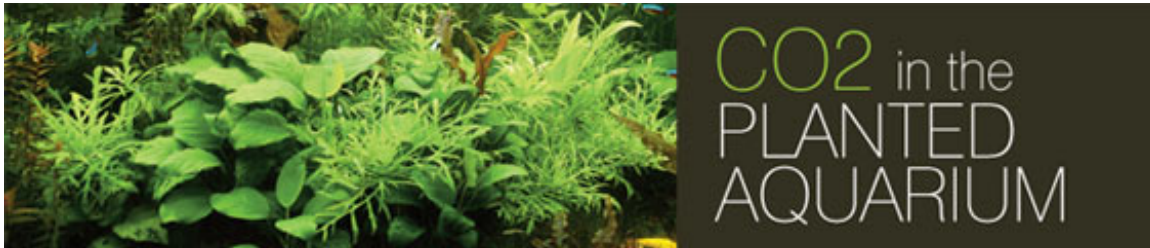


# Freshwater Planted Aquarium Care and Maintenance

Drs. Foster & Smith Educational Staff

By Greg Morin



Carbon is the backbone of all life. Every organic molecule of every living organism is predominantly carbon based. Given this simple fact, it becomes clear why carbon dioxide (CO<sub>2</sub>) plays a pivotal role in the planted aquarium. Aquatic plants extract CO<sub>2</sub> from their environment and employ it in a process called photosynthesis. Photosynthesis combines CO<sub>2</sub>, water and light energy to produce simple carbohydrates and oxygen (O<sub>2</sub>).

Growth rates of aquatic plants are strongly correlated<sup>1</sup> with availability of carbon and the plant's affinity for carbon uptake. Studies<sup>1</sup> have shown that plants with the greatest carbon affinity have the greatest growth rates, whereas those with lower carbon affinity have correspondingly slower growth rates. Because carbon availability is normally the limiting factor to growth, addition of CO<sub>2</sub> to a planted aquarium will always result in large increases in growth (assuming other critical elements are not lacking).

Without additional CO<sub>2</sub> the growth rate will be dependent on the rate at which atmospheric CO<sub>2</sub> equilibrates into the water. CO<sub>2</sub> will dissolve into CO<sub>2</sub>-free water to a degree that is dependent on the air pressure, temperature, pH and bicarbonate/carbonate content of the water. The final concentration of CO<sub>2</sub> in the water depends entirely on those factors. Once that concentration is achieved, the level of CO<sub>2</sub> will not change unless the plants remove it or one of the other factors is altered.

Plants remove CO<sub>2</sub> at a rate much greater than the rate at which it equilibrates into the water. So at the height of CO<sub>2</sub> utilization, the plants limit their own growth by using up all available CO<sub>2</sub>. Because CO<sub>2</sub> is an integral component of the bicarbonate buffer system, a drop in CO<sub>2</sub> will necessarily result in a rise in pH. As the pH rises, the influx of additional atmospheric CO<sub>2</sub> will be diminished by its conversion to bicarbonate.

This is offset somewhat by hard water plants that can utilize bicarbonate directly. However, without routine water changes or buffer additions ([Alkaline Buffer™](#) or Liquid Alkaline Buffer™), this path will eventually lead to complete depletion of the KH (carbonate hardness) which will result in dramatic pH swings from day to night (5.7 - 9.6).<sup>1</sup>

[CO<sub>2</sub> injection](#) bypasses this predicament by delivering a constant source of CO<sub>2</sub>. Because the introduction of CO<sub>2</sub> will lower pH, you have two options: (1) Monitor and calibrate the rate of CO<sub>2</sub> addition to precisely match the usage by the plants or (2) use a pH feedback metering system, such as a [pH controller](#). Option (2) is ideal because as the pH falls below a certain point, the CO<sub>2</sub> turns off, thus avoiding catastrophic pH drops.

If you are not quite ready for the initial investment in a CO<sub>2</sub> injection system but would still like to enjoy some of the benefits of adding additional carbon, there is an alternative: [Flourish Excel™](#). It provides a simple organic carbon molecule (similar to what is described above in the photosynthesis discussion) that plants can use as a building block for more complex carbohydrates. Because Flourish Excel™ is an organic carbon source, it does not impact pH. Even if you are already using CO<sub>2</sub>, you can still obtain a cumulative benefit by using Flourish Excel™ in conjunction with CO<sub>2</sub>.

Plants need carbon to create their food (photosynthesize). They obtain carbon from either carbon dioxide (CO<sub>2</sub>) or some plants can take it from carbonate hardness (KH). It is easier for plants to utilize carbon from CO<sub>2</sub>, which is naturally present in the aquarium, but not usually at the levels needed. As CO<sub>2</sub> levels disappear, plants slow their growth, forcing them to use the carbon from KH, which is the ingredient that holds pH stable. When this buffers content is lowered, pH levels can change dramatically, which may severely stress or even kill fish.



---

## **Biography**

Greg Morin is the President and CEO of Seachem Laboratories, Inc. and has been with the company since its inception over 20 years ago. He graduated from Notre Dame with a Ph/D. in organic chemistry and is actively involved in developing new and innovative products.

---

## **Resources**

1. Walstad, Diana, Ecology of the Planted Aquarium, Echinodorus Publishing, **1999**, pp. 94-97.