



PART 2

Read the text below and answer questions 14–26.

LIFE IN AN ACIDIFYING SEA: IMPACTS ON MARINE ECOSYSTEMS

Ocean acidification is sometimes introduced as a neat chemical narrative, but its most consequential effects are ecological: they unfold through interactions among species, habitats, and the timing of life cycles. A change in seawater chemistry does not act on a single organism in isolation; it changes the “rules of engagement” for feeding relationships, competition for space, and the stability of nursery habitats. For this reason, ecologists increasingly treat acidification as a systems problem. What matters is not only whether an organism can survive a lower pH, but whether it can still find food, avoid predators, and reproduce successfully when the wider community is also shifting.

A central difficulty is that acidification rarely arrives alone. In real seas it is embedded among synergistic stressors that can amplify impacts. Warming can accelerate metabolism, increasing oxygen and food demands at exactly the time that physiological performance may become constrained. Pollution can impose additional burdens on immune function and detoxification, while habitat disturbance reduces the availability of refuges. Another widely discussed stressor is deoxygenation, which reduces the energy available for growth and can make recovery from any added challenge slower. Because these pressures interact, laboratory tolerance tests can mislead if they hold constant the very factors that dominate the field. An animal that appears robust under controlled pH may perform poorly when warming, hypoxia, and limited food occur together.

The best-known sensitivities concern biogenic calcification—the process by which organisms build shells and skeletons from calcium carbonate. When carbonate ions become less available, calcifiers may face higher metabolic costs to maintain the chemistry at the site of mineral formation. This is not simply a matter of “less building material”; it is an energetic trade-off. Energy spent regulating internal acid–base balance, pumping ions, or repairing partially dissolved structures is energy not spent on growth, reproduction, or escape responses. The burden is often greatest early in life, when larvae must build essential structures quickly while also developing feeding and movement capabilities. Small delays or deformities at this stage can cascade into lower survival even if adults seem comparatively tolerant.

Reef-building corals illustrate how organism-level costs can scale into ecosystem-level change. Coral skeletons create complex three-dimensional frameworks that function as nurseries and shelter for many fish and invertebrates. If calcification slows, reefs may struggle to keep pace with erosion and storm damage, and the structural complexity that



supports biodiversity can decline. Importantly, the ecosystem impact does not require mass coral death. Even when adult colonies remain alive, weaker reef growth can gradually reduce crevices, hiding places, and stable settlement surfaces, shifting the balance toward communities dominated by fewer habitat-forming species. Such habitat simplification can alter food webs by changing which prey are available and which predators can hunt effectively.

Not all responses are uniformly negative, which is why simple predictions often fail. Some seagrasses and macroalgae can benefit from higher dissolved CO₂ because it may enhance photosynthesis under the right circumstances. In dense vegetation, chemical conditions can shift during daylight hours as plants draw down CO₂, and this can temporarily raise pH in nearby water. However, these benefits depend on nutrients, light availability, and grazing pressure; if grazers remove new growth, or if nutrients limit photosynthetic rates, the buffering effect is weaker. Even where plants thrive, increased vegetation does not automatically replace the lost ecological roles of reefs or shell beds, particularly when many animals depend on hard structures for settlement and protection.

Another layer of complexity involves sensory disruption and behaviour. Many marine organisms rely on chemical information to find habitat, locate food, and assess risk. Experiments have reported that some fish become less responsive to predator cues or show altered decision-making when the chemistry of surrounding water changes. Such effects can influence survival even without obvious physical damage, because a slight delay in avoidance behaviour can be lethal in the wild. Researchers also emphasise phenotypic plasticity—the capacity of individuals to adjust physiology or behaviour within their lifetime—which may reduce sensitivity in some contexts. Yet plasticity has limits, and rapid environmental change can outpace adjustment, especially for long-lived species or those with narrow developmental windows.

Place matters because local oceanography can reshape exposure. Coastal zones may experience daily swings in pH due to river inputs, upwelling, and intense biological activity. Populations living in such variable environments sometimes show partial tolerance to fluctuation, but variability can also mean they are frequently operating near physiological limits. In contrast, open-ocean species may face a steadier but progressively worsening trend, which can be challenging in different ways. As a result, vulnerability cannot be inferred from global averages alone; it must be tested against the local pattern of change, the life stage exposed, and the presence of co-occurring stressors.

Human communities are part of this ecological story. Shellfish farms can suffer when larval stages fail during chemically stressful periods, and fisheries may be affected if food webs reorganise or habitat quality declines. Management responses exist—monitoring



water conditions, shifting harvest timing, selective breeding for tolerance, or protecting refuges—but these measures require resources, coordination, and reliable information. Smaller operators and less wealthy regions may struggle to implement them consistently. Overall, acidification does not produce a single uniform outcome: it is shaped by species traits, life stage, synergistic stressors, and the local rhythm of environmental variability. For that reason, the most credible assessments combine field observations, experiments that include multiple stressors, and long-term monitoring that captures both trends and variability.

Questions 14–18

Select the correct answer.

14 The writer indicates that the most important significance of ocean acidification lies in its effects on

- A** the precision limits of pH sensors used at sea
- B** relationships within ecosystems and food webs
- C** the speed at which aquaculture industries can grow
- D** chemical reactions occurring on the ocean floor

15 Why does the passage warn against relying on laboratory tolerance tests alone?

- A** Laboratory animals are always healthier than wild populations
- B** Field environments are too stable to reveal sensitivity
- C** Acidification operates alongside other pressures in natural settings
- D** Temperature has minimal influence outside laboratory tanks

16 Calcifying larvae are described as especially sensitive mainly because they

- A** must build structures rapidly while other vital functions are developing
- B** experience acidification only in coastal waters
- C** cannot survive in water containing dissolved CO_2
- D** depend entirely on seagrass habitats for shelter

17 The passage suggests that higher dissolved CO_2 may assist some plants only when

- A** reefs have disappeared, removing competition for space
- B** upwelling has stopped bringing deep water to the surface
- C** fish no longer use chemical information for navigation
- D** nutrients, light, and grazing conditions are favourable

18 Which statement best summarises the writer's overall position?



- A** Acidification produces broadly uniform outcomes across regions
- B** Effects vary with species, life stage, combined stressors and local oceanography
- C** Impacts are largely confined to shell-forming organisms
- D** Laboratory experiments are generally less useful than field studies

Questions 19–23

Match each statement with the correct category, **A–D**, below. **NB** You may use any letter more than once.

List of Categories

- A** Multiple pressures acting together (Synergy)
- B** Energy or structural costs (Calcification/Habitat)
- C** Behavioural or sensory changes
- D** Human consequences and management

- 19** Some fish may struggle to respond appropriately to chemical warning signals, increasing risk even without visible physical damage.
- 20** Reef communities can change even when adult corals survive, because weaker frameworks reduce shelter and settlement surfaces.
- 21** Monitoring water conditions and selective breeding can lower aquaculture losses, but these measures may be unrealistic for smaller operators.
- 22** Organisms may appear tolerant in controlled experiments, yet perform worse when warming, pollution, and oxygen limitation occur together.
- 23** When carbonate becomes less available, calcifiers may divert energy into regulating chemistry and repairing structures rather than growth.

Questions 24–26

Answer the questions below. Choose **NO MORE THAN TWO WORDS** from the text for each answer.

- 24** Other than warming, which stressor is mentioned as reducing the energy available for growth?
- 25** What kind of cues may some fish become less responsive to when water chemistry changes?
- 26** What do coastal zones experience due to river inputs, upwelling, and biological activity?



Answer Key

14. B

15. C

16. A

17. D

18. B

19. C

20. B

21. D

22. A

23. B

24. deoxygenation

25. predator cues

26. daily swings