

## Environmental Science

### Climate Change and Ecosystems Quiz – Answer Key

1. **(C) Carbon dioxide (CO<sub>2</sub>).** While methane has higher warming potential per molecule, CO<sub>2</sub> contributes most to total anthropogenic warming due to its abundance and persistence in the atmosphere.
2. **(B) A reservoir that absorbs more carbon than it releases.** Natural carbon sinks include forests, oceans, and soil. They remove CO<sub>2</sub> from the atmosphere through photosynthesis and dissolution.
3. **(B) Absorption of atmospheric CO<sub>2</sub>.** When CO<sub>2</sub> dissolves in seawater, it forms carbonic acid, lowering ocean pH. This threatens shell-forming organisms like corals and mollusks.
4. **(B) Melting ice reducing Earth's albedo.** As reflective ice melts, darker ocean/land surfaces absorb more heat, causing further warming and more melting—a self-reinforcing cycle.
5. **(B) 1.5°C to well below 2°C above pre-industrial levels.** The 2015 Paris Agreement set this target, with countries submitting nationally determined contributions (NDCs) to achieve it.
6. **False.** The natural greenhouse effect is essential for life, keeping Earth approximately 33°C warmer than it would be otherwise. The concern is the enhanced greenhouse effect from human emissions.
7. **True.** When ocean temperatures rise, corals expel their symbiotic zooxanthellae algae, losing their color and primary food source. Prolonged stress leads to coral death.
8. **True.** Forests are major carbon sinks. Deforestation releases stored carbon (through burning/decomposition) and eliminates future sequestration capacity, contributing roughly 10% of global emissions.
9. **Natural carbon cycle:** Carbon moves between atmosphere, biosphere, oceans, and geosphere. Plants absorb CO<sub>2</sub> through photosynthesis; respiration and decomposition return it to the atmosphere. Oceans absorb and release CO<sub>2</sub>. Geological processes store carbon in rocks and fossil fuels over millions of years.  
**Human disruption:** Humans have increased atmospheric CO<sub>2</sub> from 280 ppm (pre-industrial) to over 420 ppm by releasing stored carbon faster than natural sinks can absorb it.  
**Major anthropogenic sources:**
  - (1) *Fossil fuel combustion:* Burning coal, oil, and natural gas for energy releases 35 billion tonnes CO<sub>2</sub> annually—the largest source.
  - (2) *Deforestation and land use change:* Clearing forests for agriculture releases stored carbon and reduces sequestration capacity.
  - (3) *Industrial processes:* Cement production releases CO<sub>2</sub> from limestone heating; steel and chemical manufacturing also contribute significantly.

(4) *Agriculture*: Livestock produce methane; rice paddies and fertilizers release methane and nitrous oxide.

#### **10. Climate impacts on biodiversity:**

*Habitat shifts*: Species ranges are moving poleward and to higher elevations. Example: Many butterfly and bird species in Europe have shifted northward.

*Phenological mismatches*: Timing of life events (migration, breeding, flowering) becomes desynchronized. Example: Great tits breeding earlier than caterpillar peak emergence, reducing chick survival.

*Coral reef ecosystems*: Rising temperatures and acidification threaten reefs. The Great Barrier Reef has experienced mass bleaching events, affecting thousands of dependent species.

*Arctic ecosystems*: Polar bears, walruses, and seals face habitat loss as sea ice diminishes.

*Extinction risk*: Studies estimate 15-37% of species face extinction risk from climate change by 2050.

**Conservation strategies**: Protected area networks with connectivity corridors; assisted migration for vulnerable species; reducing non-climate stressors (habitat fragmentation, pollution); ex-situ conservation (seed banks, captive breeding); ecosystem-based adaptation.