

	2012	2014	2016	2017-18	2019-20	2021-22
Overall	B	B	B	A-	A	A
Southern Zone	B	B+	B	B+	A	A
Central Zone	B+	B	B	A	A	B+
Northern Zone	B	B-	B-	B+	B	B
Outer channel Zone	B	B	B	A	A	A

## Lagoon Health & Fisheries

During the study period, the fish landing data for two years starts from January to December (2021-2022) were taken into consideration. The average annual total fish landings (fish, prawn & crab) from Chilika lagoon were estimated at 19331.51t, while comparing with the average annual total landings for the year 2019 & 2020 (16948.55t), it increased by 14.06 %. The value of average total annual landings during the years 2021 and 2022 was 33892.39 Million INR which was increased by 36.52 % as compared with the catch value of the years 2019 & 2020 (24826.37 Million INR). The average annual per capita income of active fishers during the year 2021 & 2022 was estimated at 83017.00 INR which was increased by 39.88% as compared to the income for the years 2019 & 2020. The percentage composition of total landings for the year 2021 & 2022, the fish, prawn, and crab were 63.92%, 33.51%, and 2.57 %, respectively.

During the years 2021 & 2022, the illegal zero nets khandas were removed from the Northern, Central and Southern sectors of the lagoon. The illegal Bag nets and Alimi nets used by the fishermen were removed from the Outer channel of the Chilika. Besides, the small juveniles of Mugil cephalus and Penaeus monodon illegally caught by the fishermen from the lagoon mouth area were stopped by Officers of DFO (B&T), Balugaon and CDA staffs. The above activities will certainly help in the development of fishery resources of the lagoon.

## Fishing cats in and around the lagoon:

The fishing cat (*Prionailurus viverrinus*) is a medium sized, wild elusive cat found in the Indo-Malayan region and is classified as Vulnerable in the IUCN Red List. The feline is primarily found in low-altitude wet landscapes, such as the emergent coastal floodplains and deltas of major river basins in South and Southeast Asia, including the Indus, Ganga, Brahmaputra, Mahanadi, Godavari, Krishna, Irrawaddy, Salween, Chao Phraya and Mekong, as well as in island countries like Sri Lanka and Java. Its primary prey is fish but its diet also includes small mammals like rodents, birds, reptiles, crustaceans and molluscs. It has a great affinity towards water and thus is specially adapted to aquatic habitats with some special features such as water-resistant fur, half-sheathed claws and partially webbed feet which helps in easy swimming and diving to catch fish. The fishing cat is considered as an evolutionarily distinct and globally endangered (EDGE) species.



One of the major habitats of the fishing cat is India's First Ramsar Site- "The Chilika Lagoon", Asia's Largest Brackish Water lagoon. The lagoon offers an ideal environment for fishing cats due to copious abundances of fish, wetlands, and mangroves. The dense reed beds surrounding the lagoon provide excellent cover for the fishing cats, allowing them to hunt and thrive. Survey on existence of fishing cats in the Chilika Lagoon was started in the year 2010 by the Chilika Development Authority (CDA), and fishing cat was designated as the Ambassador of the lagoon during Wildlife Week, 2020. CDA carried out the first population estimation of this species in two phases; 2021(phase I) in the marshlands present in the north and north-eastern section and 2022(phase II) in the Parikuda side along with the coastal islands of the lagoon. As per the study, a total number of 176 of these globally endangered felines were found to be present in all around Chilika. It has been observed that the presence of fishing cats is significantly higher in freshwater-dominated northern sector with vast tracts of Phragmites karka dominated marshy vegetation and significantly lower in the outer channel mostly dominated by sandy beaches and Casuarina plantations.

Fishing Cat is a Schedule I species, being a top wetland specialist predator plays a vital role in maintaining the ecological balance. Its presence in Chilika is indicative of a healthy aquatic ecosystem. Therefore, its conservation is crucial for maintaining the delicate balance of the unique environment of the lagoon. CDA is taking major steps for its conservation and restoration through protection of its habitat.

## Way Forward

Following the release of the health report card (2012-2020), intensive studies were undertaken to address knowledge gaps in thematic areas and expand the suite of ecological indicators for evaluating the ecological health of Chilika Lagoon. Indicators such as total petroleum hydrocarbons are being considered for inclusion in future report cards as part of the water quality assessment parameters. To establish appropriate thresholds for such indicators in Chilika, the Chilika Development Authority (CDA) has initiated comprehensive data collection efforts, employing advanced instrumentation facilities. The biotechnology research group at the Wetland Research and Training Centre (WRTC) focuses on molecular microbial ecology and utilizes state-of-the-art techniques to analyze the planktonic communities of Chilika Lagoon. These investigations are pivotal for generating baseline data on the microbial components of the lagoon, a critical but underexplored aspect of its ecology. Microbial communities play an essential role in nutrient biogeochemical cycling, significantly influencing the productivity and ecological dynamics of the lagoon.

Research supported by the National Plan for Conservation of Aquatic Ecosystems (NPCA) and Integrated Coastal Zone Management Project (ICZMP) has enabled the examination of planktonic microbial communities, including phytoplankton, bacterioplankton, and macrophytes (e.g., seagrasses and *Phragmites karka*), using high-throughput DNA sequencing. These microbes act as "nature's recyclers," decomposing organic matter and recycling nutrients back into the ecosystem. Monitoring these microbial communities through modern biotechnological tools is vital for understanding the lagoon's response to changing climatic conditions.

Given the challenges of establishing accurate threshold values for various ecological indicators, the ideal approach is to sustain a long-term monitoring program. Such efforts will enable the derivation of threshold values specific to this tropical lagoon ecosystem, ensuring robust ecological health assessments and informed management decisions.

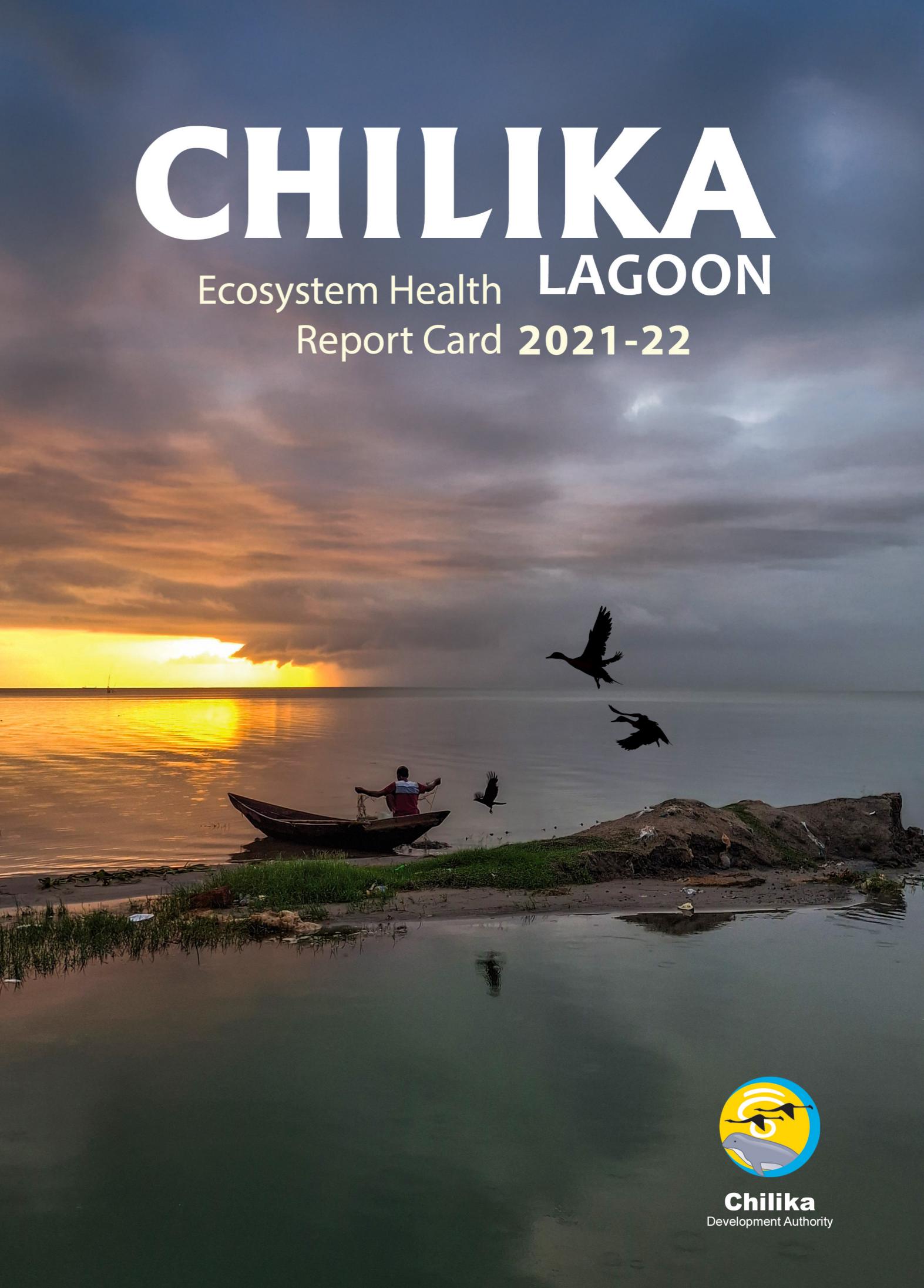
## References

- CIFRI-2005. Assessment of fish yield potential of Chilika Lake. Final report of the CDA-sponsored consultancy research project by Central Inland Fisheries Research Institute (Indian Council of Agricultural Research) Barrackpore, Kolkata. 137p.
- Muduli, P.R., Kanuri, V.V., Robin, ...Subramanian, B., 2013. Distribution of dissolved inorganic carbon and net ecosystem production in a tropical brackish water lagoon, India. *Continent. Shelf Res.* 64, 75-87.
- Smith V.H., Tilman, G.D., Nekola, J.C., 1999, Eutrophication: impacts of excess nutrient inputs on freshwater, marine and terrestrial ecosystems, *Environmental Pollution* 100 , 179-196.



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## Introduction

The health report card of an ecosystem serves as an effective communication tool that simplifies complex data and information into a format accessible to diverse audiences, including local communities, policymakers, and stakeholders. In this context, Chilika Lagoon has been scientifically assessed to develop a health report card aimed at facilitating improved ecosystem management.

The first Chilika Health Report Card was introduced in 2012 and subsequently updated in 2014, 2016, 2018, and 2020. This initiative emerged from a collaborative project titled "Global Foundations for Reducing Nutrient Enrichment and Oxygen Depletion from Land-Based Pollution, in Support of the Global Nutrient Cycle", jointly undertaken by the Chilika Development Authority (CDA), the National Centre for Sustainable Coastal Management (NCSM), and the United Nations Environment Program (UNEP/GEF), in partnership with the Application Network from the University of Maryland Center for Environmental Science, USA.

The health report cards not only provide insights into the status of the lagoon's ecological health but also raise awareness about the pressures impacting its ecological values and services. Report card-based assessments have proven to be an effective monitoring framework for the Chilika Lagoon, enabling stakeholders to track changes in ecological health over time.

The current report card, the sixth in the series, will serve as a valuable tool for comparing health trends across multiple years. By identifying key environmental variables responsible for these changes, it will support the development of strategic interventions for the sustainable management of Chilika Lagoon.

## Measures of Ecosystem Health

The ecosystem health of the Chilika lagoon was assessed by taking into consideration 9 indicators organized into three main indices: Water quality, Fisheries, and Biodiversity. Together, these indicators represented the ecosystem features of Chilika lagoon that were valued (e.g., fishing, tourism, and biodiversity) and the threats (overfishing and illegal aquaculture, pollution and sedimentation) to these values.

### Water Quality

Water clarity refers to the amount of light that penetrates through the water column and plays a critical role in determining the distribution and abundance of macrophytes, seagrasses, and phytoplankton. It is primarily influenced by factors such as wind-induced sediment churning, phytoplankton biomass, colored dissolved organic matter (CDOM), and sediment influx from surrounding rivers.

Dissolved oxygen (DO) is a vital parameter for the survival and vitality of aquatic organisms, with species-specific oxygen requirements. DO levels in an aquatic system are influenced by the rate of oxygen production through photosynthesis by phytoplankton, macrophytes, and seagrasses, as well as oxygen consumption during respiration by microorganisms and other aquatic life.

Chlorophyll-a, a measure of phytoplankton biomass, serves as a reliable indicator of ecosystem health (Smith et al., 1999). Its concentration in an aquatic environment is largely determined by nutrient stoichiometry and water clarity, making it a key metric for assessing ecosystem productivity and balance.

### Fisheries

The total catch of fish, prawn, and crab was recorded monthly at 35 landing stations around the lagoon. The fish landing monitoring allows lagoon managers to know the annual yield in comparison to a calculated maximum sustainable yield (CIFRI-ICAR, 2005). Commercial species diversity is the number of species landed each year that are commercially important for the livelihood of the fishermen. The body length of Bagada or tiger prawns (*Penaeus monodon*), Khainga or mullet (*Mugil cephalus*), and Chilika Crabs (*Scylla serrata*) should be above (or between) a prescribed length to ensure the sustainability of the species.

### Biodiversity

**Bird count and richness:** Count the number of birds and bird species utilizing the lagoon for feeding, resting, and breeding. Chilika lagoon is the largest wintering ground for migratory waterfowl found anywhere on the Indian sub-continent.

**Dolphin abundance:** Count of the endangered Irrawaddy dolphins surveyed annually in the lagoon.

**Phytoplankton diversity (microalgae):** Simpson's Index of Diversity (D) is also used to assess the condition of this microscopic algal community through analysis of the number of species present, and the abundance of each species. Phytoplankton is an important component of the lagoon's food web.

## Threshold for Each Indicator

Desired conditions were based on available guidelines, current scientific knowledge, and historical data and trends, and taking into account the influence of a variable climate from year to year. The table below outlines the desired condition and threshold values developed or identified for each indicator.

Category	Indicator	Desired condition (Threshold)	Source of data to derive thresholds
Water quality	Water clarity	$\leq 30$ NTU	CPCB, New Delhi; The Environment (Protection) Rules, 1986
	Dissolved oxygen	$\geq 4$ mg/L or 60% sat.	CPCB, New Delhi; The Environment (Protection) Rules, 1986
	Chlorophyll-a	$\leq 9$ $\mu$ g/L	Smith et al.1999
Fisheries	Total catch	% deviation above or below maximum sustainable yield (11,500t/yr)	CIFRI-ICAR, 2005
	Commercial species diversity	Ratio of species landed: desired (45 sp. desired)	CDA
	Size	Proportion of species landed above a sustainable size limit. <i>M.cephalus</i> : 262-495mm; <i>P.monodon</i> : 124-197mm; <i>S.serrata</i> : 85mm	CDA
Biodiversity	Bird count and richness	Ratio to maximum bird count and diversity recorded since 2003	CDA/CWD*
	Dolphin abundance	Ratio to maximum dolphin count recorded since 2001	CDA/CWD
	Phytoplankton diversity	Simpson's Index of Diversity(1-D)	CDA

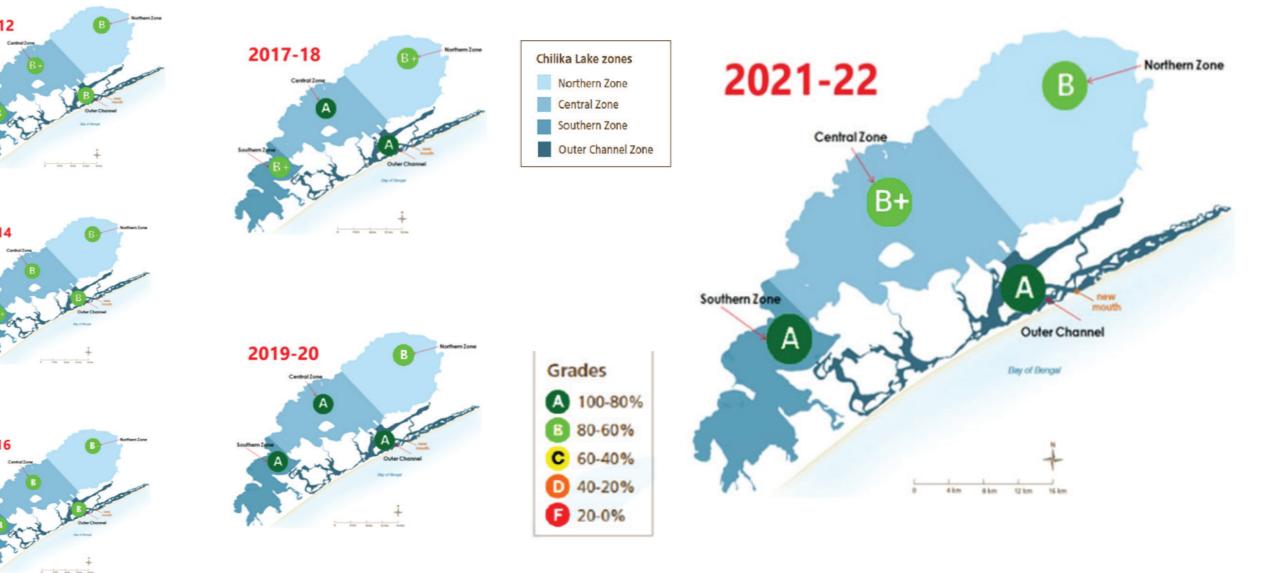
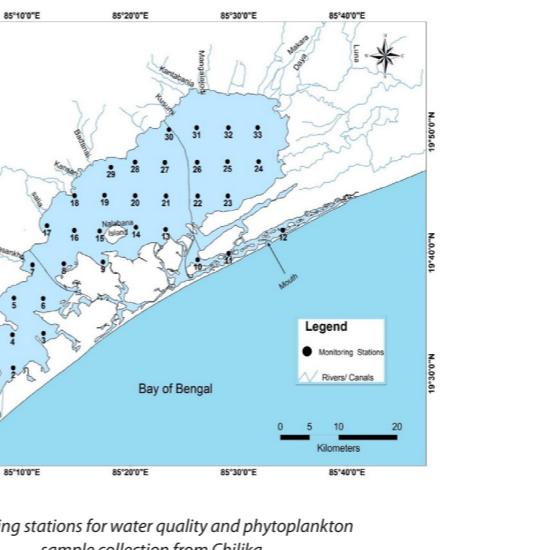
\*CWD: Chilika Wildlife Division

Chilika lagoon was divided into four zones depending on the environmental conditions as reported by Muduli et al., 2013. The scientific data recorded from January 2021 to December 2022 were divided into four zones: Northern zone (NZ), southern zone (SZ), central zone (CZ), and Outer channel zone (OCZ). The grades were calculated for each zone from the average data of water quality, fisheries, and biodiversity indices.

DO, turbidity, and chlorophyll-a data were assessed from 33 monitoring stations during the period. In the case of indicators of fisheries, monthly landing data was considered from January 2021 to December 2022. Bird count and richness data from Chilika wildlife division (CWD) were collected during the winter season of 2021 and 2022. Dolphin data from CWD for the year 2021 and 2022 were used for this report card. The Simpson's index was made for phytoplankton diversity using data of 25 sampling locations (from January 2021 to Dec 2022) as mentioned in the sampling map.

## What does the Grade Imply?

- 80 to 100%. All water quality and biological health indicators meet the desired levels. The quality of water in these locations tends to be very good, most often leading to very good habitat conditions for fish and shellfish.
- 60 to 80%. Most water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be good, often leading to good habitat conditions for fish and shellfish.
- 40 to 60%. There is a mix of good and poor levels of water quality and biological health indicators. Quality of water in these locations tends to be fair, leading to fair habitat conditions for fish and shellfish.
- 20 to 40%. Some or few water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be poor, often leading to poor habitat conditions for fish and shellfish.
- 0-20%. Very few or no water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be very poor, most often leading to very poor habitat conditions for fish and shellfish.
- Grades denoted with a +ve or -ve indicate a score that is within 2% of a score's high or low boundary. For example, a B+ve is indicative of 78-80%.



## Chilika Lagoon 2021-2022 Report Card

Overall, Chilika lagoon scored a A for ecosystem health based on the performance of water quality, fisheries, and biodiversity indices. The lagoon as a whole displayed excellent (A) dissolved oxygen concentration, chlorophyll-a, phytoplankton biodiversity, birds, total fishery catch, and size. The Dolphin indicator scored C and the rest of the indicators scored B. Scores of the nine indicators that were assessed within water quality, fisheries, and biodiversity are as follows: 84% (A) in the Southern Zone followed by 79% (B+) in the Central Zone, 86% (A) in the Outer Channel Zone and 76% (B) in the Northern Zone. A breakdown of these indicators by zone is provided below.

### Northern Zone (B):

The Northern Zone displayed excellent results for the indicators of water quality (except water clarity indicator). This zone maintained good biodiversity due to the abundance of bird count and richness with the exception to Dolphin abundance. This zone also maintained good fisheries due to excellent total catch and commercial species diversity in exception to fish size.

### Southern Zone (A):

The Southern Zone displayed excellent results for water quality, and biodiversity and good results for fisheries. In fishery except for commercial species diversity, the indicators such as size of the fish and total catch showed excellent and a mix of good and poor results respectively.

### Outer Channel Zone (A):

The Outer Channel Zone displayed excellent results for fisheries, water quality and good for biodiversity. Water clarity, Bird count and richness showed good results whereas, commercial species diversity showed poor result.

## How does the Chilika health report card for 2021-22 compare with earlier report cards

As compared to report cards published so far, 2021-22 report cards indicated the health of the lagoon is better as compared to the health condition during 2012 (Overall score changed from grade B to A). The scores of the individual sectors also evidence it. The present report card showed significant change in southern and outer channel zone as compared to 2012. As compared to previous report card (2019-20) only central zone recorded a change from A to B+.