HIGH pH: Narrative for detailed conceptual diagram

High pH levels occur when hydroxide ion concentrations are high and hydrogen ions are scarce. Although acidic conditions more commonly result from human activities, alkaline conditions also can occur and adversely affect aquatic biota. This conceptual diagram illustrates linkages between high pH and associated pH fluctuations (middle of diagram), the human activities and sources that can contribute to high pH (top of diagram), and the biological responses that can result (bottom of diagram). In some cases, additional steps leading from sources to stressors, modes of action leading from stressors to responses, and other modifying factors also are shown.

This narrative generally follows the diagram top to bottom, left to right. For more information on interpreting CADDIS conceptual diagrams, see the Conceptual Model page in the Causal Database section of CADDIS.

Linking Sources to Stressors

Certain human activities and land uses can result in increased input of hydroxide ions into aquatic systems, leading to increases in pH. These sources include: runoff of lime-rich fertilizers applied to agricultural cropfields, golf courses, and lawns; runoff from limestone gravel roads, asphalt roads, and other asphalt waste; and effluents and leachate from oil and gas brine mining wastes or from industries that use lime, lye or sodium hydroxide (e.g., asphalt and cement manufacturing plants, soap manufacturing plants). Atmospheric emissions and deposition are not significant transport sources for hydroxide ions and thus generally do not contribute to high pH conditions, a marked difference from low pH conditions. There also are natural sources which can result in high pH conditions, such as naturally alkaline geologies and lithologies and high levels of photosynthesis. Because photosynthesis produces hydroxide ions, elevated nutrient concentrations may contribute to pH increases. High pH levels also can affect other stressors, most notably by increasing the proportion of ammonia in its unionized, toxic form (see the ammonia and ionic strength modules for more information on these pathways).

Linking Stressors to Biological Response

Increases in pH and associated increases in pH fluctuation can adversely affect aquatic organisms via many potential modes of action. For example, metal hydroxides can form and precipitate, smothering or armoring stream bottoms. Ammonia excretion may be impaired, adversely affecting ionoregulatory function and protein metabolism. Indirect effects such as changes in food availability also may occur.

These different modes of action all may contribute to decreased condition, decreased growth, altered behavior, and increased susceptibility to other stressors in affected biota. Possible decreases in condition include gill hyperplasia, gill and fin erosion, lesions and skin damage (increasing susceptibility to fungal infections), and increased olfactory damage; possible changes in behavior include lethargy. Ultimately, these effects may result in increased mortality, decreased reproductive success, and changes in population and community structure and ecosystem function. For example, taxa sensitive to high pH (e.g., perciform fishes) may decrease, while more tolerant taxa (e.g., cypriniform fishes, *Cladophora*) increase; these changes may result in reduced taxa richness or diversity.