



# The Jubilee Phenomenon

## Estuary Concept

Principle 1: Estuaries are interconnected with the world ocean and with major systems and cycles on Earth.

Principle 2: Estuaries are dynamic ecosystems with tremendous variability within and between them in physical, chemical, and biological components.

## Learning Objectives

- Examine estuaries as being part of important biological, chemical, and physical cycles such as food webs, nutrient cycles, and hydrologic cycles.
- Explore how estuarine ecosystems are affected by changes in global systems and cycles such as climate and weather cycles.
- Aligned to NGSS and California state standards (see page 5).

## Teacher Preparation

See the project phenomena website to learn more about phenomena-based lessons. Use the Teacher Background Support to research the water and weather quality parameters that affect jubilees before you start investigating with your students.

## #ProjectPhenomena

The Phenomenon: [Jubilee event in Mobile Bay](#)

## Activity Information

### Grade Level

9-12

### Time Required

1-2 class periods

### Topic

Water Chemistry  
Weather and Climate  
Ecosystem interactions and dependencies  
Phenomena

## Overview

Although jubilee events may occur in other areas of the world, Mobile Bay is probably the only body of water on Earth where this phenomenon occurs regularly each summer and where jubilees are fairly predictable. Students will investigate what causes a jubilee event and how it affects animals that live in the bay.

## Teacher Background Support:

[Deadly Oxygen Levels in Mobile Bay](#)

[Water and Weather Quality Parameter Descriptions](#)

[Water Density Information](#)

### These are some connections to possible INVESTIGATIVE Phenomena:

- Water quality, tides, and weather within estuaries change and can change quickly.
- Water stratification in estuaries is caused by density differences related to salinity and temperature.
- When layers of water in estuaries are not sufficiently mixed, the bottom layer of water can become depleted in dissolved oxygen.
- Physical changes in water temperature, salinity, and dissolved oxygen can be observed and measured.
- Weather conditions, such as wind direction and speed, can be observed and measured.

## Procedure or Activity Steps

1. Show students the video of a [Jubilee Event in Mobile Bay](#).
2. Brainstorm the **ANCHORING driving question** students ask (or that is surfaced) that will be investigated and answered by students. Examples could be:
3.
  - What are the conditions that lead to a jubilee?
  - What causes these conditions, the physical/oceanographic and human inputs?
4. Use the Teacher Background Support resources to help students investigate the answers to these questions and come up with a model or explanation.
5. **Ideal Model and Explanation** or response to students' questions:

Jubilees are caused primarily by the upward movement of oxygen poor (hypoxic) bottom waters that force bottom-dwelling (benthic) fish and crustaceans ashore. Bottom water low in oxygen results from several coincidental circumstances that happen at the same time. Pockets of salty water accumulate in the deeper parts of Mobile Bay and stagnate during calm conditions in the summer. Then stratification, or the layering effect of water containing different levels of salt, occurs when dense salty Gulf water is overlain by less dense, freshwater from the rivers. When water is stratified or layered in this way, the layers don't get mixed, preventing the movement of oxygen from the air into the bottom water. Water temperature also influences the stratification of the water and is an important cause of a jubilee event. Warm water holds much less oxygen than cooler water. Mobile Bay is shallow (average depth is only 10 feet) and the water temperatures get very high in the summer months. This is the primary reason why jubilees only occur in summer.

Phytoplankton, (plant plankton), also plays an important role in the occurrences of jubilees. Plankton, along with other microorganisms form the base of the estuary food web that feeds many larger organisms in the bay. However, when an abundant supply of nutrients, such as animal wastes and fertilizers, get washed into the bay by rain, the phytoplankton population can increase drastically. At night, phytoplankton is unable to carry on photosynthesis and must actually take in tremendous quantities of dissolved oxygen from the water in order to sustain them. The more phytoplankton in the water, the more dissolved oxygen gets taken out of the near-surface water at night. This can cause the water near the surface to become more depleted of dissolved oxygen.



Credit: Lee Yokel

## Materials Needed

- Computer and projector with internet connection and you tube access
- Whiteboard, flip charts, or electronic platform to record student brainstorming and explanation

Normally, the worst oxygen-poor water remains at greater depths within Mobile Bay. However, if a gentle easterly wind creates a surface current, it will move the surface layer of water from east to west, from near shore to offshore. As a result, the oxygen-poor bottom water is moved in the other direction. It gets pushed shoreward by a rising or incoming tide from the Gulf of Mexico. (NOTE: Alabama and other states along the northern Gulf of Mexico experience diurnal tides. This means there are normally only one high and one low tide each day unless there is a neap tide. A neap tide takes place when there is very little difference between high and low tide (tidal range).

As this tide-driven, salty, low-oxygen water moves shoreward, sea creatures in its path are “driven” in front of it. Animals that are good swimmers can easily swim over the top of the advancing low-oxygen water mass, but the slower paced benthic organisms, such as crabs and flounder, must flee toward the shore (away from the low-oxygen water) as they try to get oxygen from the shallow water nearer the water’s surface. If the water near the surface is also depleted in oxygen, the animals are in big trouble.

## Standards

### Alignment to Performance Expectations

MS LS2 Ecosystems: Interactions, Energy, and Dynamics

### Alignment to Disciplinary Core Ideas

(Aspects of the Disciplinary Core Ideas that are needed to explain this phenomenon are in *italics*)

MS LS2 Ecosystems: Interactions, Energy, and Dynamics

Primary DCI:

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

Secondary DCI:

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

Supporting:

- When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (3-LS4-4)

Leads to:

- Anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

### Alignment to Science and Engineering Practices

- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions

- Engaging in Arguments from Evidence

### **Alignment to Crosscutting Concepts**

- Cause and Effect
- Stability and Change

### **Other Connections**

#### **Connections to the Environmental Principles & Concepts (EP&Cs):**

##### **Principle II**

The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.

#### **Principle Connections to Education and the Environment Initiative (EEI) Curriculum:**

Active Voices: Civil Society and the Environment 12.3.2

#### **Connections to History/Social Studies:**

12.3.2