



Ocean Anoxic Event 1a

For Prelims: Anoxic Marine Basins, [Carbon sequestration](#), [Holocene extinction](#), [Ocean acidification](#), [Coral Reef](#), [Paris Agreement](#)

For Mains: Earth's mass extinctions, Impact of volcanic eruptions on climate and ecosystems

Source: [Phys](#)

Why in News?

A recent study, published in *Science Advances*, has provided new insights into the timing and duration of **Ocean Anoxic Event 1a (OAE 1a)**.

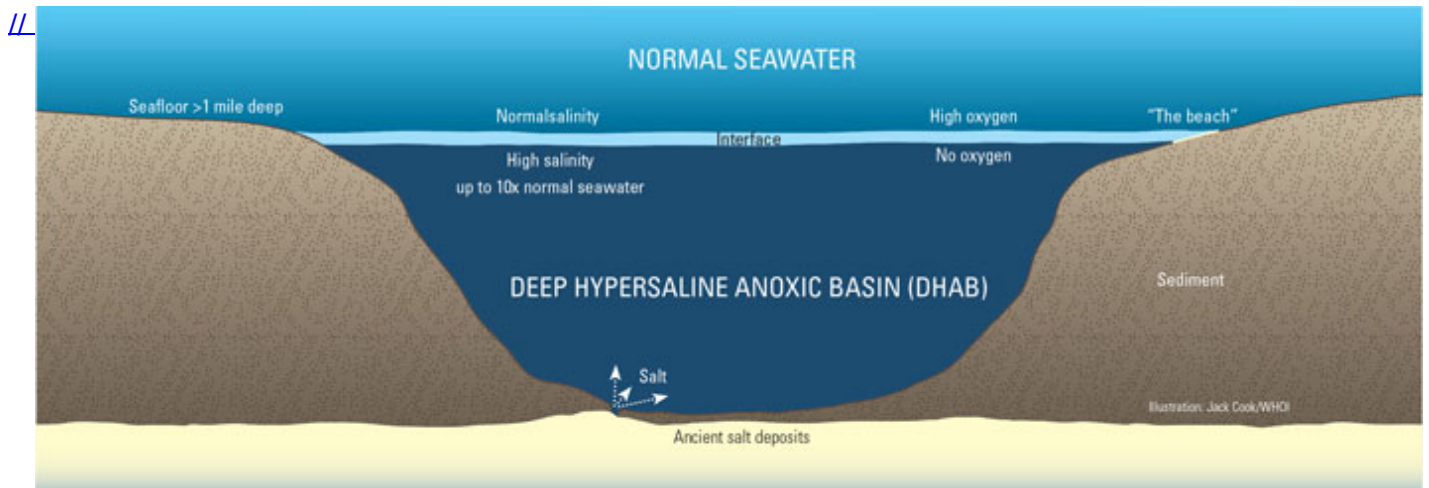
- By studying prehistoric rocks and fossils from **Mount Ashibetsu, Japan**, researchers have pinpointed the causes and timeline of the OAE 1a that caused widespread [oxygen depletion \(anoxic\) in Earth's oceans](#).

What is the Ocean Anoxic Event 1a?

- **Definition:** OAE 1a refers to a period during the **Cretaceous Period** (145 million years ago and ended 66 million years ago) when Earth's **oceans became depleted of oxygen**, causing a significant disruption in marine life.
- **Cause:** The event is believed to have been triggered by **massive volcanic eruptions** that released significant amounts of [carbon dioxide \(CO₂\)](#), leading to [global warming](#) and **oxygen depletion** in the oceans, which subsequently resulted in the formation of **anoxic marine basins**.
- **Impact:** CO₂ in seawater forms **carbonic acid**, dissolving **sea creatures' shells and lowering oxygen levels**.
 - This oxygen depletion led to the extinction of marine species, particularly plankton, and caused the formation of **organic carbon-rich layers known as black shales**.

Anoxic Marine Basins

- **About:** An anoxic basin is a body of water, typically found in deep ocean regions, where **oxygen levels are extremely low or absent**.
 - This lack of oxygen **prevents the survival of most aerobic organisms**, but allows specialized microbes and certain fungi to thrive.
 - These conditions are often associated with deep-sea areas or lakes that are **isolated from the oxygen-rich surface water**.
- **Carbon sequestration:** Anoxic basins slow the decay of organic material (due to low oxygen), preserving carbon. This makes them **potential sites for long-term [carbon sequestration](#)**, helping reduce CO₂ levels in the atmosphere.
- **Examples:** [Black Sea](#), Cariaco Basin ([Caribbean Sea](#)), and Orca Basin (northwest [Gulf of Mexico](#)).



- **Dead Zones:** These are **hypoxic areas (low oxygen)** in oceans and large lakes where oxygen levels are too low to support most marine life.

What are the Key Highlights of the Study on Ocean Anoxic Event 1a?

- **Timing of OAE 1a:** The study pinpointed the exact timing of OAE 1a to around **119.5 million years ago**, using advanced **isotopic analysis** of **volcanic tuffs** (igneous rocks formed from the compaction and cementation of volcanic ash) from **Japan's Hokkaido Island**.
 - OAE 1a lasted 1.1 million years, revealing how long oceans took to recover from CO₂-driven warming and anoxia.
- **Volcanic Eruptions:** The study confirmed that volcanic eruptions released CO₂, triggering oceanic oxygen depletion.
- **Relevance to Modern Climate Change:** The study links past volcanic CO₂ emissions to current **human-induced warming**, warning that the rapid pace of **modern warming** could trigger similar disruptions and potentially lead to a **Holocene extinction (probably a sixth mass extinction event)**.
 - It also highlights the long-term impact of elevated CO₂ on marine ecosystems and the global **carbon cycle**.

What are the Major Mass Extinction Events on Earth?

- **Ordovician-Silurian Mass Extinction (443 million years ago):**
 - **Impact:** Wiped out approximately 85% of all species.
 - **Cause:** Dramatic temperature drop and **glaciation**, leading to **sea level fall**, followed by rapid warming.
- **Devonian Mass Extinction: Occurred 374 million years ago:**
 - **Impact:** Killed about three-quarters of Earth's species, mostly marine invertebrates.
 - **Cause:** Environmental changes such as global warming, and cooling, fluctuating sea levels, and **reduced atmospheric oxygen** and carbon dioxide. Exact triggers of the extinction remain unclear.
- **Permian Mass Extinction (250 million years ago):**
 - **Impact:** Known as "**The Great Dying**," it eradicated over 95% of species, including most vertebrates.
 - **Cause:** It is linked to massive volcanic eruptions in the **Siberian Traps, Russia**, causing global warming and ocean anoxia. Volcanism, climate shifts, and a potential asteroid impact likely exacerbated the catastrophe.
- **Triassic Mass Extinction (200 million years ago):**
 - **Impact:** Eliminated about 80% of species, including many **dinosaurs**.
 - **Cause:** Extensive geological activity that raised carbon dioxide levels, global temperatures,

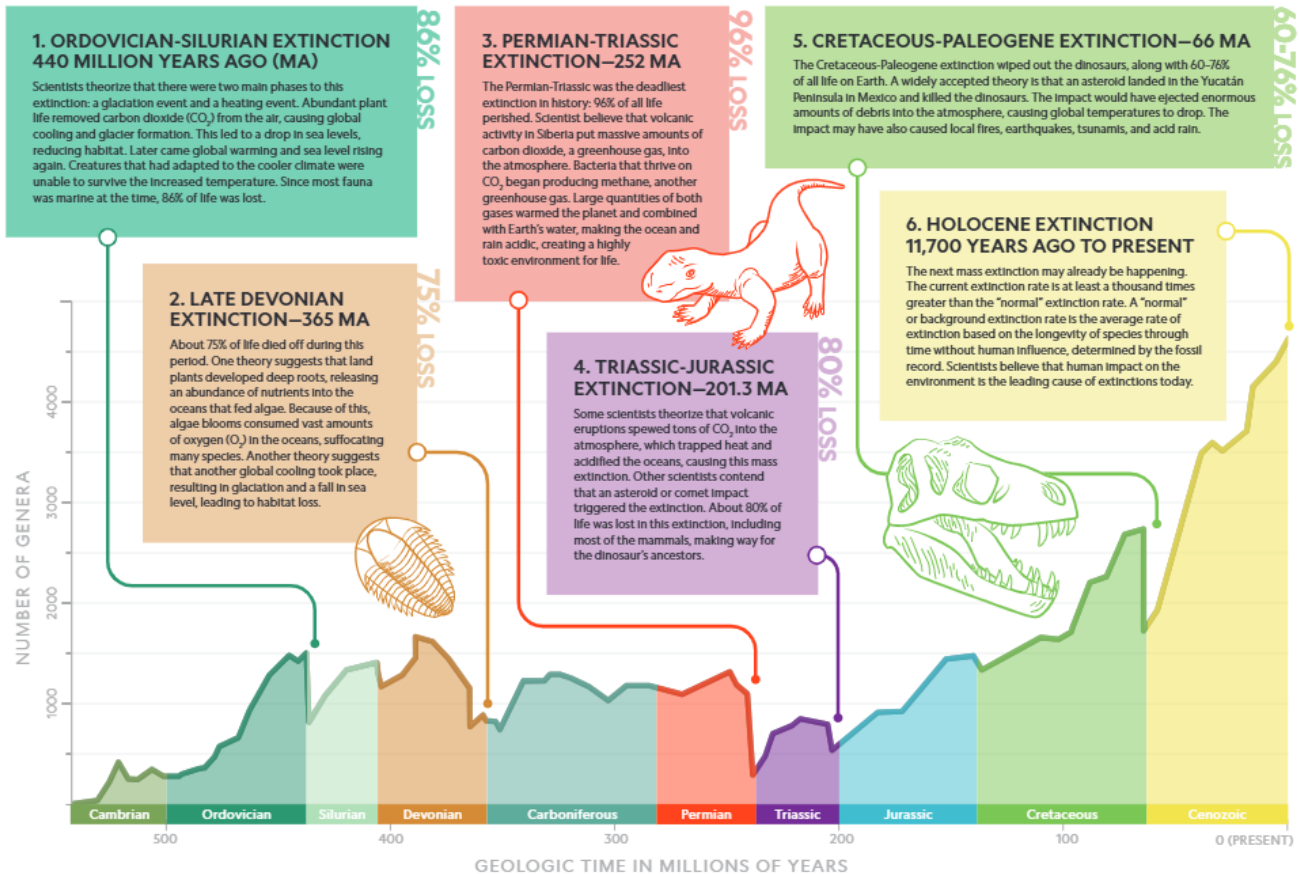
and caused [ocean acidification](#).

▪ **Cretaceous Mass Extinction (66 million years ago):**

- **Impact:** Killed 78% of species, including [non-avian dinosaurs](#).
- **Cause:** Likely caused by an asteroid impact in Mexico, creating a massive crater, global cooling, and ecosystem collapse.
 - Additionally, volcanic eruptions in **India's Deccan Plateau** may have worsened the event by **contributing to global warming**.

MASS EXTINCTIONS

A mass extinction is a sharp spike in the rate of extinction of species caused by a catastrophic event or rapid environmental change. Scientists have been able to identify five mass extinctions in Earth's history, each of which led to a loss of more than 75 percent of animal species.



What is the Holocene Extinction?

- **About:** The Holocene Extinction, also known as the **Sixth Mass Extinction**, refers to the ongoing extinction event that began around **12,000 years ago** and is largely attributed to **human activities**, unlike previous mass extinctions, which were caused by **natural phenomena**.
- **Key Drivers:**
 - **Overexploitation:** Overharvesting resources like overfishing, hunting, and poaching depletes species.
 - **Habitat Loss:** Conversion of land for agriculture and [urbanization](#) reduces habitats and fragments populations.
 - **Climate Change:** Human-induced climate shifts disrupt ecosystems, species distribution, and relationships.
 - **Pollution:** Industrial, agricultural, and waste pollution harms ecosystems through chemicals and plastics.
 - **Invasive Species:** Non-native species disrupt native ecosystems, outcompeting or preying on local species.
- **Key Examples of Holocene Extinction Events:**
 - The **Megafauna Extinction (12,000 years ago)** wiped out large mammals

like **mammoths** and **saber-toothed cats**, likely due to human hunting and **climate change**.

- **Coral Reef Bleaching** is driven by rising sea temperatures and ocean acidification, endangering reef biodiversity.
- **Amphibian Declines**, especially frogs, are caused by habitat loss, pollution, and diseases like chytridiomycosis.
- **Impact:** The current extinction rate is **1,000-10,000 times higher than natural rates**.
 - Ecosystem services, such as food production, clean water, and air, are at risk, threatening both biodiversity and human life.
- **Efforts to Mitigate the Holocene Extinction:** Strengthen commitments to cut carbon emissions and limit **global warming to 1.5°C**, as outlined in the **Paris Agreement**.
 - Collaborate globally to **conserve at least 30% of lands, inland waters, and oceans**, as under the **30X30 Initiative**.
 - Encourage individuals, businesses, and communities to adopt sustainable practices and demand accountability from governments and corporations.

Drishti Mains Question:

Discuss the causes and consequences of the ongoing Sixth Mass Extinction. How does human activity contribute to this crisis?

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. The term “sixth mass extinction/sixth extinction” is often mentioned in the news in the context of the discussion of (2018)

- (a)** Widespread monoculture Practices agriculture and large-scale commercial farming with indiscriminate use of chemicals in many parts of the world that may result in the loss of good native ecosystems.
- (b)** Fears of a possible collision of a meteorite with the Earth in the near future in the manner it happened 65million years ago that caused the mass extinction of many species including those of dinosaurs.
- (c)** Large scale cultivation of genetically modified crops in many parts of the world and promoting their cultivation in other Parts of the world which may cause the disappearance of good native crop plants and the loss of food biodiversity.
- (d)** Mankind’s over-exploitation/misuse of natural resources, fragmentation/loss, natural habitats, destruction of ecosystems, pollution and global climate change.

Ans: (D)