Instructor's Notes Sheet

Lesson Title: W32L1 Coral Bleaching – Causes and Consequences
Main Topics: Coral bleaching, climate change, zooxanthellae symbiosis, global bleaching events, conservation strategies

Lesson Objectives

By the end of the lesson, students should be able to:

- Define coral bleaching and identify its primary causes
- Explain the symbiotic relationship between coral polyps and zooxanthellae
- Describe environmental stressors that lead to bleaching (temperature, light, acidity)
- Assess global bleaching events and their impact on marine biodiversity
- Understand efforts to protect and restore coral reefs

Background Information for Instructor

What Is Coral Bleaching?

Coral bleaching is the loss of symbiotic algae (zooxanthellae) from coral tissues, causing them to turn white. This is typically a stress response—especially to elevated sea surface temperatures. Without zooxanthellae, corals lose their primary source of energy from photosynthesis, weakening them and often leading to mortality if conditions do not improve.

Bleaching does not mean the coral is dead, but it is more susceptible to disease and starvation.

Coral and Zooxanthellae Symbiosis

- Zooxanthellae are dinoflagellate algae living in coral tissues.
- They perform photosynthesis, producing oxygen and organic carbon that corals use for energy.
- In exchange, corals provide a protected environment and nutrients (nitrogen, phosphorus).
- This symbiosis allows corals to thrive in nutrient-poor tropical waters.

Causes of Bleaching

1. **Temperature Stress** – The primary global cause. Even a 1–2°C increase over several weeks can trigger bleaching.
2. **Light Stress** – Intense sunlight, especially after temperature increases, can lead to photoinhibition.
3. **Ocean Acidification** – Higher CO_2 levels reduce carbonate ion availability, stressing corals and slowing calcification.
4. **Pollution** – Nutrient runoff promotes algae growth that competes with coral, and some contaminants disrupt coral metabolism.
5. **Sedimentation** – Limits light penetration and clogs coral feeding structures.
6. **Disease and Pathogens** – Stressed corals are more vulnerable to infections.
7. **Overexposure to UV Light** – Especially in shallow waters.

Historical Global Bleaching Events

- **1998**: First recognized mass global bleaching event, coinciding with an intense El Niño. 16% of corals globally died.

- **2010 & 2016**: Subsequent widespread events, with the 2016 event devastating parts of the Great Barrier Reef.
- **Ongoing Events**: Many tropical reefs now experience annual bleaching stress, reducing recovery time.

Consequences of Bleaching

- **Biodiversity Loss** – Reef ecosystems support over 25% of marine species.
- **Economic Losses** – Affects fisheries, tourism, and coastal protection services.
- **Ecosystem Collapse** – Prolonged bleaching reduces habitat complexity and resilience.

Climate Feedbacks

- Bleaching reduces carbon sequestration capacity.
- Damaged reefs are less effective in dissipating wave energy, increasing erosion.
- Coral decline may disrupt marine food webs, affecting both marine and human communities.