THE NITROGEN CYCLE

Achieving a Balanced Aquarium for Salmon Success

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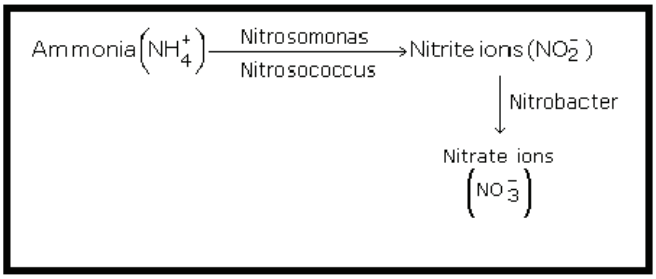
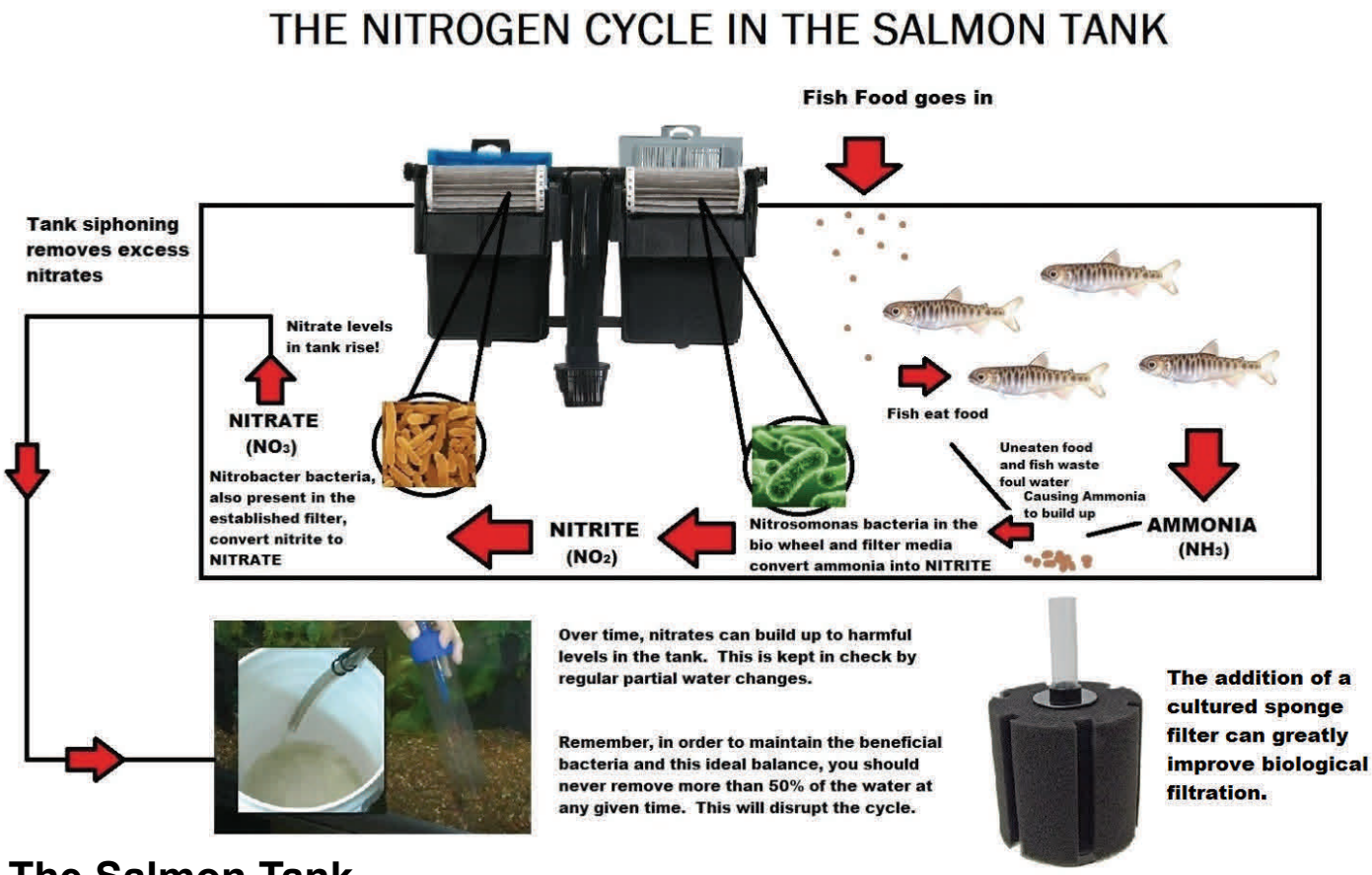
The Nitrogen Cycle



An arrow diagram depicting the nitrogen cycle

In natural ecosystems, there exists a diverse community of organisms that break down waste. This biotic community contributes to a common life cycle called the **NITROGEN CYCLE**. *Nitrosomonas* and *Nitrobacter* bacteria are key components of the cycle, and are considered a type of beneficial bacteria. The bacteria act as a natural filter. After a series of conversions, toxic waste products are rendered benign. The ideal fish tank environment will mimic this, but on a much smaller scale.

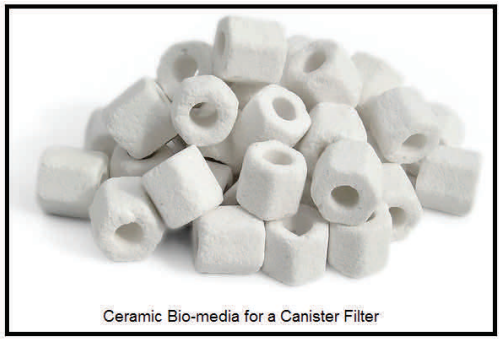


The Salmon Tank

A newly set up tank is not instantly ready to support life. The process of tank maturation, better known as “cycling”, describes how organic wastes are dealt with as bacteria establish within the confines of the aquarium. An aquarium is essentially a boxed-in ecosystem. In this environment, it can be challenging to achieve biological harmony. The tank must completely cycle for salmon to begin to thrive.

Prior to hatching, the fish are not producing waste. Therefore, it won’t be until you have swim-up fry and they begin feeding that the nitrogen cycle begins. As the fish begin to produce waste, harmful ammonia levels in the tank will rise until beneficial nitrifying bacteria begin to colonize and convert it to less toxic forms. Unassisted, this process can take many weeks to establish. Use of a bacterial additive such as a cultured sponge filter or Seachem’s *Stability* will reduce the time it takes to cycle the tank.

Beneficial Bacteria in the Aquarium



Ceramic Bio-media for a Canister Filter

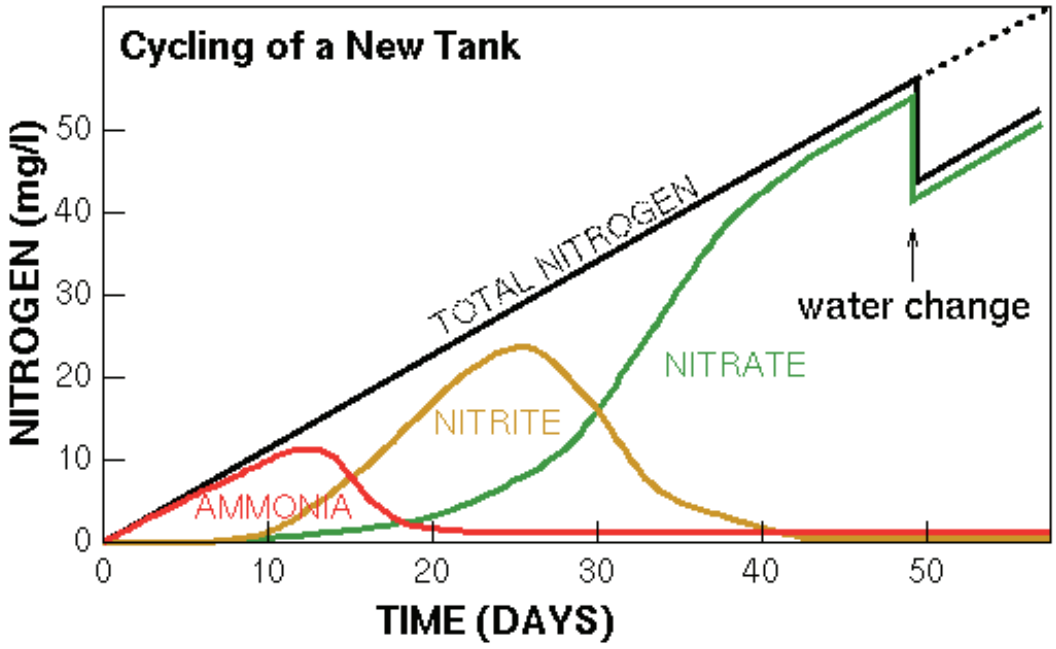
It is important to have certain bacteria in an aquarium to keep the water quality balanced by processing these wastes. When starting from scratch, everything you buy will be sterile. Beneficial bacteria will establish over time, but until colonization is complete you must take extra care in how the tank is maintained.

A healthy tank will have a house for beneficial bacteria in the form of porous filter media. This can be of sponge or ceramic design. Tank filtration consists of three stages: Mechanical, chemical, and biological. Mechanical filtration involves the trapping of wastes, chemical refers to the carbon component that absorbs impurities, and biological refers to bacterial activity on bio-media. The increased surface area and constant, driven flow of water through bacteria on the bio-media keep wastes processed between water changes. Remember, a brand new filter will be biologically useless in the first weeks of tank establishment.

The Importance of Cycling

Regardless of whether you let the tank cycle naturally or speed up the process, the tank will require a large colony of beneficial bacteria to function properly. When the nitrogen cycle is not fostered and a tank is hastily put together, the salmon you receive can suffer what is called *New Tank Syndrome*. This is a term coined from the loss of fish that commonly occurs when a tank is not cycled. Using bacterial additives (products such as *Stability* or an established sponge filter) will keep the tank at optimal functioning during this critical period.

Both ammonia and nitrite have to spike and settle independently before the tank is fully cycled. A buildup of nitrates shows that the bacteria are hard at work. Until you get test results that indicate cycling is complete, do not change filter media or perform water changes except in the case of overfeeding.

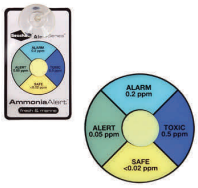


The chart above illustrates the typical progression of tank cycling.

Testing your water– How to tell when the tank is cycled

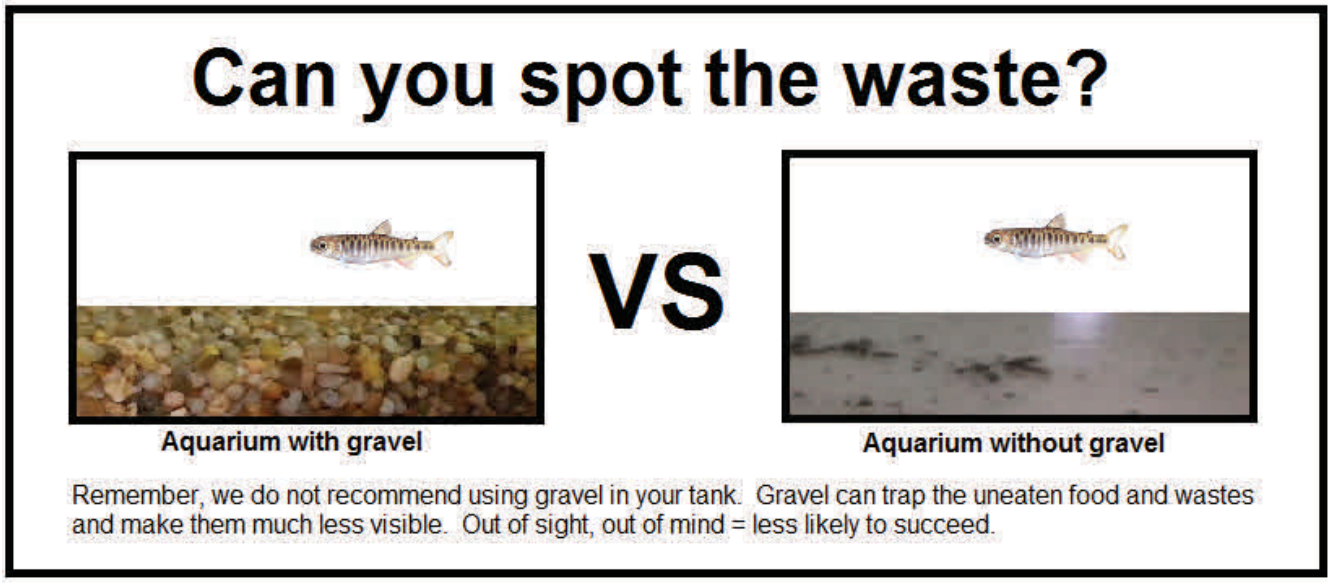
The first thing you should do is test your source water. Once you know your normal parameters, you can detect the changes in your tank over the cycling period. Since the nitrogen cycle deals with nitrogenous wastes, testing for ammonia (NH_4), nitrite (NO_2), and nitrate (NO_3) will be critical in determining the health of your tank. A new tank will go through an inevitable "ammonia spike" which will level off as the beneficial bacteria begin to establish. This is perfectly normal. Tanks with elevated ammonia levels post-cycling, however, are experiencing an increase in waste load and a decrease in efficiency of already colonized bacteria. This kind of spike must be addressed quickly.

Normal Water Quality Progression in a Cycling Tank

Readings	What's happening	Prognosis
Ammonia: 0-0.25 ppm Nitrite: 0 Nitrate: 0	Phase 1: This water may have trace levels of ammonia, but no other readings, indicating it is fresh and has little to no biological activity.	This is where you would add fish or a bacterial additive to kick-start the cycling process.
Ammonia: 0.50-4.0 ppm Nitrite: 0-0.50 ppm Nitrate: 5.0 ppm	Phase 2: This is where the ammonia is spiking as the tank begins to cycle. The nitrites are beginning to build and you are just starting to get nitrate readings.	At this point, it is important to monitor the ammonia levels. The use of *Ammonia Alert* can indicate quickly when levels gelt dangerously high.  Every salmon tank should have this.
Ammonia: 0-2.0 ppm Nitrite: 0.25-2.0 ppm Nitrate: 5.0-20 ppm	Phase 3: When the ammonia levels off and begins to drop, you are headed in the right direction. The nitrites may continue to climb slightly and the nitrates build. This is a half-way point.	The worst of the ammonia spiking has passed, so it won't be much longer until the tank reaches a balance. Continue to pay close attention to ammonia and nitrites.
Ammonia: 0-0.25 ppm Nitrite: 0-0.25 ppm Nitrate: 10-40 ppm	Phase 4: The tank has now been cycled. The ammonia and nitrite readings should be trace to zero. Nitrates in the mid-range indicate the bacteria are working.	This is the ideal range of parameters. Once the tank is cycled, only a dramatic increase in waste or decrease in bacteria will throw it off balance. Keep up with partial water changes every week from now on to keep nitrates low.

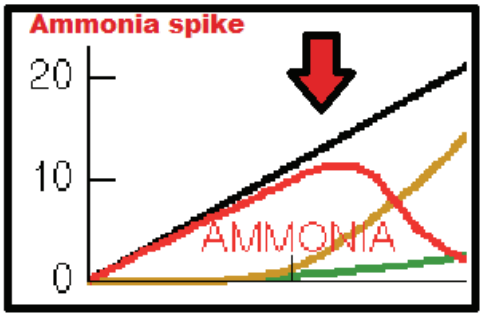
Why is my ammonia so high?

So you've tested your salmon tank, and you notice the chart reading for ammonia is REALLY high. This is a very common problem, usually caused by not enough water changes in combination with overfeeding. If uneaten food is not removed, it will decompose and release toxins into the water. The more that is left uneaten, the worse shape the tank will be in. However, if you address overfeeding quickly and do regular water changes that target siphoning the bottom of the tank, you won't likely reach an emergency situation. The stress from a sudden spike in ammonia levels can be lethal.



What is ammonia and what makes it so toxic to salmon?

In their natural environment, salmon thrive in very clean and highly oxygenated streams. They are sensitive to toxins, especially ammonia. Ammonia is a compound released from dead or decaying organic matter. In the aquarium, this is encountered with dead fish, uneaten food, and the normal respiration and excretory functions of fish. Salmon produce a lot of waste and if the tank cannot handle the load, it becomes hazardous to the animals. If they are exposed for long enough or to high enough concentrations of ammonia, both respiration and swimming will become impaired. This will manifest in labored breathing and atypical behavior. If not remedied, the cells become irreparably damaged and the fish will die.



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Alkalinity, hardness, and pH

The pH of the tank is heavily influenced by hardness and alkalinity. Hardness can be broken down into gH (general hardness) and kH (carbonate hardness). Alkalinity is a measure of the buffering capacity of a tank (and another term for the water hardness). Carbonate hardness or alkalinity is important to maintain above 2 degrees carbonate hardness (dKH). The kH levels in your salmon tank will determine how resilient the environment is to pH drop. The pH can do what is known as a pH "crash" if levels of ammonia and organic wastes contribute to an acidity that the dKH cannot buffer. This usually occurs after the tank has gone too long without proper maintenance. A test will reveal a precipitous drop in pH from the norm. In order to avoid crashing the pH, a tank with naturally low kH readings will require more frequent water changes than a tank with higher kH readings will require.

Avoid tampering with your source water as much as possible

As long as your source water is above 2-3 dKH (or 70 ppm), there isn't much need to fuss over pH or alkalinity. The best thing you can do is use the most convenient source of water for your salmon tank. Fish are most healthy in a stable environment. Adding too many chemical adjusters (such as pH increasers) may stress out the fish and result in more trouble later. In the case of extremely low kH, you can safely add the following to your water with every water change:

1 tsp Alkaline buffer and 1/2 tsp Acid butter for every 10 gallons

Lansing city water, for example, typically has very low kH and will need this additive to keep balanced. Refrain from using sources of water that have no buffering capacity at all, such as reverse osmosis (RO), rainwater, or distilled water.

Chlorine and Chloramines in source water

Chlorine and chloramines are toxic to fish. Conduct some preliminary tests or check ahead of time whether your source water contains these additives so that you can buy the product to treat the water in advance. Generally, if you are drawing from a source that does not have chlorine or chloramines, you do not need to use a dechlorniator or water conditioner. Almost all municipal supplies of water will contain chlorine or chloramines, so if you have city water sources you will need a treatment product such as Seachem's *Prime*.

What if water from my tap tests positive for ammonia?

If your initial tap water test yields ammonia, it is advised you treat your water with a water conditioner product called *Prime*. This product will neutralize trace amounts of ammonia as well as neutralizing chlorine and chloramine at five times regular dosage for up to 24 hours. *Amguard* is another product that can work for this, and exclusively treats for ammonia.

Using your understanding of the nitrogen cycle

Ammonia and nitrites are kept in check by established bacterial colonies, but that does not mean you don't have to clean the tank. Long gaps between water changes allow nitrate to build up, slowly but surely, to the point of becoming increasingly toxic. Nitrate is a chronic exposure risk. So make sure you also keep up on water changes once a week after the tank is cycled to avoid unnecessary fish loss. If the bio-load exceeds what the tank can handle, the ammonia, nitrite, and nitrates will rise again.

Avoid *New Tank Syndrome*:

- Feed only as much as directed. Opt to slightly underfeed rather than overfeed.
- Add bacterial supplement such as a cultured sponge filter or *Stability* to help cycle tank and keep bio-load in check
- Test water daily and focus on ammonia, nitrite, and nitrate readings for diagnosis. Add acid and alkaline buffer as directed if the kH is below 3 dKH.

Important things to remember

1. Stress is often the underlying cause of problems with fish.

2. Poor water quality is a major cause of stress.

3. Water quality is improved by beneficial bacteria.

4. Bacteria and filtration work together to keep the tank clean for a finite amount of time.

5. The long-term balance and health of this tank "Ecosystem" requires regular maintenance (water changes, testing, changing filter media).

Find your companion.

Preuss Pets

To help cycle your salmon tank, we recommend an established sponge filter. Coming straight out of the box, a sponge filter will have no beneficial bacteria. Preuss Pets in Lansing, MI offers established sponges at the same cost as new. Contact the store via telephone or e-mail to inquire about this useful service.

Preuss Pets proudly supports Salmon in the Classroom.

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