Marine Heatwaves

For Prelims: Marine Heatwaves (MHWs), Sea Surface Temperatures, El Nino, Pacific Decadal Oscillation (PDO), Gulf Stream, Kelp Forests, Seagrass Meadows, Coral Reefs, Marine Protected Areas (MPAs), Wetlands, UNCLOS, UN Decade of Ocean Science (2021-2030), UN Plastic Treaty.

For Mains: Marine Heatwaves, its causes and consequences, Steps needed to curb marine heatwaves.

Source: TH

Why in News?

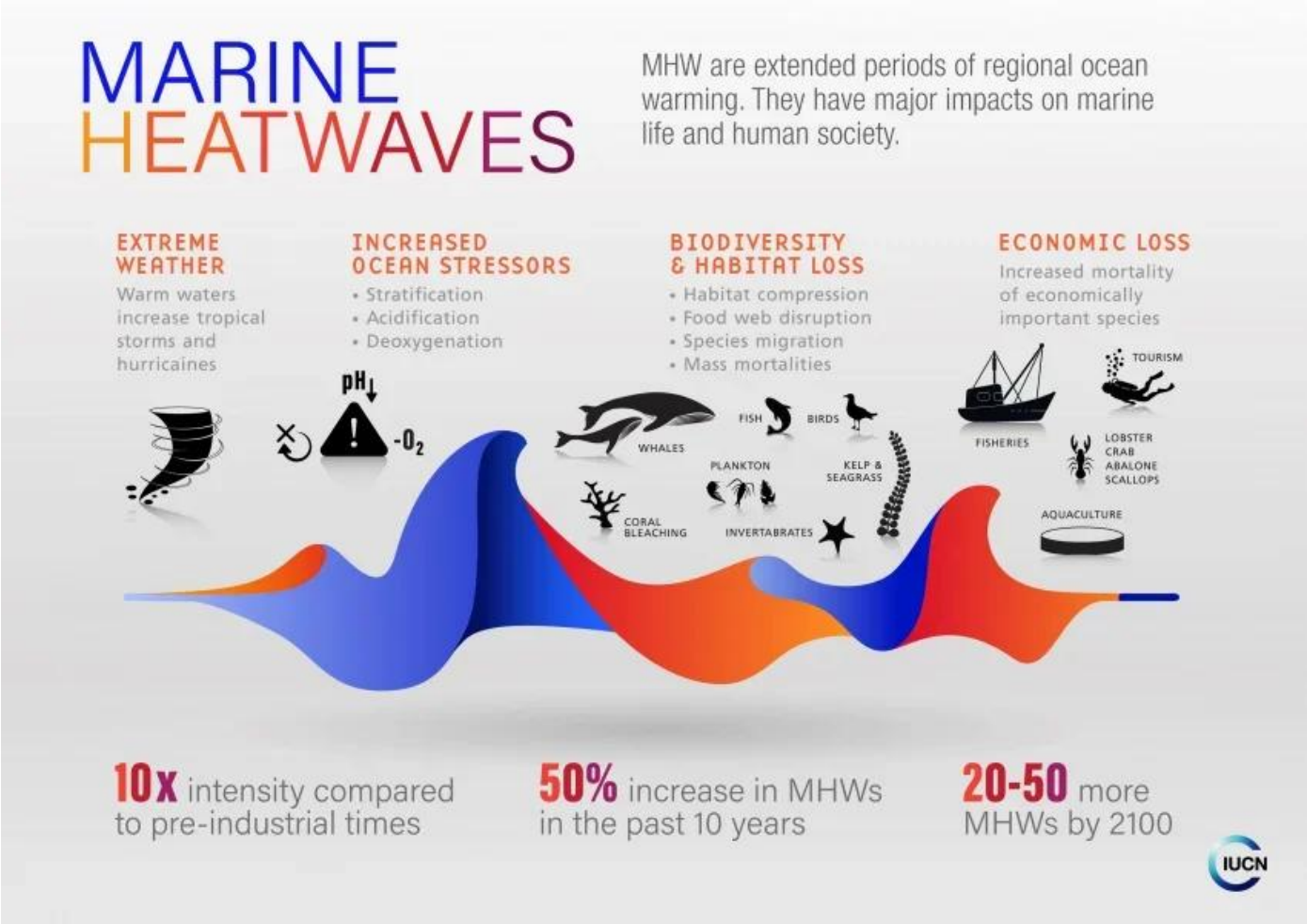
Scientists have found that the **marine heatwaves (MHWs) affected 96%** of the ocean surface in 2023, raising fears of a **permanent temperature shift** that could disrupt **life in oceans and on land**.

What are Key Facts Regarding Marine Heatwaves?

- **About:** A **MHW** is an **extreme weather event** marked by **sea surface temperatures** rising **3 to 4°C above average** in a specific region for **at least five days**. It can persist for **weeks, months**, or even **years**.
- **Key Causes of MHWs:**
  - **Global Warming: Rising CO_2 levels** trap heat, warming the **ocean surface and depths**, while oceans absorb **90% of excess heat**, increasing the risk of **MHWs**.
  - **El Nino: El Nino** warms **upper ocean layers**, weakening **upwelling** and trapping **surface heat**, while the **Pacific Decadal Oscillation (PDO)** amplifies **marine heatwaves** by shifting **Pacific temperature patterns**.
    - PDO is often described as a **long-lived El Nino-like pattern** of Pacific climate variability.
  - **Reduced Cloud Cover:** With **fewer clouds**, more **sunlight reaches the ocean**, causing **rapid surface warming** e.g., **Atlantic heatwaves of 2023**.
  - **Changing Ocean Currents:** Changes in ocean currents like the **Gulf Stream** can raise **regional sea temperatures**, worsening **marine heatwaves**. E.g., a **weaker Gulf Stream** has caused **warmer waters** along the **US East Coast**, affecting **hurricanes** and **sea-level rise.**
  - **Human-Induced Feedback Loops: Arctic warming** melts **reflective sea ice**, exposing **dark waters** that absorb more heat, while **coral die-offs** reduce **CO_2 absorption**, accelerating **global warming**.
- **Projected Trends:** The **ocean's average temperature** has risen by **1.5°C over the past century**, and by **2100**, **MHWs** could become up to **50 times more frequent** than in **preindustrial times.**

What are the Effects of Marine Heatwaves on Oceans and Climate?

- **Climatic Impacts: MHWs** can fuel **extreme weather** such as **tropical storms and hurricanes**, and **disrupt the water cycle**, increasing the frequency and intensity of **floods, droughts**, and **wildfires**.
    - E.g., **Hurricane Ian**, a **Category 4 storm**, in **Florida, US.**
- **Economic Impact:** MHWs impact **aquaculture** as **farmed species require stable temperatures**, and harm **fisheries** by driving species away from warming waters, affecting **local economies.**
    - E.g., Decline is recorded in key species like **lobster and snow crab** (Northwest Atlantic) and **scallops** (Western Australia).
- **Ecological Consequences:** MHWs cause **mass mortality of invertebrates**, disrupt **food webs**, trigger **wildlife behavior changes** (e.g., whales entangled in gear), and promote the **spread of invasive species**, threatening **native biodiversity**.
    - **Kelp forests**, **seagrass meadows**, and **coral reefs** are highly vulnerable to **MHWs**. E.g., the **2011 MHW event off Western Australia** caused **ecosystem collapse** and **local extinctions** over **hundreds of kilometers.**
- **Compounding Environmental Stressors: MHWs** often coincide with **ocean acidification**, **deoxygenation**, and **overfishing**, creating **combined pressures** that worsen **habitat destruction.**



How Can We Prevent and Mitigate Marine Heatwaves?

- **Strengthen Ocean Monitoring: Expand marine monitoring systems** and **enhance climate modelling** to improve real-time tracking and accurate prediction of **MHWs**.
- **Protect and Restore Marine Ecosystems:** Conserve **coral reefs** and **mangroves**, establish **Marine Protected Areas (MPAs)**, and restore degraded **coastal zones** like **seagrasses**, **salt marshes**, and **wetlands** **that absorb CO_2** to boost **ecosystem resilience** and **biodiversity**.
- **Advance Sustainable Fishing and Aquaculture:** Promote **climate-resilient aquaculture** with

heat-tolerant species and sustainable feed, and develop **early warning systems** to alert fishing communities about **MHWs.**

- **Enhance Global Cooperation:** Strengthen **Paris Agreement** commitments, support **vulnerable nations** with climate finance and technology transfer, and promote **global ocean governance** through treaties like **UNCLOS** and the **UN Decade of Ocean Science (2021-2030)** .
- **Reduce Greenhouse Gas Emissions (GHGs): Transition to renewables**, **implement carbon pricing**, and **promote sustainable transport and industries** to cut **emissions** and combat **climate change**.
- **Reduce Local Stressors on Oceans: Reduce ocean stressors** by **curbing pollution** through the **UN Plastic Treaty** and **sustainable farming**, and **cool ocean surfaces** using **reflective infrastructure** and **artificial upwelling**.

Conclusion

Marine heatwaves threaten **ocean health**, **weather stability**, and **coastal economies**. Combating them requires **global emission cuts**, **marine ecosystem protection**, and **advanced monitoring**. Without urgent action, **MHWs will intensify**, causing **irreversible damage** to **biodiversity** and **human livelihoods**. A **coordinated climate-ocean policy** is essential to safeguard our **oceans** and **future**.

Drishti Mains

Question: "Marine heatwaves are emerging as a silent crisis for ocean ecosystems." Discuss their causes, impacts, and mitigation strategies.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. With reference to Ocean Mean Temperature (OMT), which of the following statements is/are correct? (2020)

1. OMT is measured up to a depth of 26ºC isotherm which is 129 meters in the south-western Indian Ocean during January-March.
2. OMT collected during January-March can be used in assessing whether the amount of rainfall in monsoon will be less or more than a certain long term mean.

Select the correct answer using the code given below:

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Ans: (b)

Mains

Q. Discuss global warming and mention its effects on the global climate. Explain the control measures to bring down the level of greenhouse gases which cause global warming, in the light of the Kyoto Protocol, 1997. (2022)

Q. Assess the impact of global warming on the coral life system with examples. (2017)