No	↑ S
Nov	No	↑ S	Nov	No	↑ S
Dec	No	↑ NS	Dec	No	↑ S

↑ indicates increase; ↓ indicates decrease; S = Significant; NS = Not significant

Table 6. Comparison of decadal mean surface water temperature in Vembanad, Pulicat and Chilka lakes and corresponding offshore regions

	1960-69	2000-09	ΔSWT	Likely climate change impact based on % of significantly impacted months
Vembanad Lake	28.11	28.51	0.4	Likely to be moderately impacted (50%)
Offshore Vembanad	28.34	28.78	0.44	Likely to be moderately impacted (50%)
Pulicat Lake	28.16	28.03	- 0.13	Likely to be mildly impacted (25%)
Offshore Pulicat	28.21	28.48	0.27	Likely to be moderately impacted (42%)
Chilka Lake	27.97	28.38	0.41	Likely to be strongly impacted (67%)
Offshore Chilka	27.89	28.4	0.51	Likely to be moderately impacted (58%)

Based on the percentage of significantly impacted months, it can be inferred that Chilka Lake is likely to be significantly impacted and offshore region moderately impacted.

Comparison of seasonal SWT during the decades 1960-69 and 2000-09

Vembanad Lake

Among the four seasons, the increase in temperature during the summer monsoon in the lake and offshore region were significant while increase in temperature during winter monsoon was significant only in the lake, while in the offshore region, it was not significant (Table 7). In the lake, the temperature during the inter-monsoon fall and inter-monsoon spring was found to be decreasing, though the values were not significant. In the offshore region, ΔSWT were not significant.

Pulicat Lake

In Pulicat lake, temperature during the summer monsoon and inter-monsoon spring was found to be decreasing and the ΔSWT during the latter season was significant (Table 8). However, in the offshore region, temperature showed an increasing trend and the ΔSWT was significant in the inter-monsoon fall.

Chilka Lake

The temperature was found increasing during summer monsoon and winter monsoon and the ΔSWT was significant during the latter in the lake and offshore region (Table 9). In the lake, the temperature was found to decrease during the inter-monsoon fall and inter-monsoon spring but the ΔSWT was not significant. In the offshore region, the ΔSWT during the inter monsoon fall was significant.

Table 7**.** Comparison of seasonal variation in ΔSWT in Vembanad Lake and offshore region

	Vembanad Lake			Offshore Vembanad Lake		
	1960-69	2000-09	ΔSWT	1960-69	2000-09	ΔSWT
Summer monsoon	26.8482	27.63	0.8	27.40	28.11	0.71
Inter-monsoon fall	28.003	27.91	-0.1	28.17	28.50	0.33
Winter monsoon	28.288	28.76	0.5	28.32	28.75	0.43
Inter-monsoon spring	29.6047	29.50	-0.1	29.70	29.80	0.10

Table 8. Comparison of seasonal variation in ΔSWT in Pulicat Lake and offshore region

	Pulicat Lake			Offshore Pulicat Lake		
	1960-69	2000-09	ΔSWT	1960-69	2000-09	ΔSWT
Summer monsoon	28.6017	28.4312	-0.2	28.71	28.75	0.05
Inter-monsoon fall	28.8683	29.2843	0.4	28.55	29.74	1.19
Winter monsoon	27.0366	27.1504	0.1	26.90	27.02	0.11
Inter-monsoon spring	28.8186	28.3225	-0.5	29.12	29.56	0.44

Table 9. Comparison of seasonal variation in ∆SWT in Chilka Lake and offshore region

Season	1960-69	2000-09	∆SWT	1960-69	2000-09	∆SWT
Summer monsoon	28.9591	29.3325	0.4	29.10	29.45	0.35
Inter-monsoon fall	29.2175	29.12	-0.1	28.50	29.24	0.73
Winter monsoon	26.0577	26.9429	0.9	26.11	26.73	0.62
Inter-monsoon spring	28.5606	28.4191	-0.1	28.44	28.76	0.32

Evaluation of likely impacts on spawning or survival/ growth of eggs, larvae, juveniles (recruitment success) and possible impact on fishery

Vembanad Lake

In general, it can be stated the spawning/recruitment success of fishes/shellfishes during February and April to September are likely to be impacted, since there is significant increase in temperature and shift in peak (April to May). Spawning/recruitment success of fishes/ shellfishes in the open sea, off Vembanad Lake, during the months February, June-September and November are likely to be impacted, since there is significant increase in temperature during this period.

Case studies

- The major spawning period of *Metapenaeus dobsoni* and *Metapenaeus monoceros* in the offshore region of Vembanad Lake is likely due to be moderately affected (Table 10).
- The major nursery period of *M. dobsoni*, *Fenneropenaeus indicus* and *M. monoceros* in Vembanad Lake will not be affected
- The secondary spawning of *M. dobsoni* and *F. indicus* in the offshore region of Vembanad Lake and corresponding nursery phase in the Vemband Lake are likely to be mildly affected
- The nursery phase of *Liza parsia* and *Liza macrolepis* in the Vembanad Lake is likely to be mildly affected
- The spawning and nursery phase of *Mugil cephalus* in the Vembanad Lake are likely to be strongly affected

Pulicat Lake

Case studies

- Spawning and nursery phase of *Penaeus monodon* and *Penaeus semisulcatus* during the summer monsoon and inter-monsoon fall are not likely to be impacted (Table 11)
- Spawning and nursery phase of *F. indicus* in the Pulicat Lake is likely to be mildly impacted
- Spawning and nursery phase of *P. semisulcatus* during the inter-monsoon spring are likely to be moderately impacted.

Table 10. Evaluation of likely impacts on spawning and early life history (ELH) of common species of Vembanad Lake

Species	Location	Stage	Period	%	Grade	
M. dobsoni	VL	ELH	Nov-Dec	0	I	(green)
M. dobsoni	OVL	Spawning	Nov-Dec	50	III	(orange)
M. dobsoni	VL	ELH	Mar-Jun	50	III	(orange)
M. dobsoni	OVL	Spawning	Mar-Jun	25	II	(yellow)
M. monoceros	VL	ELH	Nov-Dec	0	I	(green)
M. monoceros	OVL	Spawning	Nov-Dec	50	III	(orange)
M. monoceros	VL	ELH	May-Jun	50	III	(orange)
M. monoceros	OVL	Spawning	May-Jun	50	III	(orange)
F. indicus	VL	ELH	Oct-Dec	0	I	(green)
F. indicus	OVL	Spawning	Oct-Dec	33	II	(yellow)
F. indicus	VL	ELH	Feb-May	50	III	(orange)
F. indicus	OVL	Spawning	Feb-May	25	II	(yellow)
Liza parsia	VL	ELH	Mar-May	33	III	(yellow)
Liza macrolepis	VL	ELH	Mar-May	33	III	(yellow)
Mugil cephalus	VL	ELH	Jun-Aug	100	IV	(red)

OVL-Offshore Vembanad Lake; VL –Vemabanad Lake; ELH –Early life history stages (eggs/larvae/juveniles); Grade I=0% No impact; I = 1-33% impacted; II=34 to 67% moderately impacted; IV-68 to 100% strongly impacted.

Source: Kuttyamma (1975)

Chilka Lake

Case studies

- Of the 11 species of fishes whose spawning periods were analysed, 64% (7 nos.) *viz.*, *Hilsa ilisha, Nematalosa nasus, Pseudosciaena coibor, Rhinomugil corsula, Rastrelliger kanagurta, Lates calcarifer* and *Eleutheronema tetradactylum* are likely to be severely impacted and 36% (4 nos.) such as *Liza macrolepis, Etroplus suratensis, Mugil cephalus* and *Sillago sihama* are likely to be moderately affected (Table 12).
- Of the four species of shrimps studied, the spawning of three species namely, *F. indicus, M. dobsoni* and *P. semisulcatus* is likely to be severely affected.
- The spawning and nursery phase of *M. monoceros* is likely to be moderately impacted.

Table 11. Evaluation of likely impacts on spawning and ELH of common species of Pulicat Lake

Species	Location	Stage	Period	%	Grade
F. indicus	PL	ELS	Jan-Apr	25	II
F. indicus	PL	ELS	Jun -Sep	25	II
P. monodon	PL	ELS	Jan-Apr	25	II
P. monodon	PL	ELS	Aug-Nov	0	I
P. semisulcatus	PL	ELS	Mar-Jun	75	III
P. semisulcatus	PL	ELS	Sep-Oct	0	I

PL –Pulicat Lake; ELH –Early life history stages (eggs/larvae/juveniles); Grade I=0% No impact; I = 1-33% mildly impacted; II=34 to 67% moderately impacted; IV-68 to 100% strongly impacted.

Source: Subramanyam and Rao (1968)

Table 12. Evaluation of likely impacts on spawning and ELH of common species of Chilka Lake

Species	Location	Stage	Period	%	Grade
F. indicus	CL	S & ELH	Apr-May	100	IV
F. indicus	CL	S & ELH	Jul-Sep	100	IV
M. dobsoni	CL	S & ELH	Apr-May	100	IV
M. dobsoni	CL	S & ELH	Jul-Aug	100	IV
M. dobsoni	CL	S & ELH	Jul-Aug	50	III
P. semisulcatus	CL	S & ELH	Jul-Sep	100	IV
M. monoceros	CL	S & ELH	May -Jun	50	III
Hilsa ilisha	CL	S	Aug-Nov	75	IV
Hilsa ilisha	CL	ELH	Nov-Jan	67	III
Nematalosa nasus	CL	S	Apr-Aug	80	IV
Nematalosa nasus	CL	ELH	May, Sep	100	IV
Pseudosciaena coibor	CL	S	Apr-Jul	75	IV
Pseudosciaena coibor	CL	ELH	Jul-Sep	100	IV
Liza macrolepis	CL	S	Oct-Feb	40	III
Liza macrolepis	CL	ELH	Nov-Feb	50	III
Etroplus suratensis	CL	S & ELH	Mar-May	100	IV
Etroplus suratensis	CL	S &ELH	Nov-Jan	67	III
Mugil cephalus	CL	S & ELH	Oct-Mar	40 -50	III
Rhinomugil corsula	CL	S & ELH	Jul-Nov	80	IV
Rastrelliger kanagurta	CL	S	Jul-Nov	80	IV
Lates calcarifer	CL	S & ELH	May-Jun	50	IV
Eleutheronema tetradactylum	CL	S	Jan-Jun	67	III
Eleutheronema tetradactylum	CL	ELH	Apr-Oct	71	IV
Sillago sihama	CL	S & ELH	Oct-Jun	56	III

CL - Chilka Lake

Database on trace metal levels in the Indian marine ecosystem: decadal trends of lead and cadmium in sediment off Cochin

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The Fishery Environment Management Division (FEMD) of Central Marine Fisheries Research Institute (CMFRI), Kochi, has been documenting the real-time data on total concentration of metals *viz.*, Pb, Cd, Cu, and Zn since 1994, in sediments off Cochin and since 2002, data on Pb, Cd, Ni, Hg, Cu, Cr, Zn, Mn and Fe, in sediments from different regions of the Indian coast. Database on these vital parameters determining the sediment quality with respect to environmental toxicity is available in the FEM Division of CMFRI since 1994. The locations of data collection included three sites each from Veraval (Gujarat), Mumbai (Maharashtra), Karwar and Mangalore (Karnataka), Mandapam, Tuticorin and Chennai (Tamil Nadu), Visakhapatanam (Andhra Pradesh) and four sites from Cochin (Kerala) covering the Indian coast from different regional/ research centres as well as headquarter of CMFRI. The data were collected as part of the inhouse projects entitled "Monitoring marine pollution in relation to protection of living resources" (FEM/MP/1) from 1994-2002 and "Monitoring the environmental contaminants from coastal water with reference to bioaccumulation and bio-magnification in fishes" (FEM/02) from 2002 onwards. Recently, analysis of these data was done to understand the decadal trends in the content of lead and cadmium in sediment in the coastal waters of Central Kerala. Summary of the salient findings of this analysis is given below.

Sediment samples were collected from four stations (two stations belonging to the estuarine waters and two stations belonging to the inshore waters), off Cochin, using Van Veen Grab having an area of 0.05 m^2. The samples after processing and digestion were used to quantify total lead and total cadmium concentrations ($\mu g\ g^{-1}$) using atomic absorption spectrophotometer (AAS). Quality check, quality control and quality assurance procedures were maintained throughout.

Lead accumulation in sediment

The result of the analysis of total lead ($\mu g\ g^{-1}$) are plotted in figures 1 and 2. As per the sediment quality guidelines issued by NOAA (National Oceanographic and Atmospheric Administration, USA) based on assessment of the potential for biological effects of sediment adsorbed lead, the probable effects level is 112 $\mu g\ g^{-1}$ in marine conditions. The NOAA sediment quality guidelines are non-regulatory guidelines for use in interpreting chemical data. The probable effect level indicates a potential risk from the concerned contaminants to the biological field. The concentration of lead in sediment ($\mu g\ g^{-1}$) in harbour and barmouth (Fig. 1) did not go above probable effect level (PEL) in Cochin, except in 2002, during January to April (pre-monsoon).

Lead as a contaminant enters the marine ecosystem from different sources. The natural sources are atmosphere and intrinsic content in

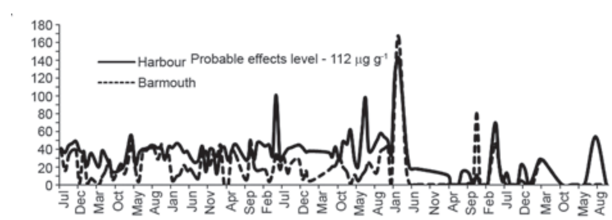

Fig. 1. Decadal trend of lead ($\mu g\ g^{-1}$) in sediment in Vembanad Estuary

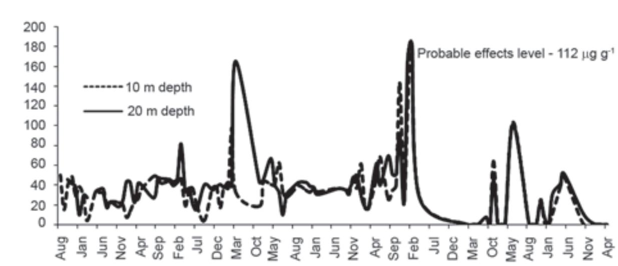

Fig. 2. Decadal trend of lead ($\mu g\ g^{-1}$) in nearshore sediment, off Cochin

lithosphere reaching the hydrosphere. Lead also enters the hydrosphere through anthropogenic activities including industrial effluent discharge. Lead is widely used in battery casings, pipes and lead based additives in fuels. High levels of lead have been reported in marine life near areas of car density in California and UK (Law *et al.*,1992). Toxic quantities of lead consumed by humans can cause anaemia, hypertension, cardiac disease, immune system suppression (antibody inhibition) and neurological damage.

The lead accumulation level in nearshore sediments off Cochin were well below the level of potential risk (*i.e.*, the probable effect level of 112 $\mu g\ g^{-1}$) except in November 2001 and in January – February 2002 at 20 m depth (post and pre-monsoon). The incidence of lead above PEL is 2.4% of the total observations (N = 421). These stray occurrences of higher accumulation of lead, during particular periods of one to three months in post and /or pre-monsoon might be from anthropogenic origin. The index for anthropogenic accumulation of metals worked out as "enrichment factor" for lead in sediment was high in post and pre-monsoon seasons whereas it was practically nil in monsoon seasons. This can be a sign of potential risk for lead accumulation in sediment in post and pre-monsoon seasons in estuary as well as inshore areas and dilution in monsoon. It also shows that the resident time of potential lead contamination is less and the threat for biota for exposure to the potential risk level is too little. There is no permanent binding of lead by the sediment at the potential risk concentration. Hence the sediments can be considered as generally in the state of safe environment as far as lead accumulation is considered.

Cadmium accumulation in sediment

Cadmium enters the aquatic system as contaminant in many ways. Cadmium was used widely in electroplating, in solder and as a pigment for plastics, but less frequently now due to health concerns. Main sources presently are as by-product of zinc mining, nickel-cadmium battery production, burning of coal and oil, wearing down of car tyres, corrosion of galvanized metal, phosphatic fertilizers and sewage sludge. Out of the cadmium input into the oceans, around 50% is anthropogenic.

In human beings, cadmium in high levels can cause depressed growth in children, kidney damage, cardiac enlargement, hyper tension, foetal deformity and cancer. In humans, cadmium concentration above 200-400 ppm in kidney tissue can lead to renal damage. Kidney malfunction has been reported in cetaceans when liver concentrations of Cd exceeded 20 ppm wet weight (Fujiso *et al.*, 1988).

Decadal trend of Cd ($\mu g\ g^{-1}$) in sediment in Vembanad Estuary is plotted based on the data recorded at FEM Division, CMFRI, from 1994 – 2006. The Cd concentration was above the NOAA probable effect level (above 4.2 ppm) in harbour region, during October to January in 1999, 2001, 2003 – 2004 and 2006 (Fig. 3).

In the barmouth region, the concentrations were above PEL (above 4.2 ppm) in October 2001, October - December 2003, January – February 2004 and October 2006 (Fig. 3).

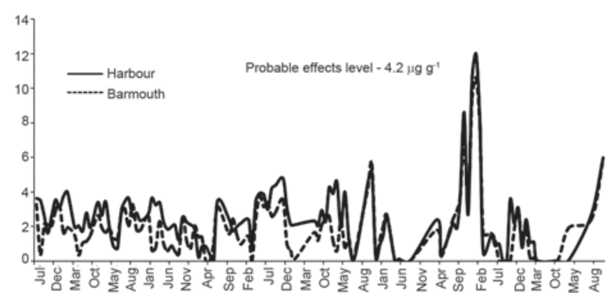

Fig. 3. Decadal trend of Cd ($\mu g\ g^{-1}$) in sediment in Vembanad Estuary

In 10 m depth inshore sediment, the concentrations were above PEL (above 4.2 ppm) in December 1998, September 1999, November 2000, September – October 2001, September – December 2003 and January-February 2004 (Fig. 4). The inshore sediment at 20 m depth showed concentrations above PEL (above 4.2 ppm) in September–November 1999, December 2000, September 2001, October – December 2003 and January – February 2004 (Fig. 4). The incidence of cadmium above PEL is 9.5% of the total observations (N = 421). Here also, the occurrence of levels above PEL was mainly during post-monsoon and pre-monsoon months and the resident time did not exceed 3-4 months. With the onset of monsoon, the level of metal became low and therefore no permanent binding of the metal occurs. The enrichment factor for cadmium also showed values of high anthropogenic influence in post and pre-monsoon seasons which became nullified in monsoon. The inherent metal content of these sediments did not reach level for potential risk.

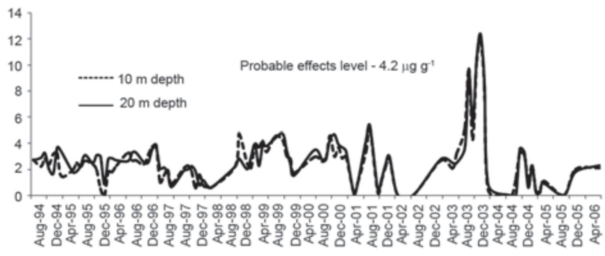

Fig. 4. Decadal trend of Cd ($\mu g\ g^{-1}$) in nearshore sediment off Cochin

Though the estuarine and inshore sediments off Cochin came within the class of unpolluted to slightly polluted, over the decadal analysis, the importance for continuous investigation for potential risk does not cease, since the anthropogenic and industrial pressure increases invariably in the present scenario in Cochin. Hence the need for surveillance as well as control increases. Creating awareness of the potential setback among the public, industrialists, fishermen, youth and policy makers through participatory approach for reducing the contamination through regulatory and non-regulatory volunteer practices becomes a must in current approach for management of this crisis.

Strontium to calcium (Sr/Ca) ratio in otolith as a tool for stock discrimination of oilsardine and mackerel

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Otoliths are found in the membranous labyrinth of the inner ear of teleost fish and serve mainly in balancing the organism. They are composed of calcium carbonate and are deposited rhythmically as aragonite crystals within a protein matrix. They have long been used in fish aging studies. Recently, changes in the strontium (Sr): calcium (Ca) ratios in otoliths have received increasing attention, as these provide a method of reconstructing environmental history of the fish. Strontium is a calcium analogue sharing a similar crystal ionic radius and can substitute for Ca in the aragonite lattice of otoliths. The Sr concentration in seawater is approximately 100 fold greater than that in freshwater (Campana, 1999), and a good relationship exists between otolith Sr:Ca ratios and ambient salinities (Secor *et al*., 1995, Tzeng, 1996). Thus Sr:Ca ratios in otoliths have widely been applied for studying habitat use and migratory behaviour of fish (Chang *et al*., 2004) and in stock discrimination (Volpedo and Cerelli, 2006).

As a part of the in-house project on the “Impact and yield study of environmental changes on the distribution shifts in small pelagics along the Indian coast”, otolith chemistry with special reference to Sr/Ca ratio in otolith collected from different zones of the Indian coast were worked out for oilsardine (*Sardinella longiceps*) and mackerel (*Rastrelliger kanagurta*). Database on Sr/Ca ratio of otolith of oilsardine and mackerel were developed in the Fishery Environment Management Division (FEMD) of Central Marine Fisheries Research Institute (CMFRI), Kochi. The locations of otolith collection were : Veraval (Gujarat), Mumbai (Maharashtra), Karwar and Mangalore (Karnataka), Mandapam, Tuticorin and Chennai (Tamil Nadu), Visakhapatanam (Andhra Pradesh) and Cochin (Kearala) covering the Indian coast from different regional/research centres and headquarter of CMFRI. Cochin. The salient findings from the analysis carried out on this database is presented here.

From the otolith samples of oilsardine and mackerel collected at different centres of CMFRI, intact pairs were selected, processed and chemically digested in the Environment Laboratory of CMFRI, Kochi. Further analysis using Inductively Coupled Plasma Spectroscopy for Ca and Sr were outsourced at Cochin University of Science and Technology. The data were subjected to statistical analysis on Pearson Correlation and Analysis of Variance using SPSS 16.

Correlation analysis was done with Sr/Ca ratio of otolith *vs* ambient salinity in the location and significant positive correlation was observed in the case of otoliths of both oilsardine and mackerel.

Otolith chemistry (Sr/Ca ratio) from different zones of the Indian Coast

The results on variation in Sr/Ca ratio in otolith pairs of oilsardine collected at different centres of CMFRI are plotted in figures 1 and 2.

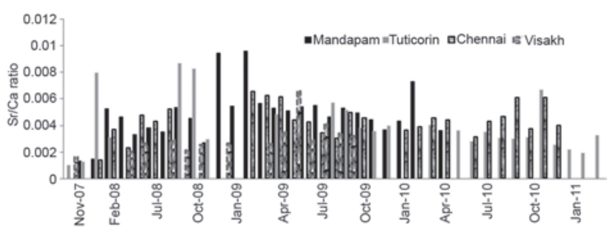

Fig. 1. Sr/Ca ratio of oilsardine otolith collected from selected centres along the Indian coast

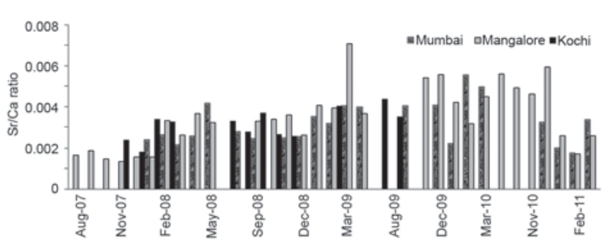

Fig. 2. Sr/Ca ratio of oilsardine otolith collected from selected centres of the Indian coast

Statistical analysis (ANOVA) showed significant difference between the Sr/Ca ratio of oilsardine otolith of the east coast and west coast ($p<0.01$). Significant difference was seen among the different locations of the east and west coast together ($p<0.05$). No significant difference was seen among the monthly variability of the Sr/Ca ratio of the oilsardine otolith of the east and west coast together.

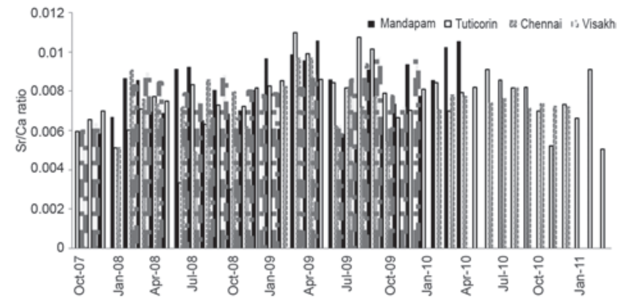

Fig. 3. Sr/Ca ratio of mackerel otolith collected from selected centres along the east coast of India

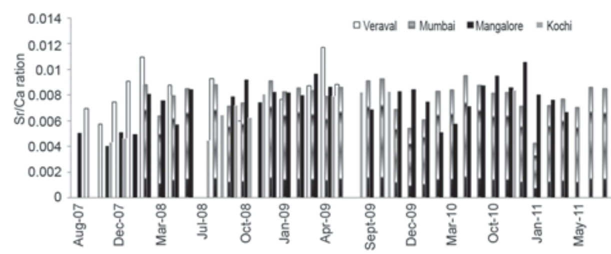

Fig. 4. Sr/Ca ratio of mackerel otolith collected from selected centres along the west coast, India

The results on variation in Sr/Ca ratio in otolith pairs of mackerel collected from different centres of CMFRI are depicted in figures 3 and 4.

No significant difference was observed between the Sr/Ca ratio of mackerel otolith of the east coast and west coast. No significant difference was seen among the different locations of the east and west coast together. But significant difference was seen among the monthly variability of the Sr/Ca ratio of the mackerel otolith of the east and west coast together ($p<0.05$).

The database on Sr/Ca ratio of otolith from different regions of the Indian coast does show significant spatial variability in the case of oilsardine. In mackerel otolith, temporal variability in the Sr/Ca ratio was reflected from this analysis. The data can be further subjected to Discriminant Analysis, making use of the data on size variability of the corresponding fishes from which the pair of otoliths have been collected, resulting in classification of discrimination in the stock of oilsardine and mackerel which are fishes found to be spreading towards other parts of the Indian coast, other than their natural historic distribution. The stock discrimination analysis can further be confirmed with DNA stock identification technique.

Oyster farm management advisory: spacing between farms

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The edible oyster *Crassostrea madrasensis* commonly known as the backwater oyster is farmed in the estuarine regions of Kerala by setting up wooden rack farms from which rens are suspended. Proximity to the homesteads is one of the reasons for this technology to become popular among women self help groups. The farming season is from November/December to June, but may extend to July also depending on the onset of monsoon. At present, the farm structures are near to the shore line in a linear manner, providing space for navigation in the inner part of the estuarine channels. Initially when commercial farming started in Sattar Island in the year 2002, there were only few farms, hence, spacing of farms was not a problem. Recently due to development in oyster market, more villagers have adopted oyster farming and sometimes the farms are spaced closely. Environmental impact studies with special reference to sediment texture and organic carbon were carried out. Accordingly management advisory is put forth based on sediment characteristics for sustained development of oyster farming and for reducing impacts on benthos.

Top sediment samples upto 5 cm depth were collected using a PVC corer from two farms (Farm 1 and Farm 2) stocked with edible oyster and from two locations outside the farm; one from the channel side and the other from the inter space between Farm 1 and Farm 2 for environmental impact assessment (EIA) studies. The space between farms was 2 m. Soil texture (percentage sand, silt and clay) was analysed by the International pipette method and percentage organic carbon by the Walkely and Black method.

The inter-space between Farm 1 and Farm 2 was found to be impacted by oyster farming. The sediment from this site showed 20% increase in silt than that of Farm 1 and 15% increase in silt than that of Farm 2 (Fig.1). However, in the sediment from the channel site there was no significant difference.

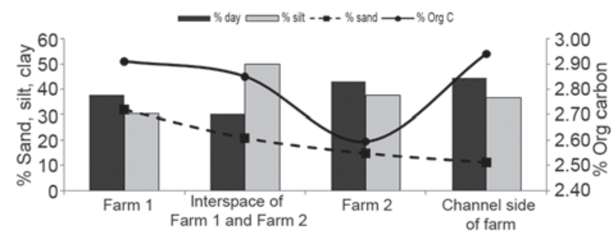

Fig. 1. Soil texture and organic carbon in the top sediment of oyster farms and impact sites

It is inferred that when the farms are very close, the inter space between the two farms is impacted by both the farms. When oyster rens are suspended from the racks, the fecal and pseudofecal matter fall from the column to the sediment with the tidal water flow. From the rens bordering the farm, the fecal matter can fall outside the farm also due to tidal flow. If farms are closely spaced, the water flow will be reduced and this can increase sedimentation rates within the farm and in the inter space region. Also, when the spacing is less, the inter space will be impacted by both the farms and this can change soil texture. In the channel area, percentage of silt is similar to the farm area since there is no obstruction. Even though there is slight increase in organic carbon in the inter space region from that of Farm 2, it was less than that of Farm 1. There was no significant change recorded in the organic carbon levels.

Since the benthic faunal assemblages can change depending on the sediment texture and organic carbon, it is recommended that the interspacing between two oyster farms should be made mandatory and can be kept at a minimum of 10 m . Sediment changes can lead to variation in benthic biota which can cause imbalance in the food web. Hence, scientific advisories which can reduce the negative impacts of mariculture are essential for sustained farming.

On the mud bank fishery observed in Thrissur District, Kerala during June, 2012

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During the month of June, 2012 from 25th to 30th, mud bank fishery was observed in Thrissur District, Kerala. During the six days of mud bank fishery , the landings of the district concentrated only at five centres, namely Puthan kadapuram, Blangad, Chettuva, Kaipamangalam (Companykadavu) and Perijanam (Bhajanamadam). The phenomenon was first noticed along the west coast, off Chettuva and Kaipamangalam, mostly in 5 to 16 m depth range.

Both motorised and mechanised crafts were used in this fishery. Motorised craft, included *murivallam* and *vallam* with outboard engine. The gears operated are *choodavala* and double net (mini trawl net). *Thanguvla* was the gear operated in mechanised craft during the period.The details of species obtained in different gears are as follows:


Landings of the mud bank fishery at different centres in Thrissur District

Choodavala: *Metapenaeus dobsoni, Fenneropenaeus indicus, Ambassis* spp.*, Stolephorus* spp. and *Raconda russeliana.*

Double net : *Metapenaeus dobsoni, Parapenaeopsis stylifera, Penaeus monodon, Fenneropenaeus indicus, Stolephorus* spp., *Thryssa* spp., *Leiognathus* spp., *Ambassis* spp., *Raconda russeliana, Portunus pelagicus, Johnius* spp. and *Trypauchen vagina.*

Thanguvala: *Metapenaeus dobsoni, Fenneropenaeus indicus, Sardinella longiceps, Thryssa* spp., *Esculosa thoracata, Ambasis* spp., *Leiognathus* spp., *Raconda russeliana* and *Pampus argenteus*.

Green turtle, *Chelonia mydas* rescued from Dabholi-Waingani Landing Centre, Maharashtra

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Field centre of CMFRI, Ratnagiri
**Research centre of CMFRI, Mumbai*

Sea turtles are found all along the coast of India including the Lakshadweep and Andaman & Nicobar Islands. Five species inhabit the Indian seas *viz*., *Dermochelys coriacea* (Leatherback turtle), *Eretmochelys imbricata* (Hawksbill turtle), *Chelonia mydas* (Green turtle), *Lepidochelys olivacea* (Olive ridly turtle) and *Caretta caretta* (Loggerhead turtle). Turtles are categorised as endangered in the IUCN Red List (IUCN, 2002) and are included in Schedule I of Indian Wild Life (Protection) Act, 1972.

On 26th February 2011, a huge green turtle, *Chelonia mydas* locally known as 'Hirve kasav' was

Green turtle, *Chelonia mydas* caught in shore-seine at Dabholi-Waingani entangled in the *rampani* (shore-seine) net operated during 5 am to 7 am and the catch was landed on the beach at Dabholi-Waingani Landing Centre in Vengurla, Mahatashtra. Apart from the green turtle, the catch included crabs, juveniles of seerfish, mullets, mackerel, squid *etc.* The turtle was a female weighing around 250 kg with a carapace length of 153 cm and carapace width of 102 cm. The turtle was very active and with out much injury. The present record appears to be the largest recorded green turtle from Maharashtra waters.

The occurrence of olive ridley turtles is rare along this shore. As the news of the landing of the green turtle spread, local people flocked to the beach to have a glimpse as they venerate the turtle as an incarnation of Lord Vishnu. The fishermen in Dabholi-Waingani and nearby villages are aware that turtles are endangered and hence they actively take part in conservation of turtles. Moreover religious importance goes a long way in the implementation of conservational measures of turtles in India. The turtle was therefore released soon to the sea by the fishermen in the presence of forest department personnel.

Observation on a deformed specimen of grey bamboo shark *Chiloscyllium griseum*, Muller & Henle, 1838 from the Arabian Sea off Karwar, Karnataka

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Research Centre of CMFRI, Karwar

The grey bamboo shark, *Chiloscyllium griseum* is a common inshore shark species that occurs from 5 to 80 m depths along the east and west coasts of India. It is one of the common species in incidental capture in trawl nets used for catching crustaceans and cephalopods and does not have commercial importance. This species feeds on invertebrates and fishes.

An abnormal specimen of the grey bamboo shark was observed at Baithkol Landing Centre, Karwar on 30th April 2012. It was caught off Karwar by trawl net operated at around 20 m depth. The specimen had a deformed wavy body with a series of dorsal and ventral curvatures of the spine. Similar deformities have been observed in different species of wild shark (Officer *et al*., 1995; Heupel *et al*., 1999). Earlier workers suggested parasitic infestation, tumours, bad nutrition, congenital abnormality, unfavourable environment during embryonic development, pollution, pesticide toxicity or injury as etiological factors for such spinal abnormalities in fishes. The specimen had a total length of 33.2 cm and weighed 186 g. The specimen is deposited in the Museum of the Karwar Research Centre of the Cental Marine Fisheries Research Institute.

Deformed shark, *Chiloscyllium griseum*, landed at Baithkol, Karwar

Deformity recorded in the lower jaw of Malabar red snapper, *Lutjanus argentimaculatus* landed at Chennai

S. N. Sethi, S. Rajapackiam and N. Rudramurthy
Research Centre of CMFRI, Chennai

Deformity of lower jaw as a dislocation of the hyoid bones between the mandibular branches was observed in the Malabar red snapper, *Lutjanus argentimaculatus* landed at Kasimedu Fishing Harbour, Chennai on 20th July 2011. There was about 1.8 t of *L. argentimaculatus* (in the size range 520-620 mm length and 4.5 - 5.5 kg weight) landed by mechanised trawlers. The lower jaw outgrowth size was 80 mm. A similar type of lower jaw deformity has been reported in salmon fry as a drop of the hyoid bones between the mandibular branches. In severe cases, this was visible as a “double mouth”. This deformity is often sorted out early, or the fish die, possibly from problems with eating (Institute of AKVAFORSK, Norway). Fishes with an evident deformity in the lower jaw (Jaw Deformity, JD), was reported in Atlantic salmon, *Salmo salar* from Chile during 1998, from Scotland (Bruno, 1980) and Ireland (Quigley, 1995).

Lower jaw deformity in *Lutjanus argentimaculatus* landed at Chennai

Occurrence of large sized talang queen fish, *Scomberoides commersonnianus* (Lacepede, 1802) at Karwar, Karnataka

S. M. Sonali
Research Centre of CMFRI, Karwar

A large sized talang queen fish, *Scomberoides commersonnianus* (Family: Carangidae) was caught in gillnet from nearshore waters near Aligadda, Karwar during the morning hours on 23rd July, 2012. The fish measuring 104 cm in total length (TL) and weighing 9.58 kg is the largest specimen hitherto reported from Uttarkannada. Generally small sized individuals are landed, though sexually mature specimens have been recorded earlier in trawl landings at Karwar. Talang queen fish having a total length of 110 cm and weighing 10 kg was recorded

S. commersonnianus caught at Aligadda, Karwar earlier from Chennai coast of India during October 2005. The maximum length reported for talang queen fish is 120 cm TL (Fishbase and FAO). The species is locally called as 'diana'in Konkani and 'halge meenu' in Kannada. The fish was sold for ₹ 500/- in the local market.

Occurrence of yellow tail blue snapper *Paracaesio xanthurus* at Chennai

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Research Centre of CMFRI, Chennai

About 50 kg of yellow tail blue snappers (*Paracaesio xanthurus*) locally called as "methi meen" belonging to family Lutjanidae were landed by mechanised gillnetters at Chennai Fishing Harbour in July 2011. On 17th July 2011, about 300 kg of *P. xanthurus* was landed by ring seine at Mahabalipuram area from a depth of about 30 fathom. The size of the fishes ranged from 310 to 435 mm with dominant mode at 360-379 mm and the weight ranged from 0.6-1.5 kg. In August 2011, about 60 kg of yellow tail blue snappers in the size range of 200 to 319 mm were landed at Notchikuppam landing centre by gillnetters.

Paracaesio xanthurus landed at Kasimedu Fishing Harbour

Green turtle *Chelonia mydas* (Linnaeus, 1758) washed ashore at Visakhapatnam

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Regional Centre of CMFRI, Visakhapatnam

A green turtle, *Chelonia mydas* (Linnaeus, 1758), the largest of the sea turtles, was found dead on the sandy shores of Visakhapatnam on 3rd August 2012. It is probable that it was hit by a boat propeller and washed ashore. It is a matter of concern since green turtles are endangered and are protected as per various international agreements. Green turtles are classified as endangered by the World Conservation Union (Baillie and Groombridge, 1996). They are listed in Annexure II of the SPAW (a Protocol Concerning Specially Protected Areas and Wildlife), Appendix I of CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) and Appendices I and II of the Convention

Green turtle *Chelonia mydas* stranded at Visakhapatnam on Migratory Species (CMS). The species is also included in the annexures of the Western Hemisphere Convention, intended to convey that their protection is of "special urgency and importance" (Eckert, 1995). Green turtles are vulnerable to several anthropogenic and environmental threats. Mortality associated with entanglement in marine fisheries is the primary incidental threat.

Stranding of spinner dolphin, *Stenella longirostris* (Gray, 1828) at Karwar, Karnataka

Narayan G.Vaidya, Narasimhulu Sadhu, Praveen N. Dube and Satyanarayan V. Pai
Research Centre of CMFRI, Karwar

A spinner dolphin, *Stenella longirostris* , locally called 'handi meenu' was noticed in dead condition floating near the marine cage farm of CMFRI, Karwar, approximately 600 m away, from sea shore of Aligadda village in the evening hours on 31st August 2012. The specimen was an adult female of 175 cm total length and 55 kg weight. The animal had a small injury near its left eye probably as a result of getting entangled in fishing nets or got injured in purse-seine operation which resulted in its death. The specimen was collected by officials of the Department of Forest and buried in the sea shore after postmortem.

Spinner dolphin stranded at Karwar

Spinner dolphin washed ashore at Puthenkadappuram, Thrissur

K. G. Baby
Central Marine Fisheries Research Institute, Kochi

A female dolphin *Stenella longirostris* (Grey, 1828) was washed ashore near Puthenkadappuram landing centre in Thrissur District on 23rd April 2012. The animal was in decayed condition and had an injury near anal base.

The body measurements recorded were :

Total length (Snout to notch of caudal flukes)	-	252 cm
Length of upper jaw	-	39 cm
Length of lower jaw	-	39 cm
Total number of teeth on each side:		
Upper jaw	-	45 to 45
Lower jaw	-	46 to 48
Approximate weight	-	200 kg

Spinner dolphin washed ashore at Puthenkadappuram, Kerala

Scomberoides commersonnianus caught at Aligadda, Karwar