Establishing a Reef Tank… ReefGeezer Style

This text is intended to describe a process for establishing a moderate sized reef tank full of fish and sensitive SPS corals. The processes used to establish this system are designed to establish a mature environment capable of supporting the most demanding of corals without promoting the growth of pest Cyanobacteria, Dinoflagellates, and microalgae.

To ensure the desired outcome, this process is implemented in a very specific way. Waiting periods and timelines are not used in this process. The entire process can be accomplished as rapidly as the tasks can be performed and the milestones reached.

We are dealing with biological processes. Things will certainly occur a little differently in each individual system. I am confident that the organisms we are trying to encourage will respond in a manner similar to that specified in this text.

Let's talk about the Reefing Hobby. Just keeping very sensitive corals alive is difficult. Getting them to flourish is a real challenge. Corals are simple organisms that have evolved to live in a specific and stable environment. They have little capacity to adapt to conditions that stray very far from their natural environment or to tolerate changing conditions.

While setting up a system and establishing the nutrient pathways and food web are absolute requirements, the element that will make or break your success is how the system is maintained. This maintenance, sometimes referred to as "Husbandry", is really the core of the hobby we call Reefing. Testing, observing, dosing, changing water, equipment cleaning, glass cleaning, feeding, coralline scraping, algae scrubbing, and a host of other tasks will occupy you, at least for a few minutes, on almost a daily basis. After all that, you'll get to sit back and enjoy the tank for a few minutes.

I have attempted to incorporate the information I wish I had known when I started my first real reef tank. I won't sugar coat this truth or try to make anything in this process sound easy. You are going to have to get comfortable mixing some chemicals and doing some math. I'll ask you to look up some information on the internet. The expenses involved in implementing any reef system are high. In this method, they are front loaded. I'll ask that you purchase quality equipment, and do so during the set-up phase rather than a little at a time. If you're still interested, get out laptop and your charge card and let's get started.

The implementation if this process in broken into phases. There is a Milestone Checklist included in the appendix to help you successfully accomplish the tasks included in each phase.

PHASE 1: SET UP THE SYSTEM

The system is intended to be implemented using a reef ready aquarium and stand; a sump with a decent sized refugium; and a moderately priced skimmer. A pure water source, quality lights, wave makers, a quality automatic top-off system, and a couple of good dosing pumps will also be needed.

This system will save you some money on equipment though. You will <u>not</u> need Algae Turf Scrubbers, Refugium lights, GFO Reactors, Biopellet Reactors, Cheato Reactors, or any other device aimed at reducing nutrients or controlling algae.

I won't bore you with the steps needed to set up a reef tank's equipment and get it filled with water. That's an easy look-up on the internet. However, here are a few rules to consider during the planning and set-up of your system…

Systems must be planned for the long run.

Any system can work for a while. However, reef tanks take a long time to establish, corals grow slowly, and they aren't truly impressive until they grow into larger colonies. "A while" is just not long enough. Well designed and operating systems are required to optimize the growth, color, and overall health of the reef and its inhabitants.

If you buy cheap, you will buy twice.

This is another old rule and it applies to many things, but is particularly applicable here. Even the simplest reef tanks require some equipment. I don't know how many times I bought "inexpensive" equipment only to find it did not do the job or failed too quickly. That money was wasted. I had to pony up more cash to replace the substandard equipment. Remember, if you plan on keeping your reef long enough to see the fruits of your labor, the equipment will have to operate effectively for long periods of time without fail.

If maintenance is difficult, it will not get done often enough.

Place components that require frequent maintenance within easy reach and provide for isolation of the components requiring removal for maintenance. Planning your maintenance tasks should be a high priority when planning your system.

A system that is capable of supporting the organisms that make up the nutrient processing pathways and food web is necessary for this process to operate properly. Most of the systems that will be needed should be set up and operated from the inception of the project to ensure their proper function when needed. The equipment must operate for a long time. The inhabitants rely on this equipment. The outcome you get from the great amount of time and money you are going to invest relies on this equipment.

You are going to be running some hoses, wires, tubes, and pipes while setting up this system. Be aware that almost all of these will someday need to be removed for cleaning, servicing, or repairs. Keeping these things organized is a great idea. However, try to ensure that they can be easily removed when needed. If this is new to you, take a look on the internet at how others have performed the tasks.

A word about artificial sea water mixes… If you aren't lucky enough to be near an unpolluted source of real sea water, there are a host of artificial sea water mixes that are a suitable substitute. Almost all will perform adequately in a reef tank. However, later in this article, alkalinity levels will be discussed. For reasons that will be explained, finding a mix that yields a lower alkalinity (as close to 8 dKh as possible) is advisable. Additionally, consistency of the mix is important.

Let's talk about testing instruments and kits… From here, you will begin to check the chemistry of the water in the system. Inexpensive but trustworthy test equipment and kits are required. You will need to check salinity, alkalinity, calcium, magnesium, phosphate, and nitrate on a regular basis. The equipment and kits you select must be accurate enough to ensure you get useable data and have a resolution that will enable you to see changes at low enough levels to see trends. Here are my choices:

Salinity – Milwaukee Digital Salinity Meter (MA887) and the appropriate calibration solution;

Phosphate – Hanna Ultra Low Phosphate Colorimeter;

Calcium - Salifert Calcium Test Kit;

Magnesium – Salifert Magnesium Test Kit; and

Alkalinity – Salifert Alkalinity Test Kit

Supplies… There are a few things you'll need to keep on hand. These supplies will be used during various steps in this process. I'm not suggesting you go out a get them now, but figuring out where to buy them would be advisable.

1. Dual Bed, Color Changing Deionizing (DI) Resin for the RODI Unit
   a. You'll have to change this from time to time as you produce pure water for your system
2. Two-Part Epoxy Putty and Super Glue Gel
   a. You will use these to glue live rocks together and to stick corals to the rock
   b. You don't need aquarium specific products
3. Sodium Nitrate and Trisodium Phosphate Powders to make stock solutions to manage nitrate and phosphate levels
4. Calcium Chloride, Baking Soda, Magnesium Chloride and Magnesium Sulphate to make solutions to manage calcium, alkalinity, and magnesium levels
5. Calcium Carbonate Powder and Microbacter 7 (MB7) to create the DIY Liquid snow we'll use for maintenance purposes
6. With Vinegar (5% Acetic acid) to encourage the growth of beneficial bacteria
7. Red Sea DipX Coral Bath and Lugol's solution (or similar)
   a. Products to dip corals prior to putting them into the tank
8. Artificial Sea Water (ASW) Mix
9. Tropic Marin All-For-Reef
   a. This is a product that will eventually meet the need to supplement calcium, alkalinity and magnesium, and add some beneficial trace elements

MILESTONE 1

At this point the system should be set-up and operating properly. That means:

1. Equipment for pure water production and automatic top off of evaporation are in place
2. All the equipment is assembled and operating, there are no leaks, the water temperature is 75-80^{O}F and varies only a couple of degrees in any given period, and salinity is stable at 35 ppt. The water is clear;
3. You know where to obtain the supplied you will need; and
4. Adequate test instruments and kits are available.

We have done nothing to this point that is different from old school processes for establishing a reef tank. We have simply set up a system to ensure our future success:

1. We have planned our system for the long run;
2. We have built our system to ensure maintenance is simple and easy as possible to accomplish;

3. We have employed the equipment that we will need to ensure stability; and
4. We have employed quality equipment that is likely operate properly for long periods.

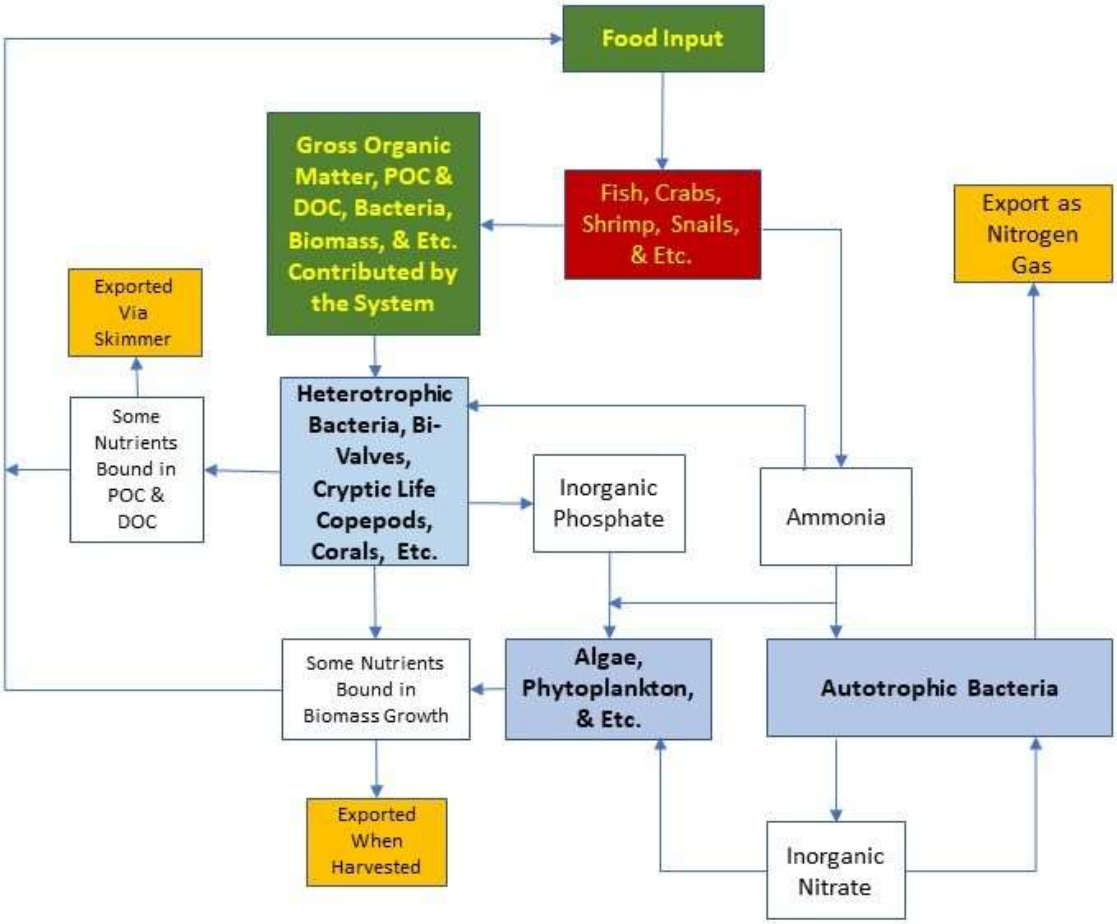
From this point forward, we will deviate greatly from the old school processes. We will focus our activities on strategically adding the organisms required to establish and maintain nutrient processing pathways and food webs. Don't worry, the pathways and food webs include the cool fish and corals you want. As a matter of fact, you'll be adding them much more quickly than you would if you were using old school methods.

PHASE 2: START THE SYSTEM'S LIFE CYCLE

Before we start… There is a rule that applies to this step also. It is a very important.

You must understand how food and nutrients, in all of forms, are used in the reef tank.

Nutrient processing pathways make our systems work. The following chart attempts to provide an overview of these pathways. Notice that the pathways are actually loops in many cases.



Notice that the output (waste & excess nutrients) produced by one activity provides input (food & nutrients) for another. This is the "Food Web". It is an intricate part of the nutrient pathway. This is the important observation. Artificially limiting "food" (input) from one pathway limits the function of the others. Our system will be set up to optimize these nutrient processing pathways and food webs.

You won't need a PhD in Marine Biology, but you have to understand at a basic level how organisms, food, and nutrients interact in the reef tank. The system's life cycle is so much more complicated than just the basic nitrogen cycle or control of nitrate and phosphate. It is about how food input is used and processed in interrelated pathways and food webs. Developing an understanding of the diversity required to complete the pathways, the inputs required to maintain them, and how limiting a pathway affects the others will help you reach your reefing goals. It will also reduce the difficulty in decision making and save you a lot of money.

Theory of Operation

The process for creating nutrient pathways is based on a holistic view of food input and nutrient processing pathways as the basis for building a system and bringing it to maturity as quickly as possible.

The goal is to create an environment where nutrients are used and reused, or bound and exported to the point that they are never elevated to levels that might promote major outbreaks of pest organisms like Cyanobacteria and hair algae. Finally, it will provide food and nutrients required for coral health.

Ok, let's get the life cycle started… but first… A couple more rules come to mind that apply from this point forward…

Nothing good happens fast in a reef tank

I didn't make this one up. It has been around forever, and is still ever so true. Patience is an absolute requirement for establishing and maintaining a healthy reef tank. You will be waiting for something to happen from day one.

Change is bad

Making changes to an established system may set it back no matter how beneficial the change may be in the long run. Stability is the key to maintaining a sustainable and amazing reef. That stability extends to every part of the environment, measurable or not. This rule isn't intended to mean that we won't ever change things. It is an encouragement to plan in advance so needed changes are few.

Order Live Base Rock, Live Rubble Rock, and Live Sand

Quality Live Rock and Live Sand are the heart of our system. They provide an environment and many of the organisms required to create the diversity needed for the food web and nutrient processing pathways to function properly.

The majority of the cool looking life on "premium" live rock like colonial corals, sponges, bivalves, gorgonians, and tube worms will probably not survive in a new tank. The life that is likely to survive and is most important to your future reef tank are things like coralline algae, cryptic sponges, bacteria, and small critters. Populations of that life are present in and on less expensive "base" live rock. That is what I would order in this phase.

For this process, the live rock, rubble rock, and live sand desired is cultured in the ocean, not a tank. It is provided by reputable suppliers that culture rock in pristine parts of the ocean, harvest it, care for it properly, and ship it directly to you, over-night. The life in ocean cultivated live rock and sand is an important characteristic not available from rock cultivated in a tank. It is held and shipped in water, not in wet paper. You will have to ask for rubble Rock. Most vendors are happy to oblige.

Live rock and sand IS NOT the rock that is kept in another reefer's aquarium or a tank at the LFS. This rock may have some life in and on it, but it will not be as diverse as ocean cultured live rock. It may also suffer from the as many pests as ocean cultured live rock with the added disadvantages of the unwanted Cyanobacteria, Dinoflagellates, and microalgae that tend to come with it.

Let's talk about the bacteria… We hear a lot about the nitrifying and denitrifying bacteria that are responsible for the nitrogen cycle and the process for establishing them in a new reef tank. We will not need to worry about this process. What is important to emphasize here, is that the live rock will contain more than a sufficient quantity of these bacteria to manage the ammonia produced as we add life to the system as instructed. No additional bacteria or ammonia additives are necessary for the growth of this bacteria. This type of bacteria is called autotrophic bacteria. In simplistic terms, it can derive food from CO_2 and the ammonia, nitrite, and nitrate we are trying to get rid of. **This is important… DO NOT ADD AMMONIA before of after the rock is added. There is no need to "Cycle" the tank prior to adding the rock.**

There is another type of beneficial bacteria at work in our system. These are heterotrophic bacteria. These bacteria can't derive their carbon from CO_2 and must uptake organic carbon instead. These bacteria are also present in great numbers in the live rock and sand. They are partly responsible for the process that yields the dissolved and particulate organic compounds that drive many of the nutrient processing pathways and provides a thread in the food web in our systems.

Bacteria exist everywhere… yes, even the ones that colonize the rocks in the ocean. They will colonize systems anywhere when the conditions are right for them to grow. Some of these bacteria are beneficial. Some are destructive. They compete for the same chemical and organic compounds.

Once a particular strain of bacteria is established, it is harder for other strains of bacteria that have similar requirements to compete. LET ME REPEAT THAT… **Once a particular strain of bacteria is established, it is harder for other strains of bacteria that have similar requirements to compete**.

We are trying use this to our advantage. We'll establish the bacteria we want by starting the system with live rock and sand containing large numbers of the autotrophs and heterotrophs that we want. That makes it hard for other strains we don't want to compete and get established. Given proper care and attention, other, less desirable bacteria won't be able to compete or cause problems.

So why can't we just seed sterile substrates like dry rock with live rock and sand?

This is a popular idea that just doesn't work as well as theorized. The bacteria present in the live rock used for seeding can't propagate fast enough to outcompete the other bacteria already present. In addition, the surfaces that are not live rock may not provide a suitable habitat for the bacteria. Nature will supply other bacteria that can survive on the bare surfaces long before the more desirable bacteria can get a foothold. That will allow for the ugly stage that we are trying to avoid.

Discouraging pest algae… The live rock and sand, along with the organisms they contain, and the biofilms that cover their surfaces, are a deterrent to pest algae also. These organisms: 1) Reduce or bind nutrients needed for algae to grow; 2) Compete for substrate on which to algae might otherwise grow; and 3) Consume the algae as it attempts to get a foothold.

You may ask what all the above gibberish means. Well… It means that starting our system with OCEAN CULTURED live rock and live sand greatly reduces the risk of prolonged periods of microalgae, Cyanobacteria and/or Dinoflagellates infestations that are commonly referred to as "THE UGLIES". It also means we will not waste time and money battling these unwanted pests.

Live Rock Expectations… Today's manmade live rock is much denser than the more porous rock we got back in the good ole days. If you were around back then, lower your expectations for the volume of rock you will receive. Order about 1 lb. per gallon of "Base" live rock and 1 lb. of live sand per gallon. More rock, up to two a total of pounds per gallon, is good. Make sure all is shipped water. Order a few lbs. of rubble live rock in the mix also. This is expensive. Remember though, this it is the life blood of your future system. It will also replace all the expensive equipment we might otherwise have to buy to reduce nutrients and to prevent or combat the problems that would be encountered if trying to establish a reef tank without the live rock. I firmly believe that every dollar spent on live rock & live sand saves two or more during the life of the tank.

Shop around. Some suppliers provide lighter rock than others. All other things being equal, "Lightness" is a valuable characteristic. Not only does it indicate more desirable porosity, but it means you will receive a greater volume for your money. Some suppliers will also negotiate prices some if you contact them directly.

Prepare Live Rock, Rubble Rock, and Live Sand

There is little to do to prepare these items if you ordered from a reputable supplier that ships the items in water. It is important that you make plans so you can do the preparation immediately upon receipt. Each supplier will provide instructions for preparing and acclimating the new items. Follow their instructions carefully and start the task a soon as you possibly can. I do try to pick macroalgae and plant life off of the rock. They will become pests if they don't die off. In case the instruction do not include it, preparation should always include a bath in high salinity (1.033 or 43-44 ppt) saltwater. This causes the many of the critters hiding inside the rock to emerge. The pests can then be removed and good hitchhikers can be added to the tank. Tweezers and gloves are a good idea for this step. Swishing the rock around in the high salinity water helps also.

The next weeks are used to establish some life in the reef. This is the start of the life cycle of the tank. From here, the tank will progress toward maturity.

Aquascape the display tank with prepared live rock

The prepared live rock is the first strategic addition of life. It harbors organisms that are net nutrient users and also provides a source to populate the system with nitrifying and denitrifying bacteria.

The tank is bare bottom. The live sand we purchased is not the pure white aragonite sand we normally see in the bottom of reef tanks. It is more like shell and coral chips and pebbles and has a pinkish-brown tint. We'll keep the sand in the refugium and leave the display tank bottom bare.

Stop all pumps. Stack & secure the Live Rock in the display tank to aquascape to your liking. Don't get crazy with the aquascape though. Remember, this is base rock that is intended as a landing spot for future premium live rock and corals. Avoid trying to make intricate rock work. Remember, if you do your job correctly, the rocks will be covered in corals anyway. Creating some larger islands or outcroppings that have some height and maybe a cave and others that are small and low seems to work best. Beware of potential avalanches. Secure the rock with epoxy putty & super glue if possible. It won't hurt the rock at all if it sits out of water for a few minutes. Use this time to secure the rocks together enough to make them stable. Consider placing the islands and outcroppings away from the glass all the way around so that you can get to all the surfaces easily. You will have to drain a little water from the system as you add rock & sand. Save a little to add back when you start the skimmer. Do not mix in dry rock to enhance the aquascape. It will just provide sterile substrate that might provide a foothold for undesirable organisms.

REMEMBER: The live rock does not have to all go in the display tank. We spent good money on a decent sized Refugium. Use it. It is really more advisable to put a lot of live rock in the refugium and overflow partitions rather than stacking too much in the display tank.

Populate the refugium with the live sand, live rubble rock, and any live rock that would not fit in the display tank.

No light is used for this refugium. This is referred to as a Cryptic refugium. It encourages things like sponges, bivalves, tube worms, arthropods, and copepods to grow. These organisms contribute greatly to nutrient processing pathways and the food web. In addition, the darkness discourages algae and other undesirable organisms from growing in the sump.

If Durso or other types of overflow plumbing are used, there may be some space at the bottom of the overflow partition(s) that can serve a part of the refugium in this system. Drop some live rock rubble in the bottom of them and cover them to block light. Don't add a lot of rock, just enough to promote some growth the overflow area. This creates more cryptic zones in the system.

Once everything is in place, let the water clear before starting the return pump and slowly bring up the circulation pumps to a moderately slow speed. No additional flow is need in this kind of refugium. Yes, stuff will settle out in this space. That is intentional. The live rock and sand will contain creatures and organisms that will use this as a food source and the resulting carbon and inorganic nutrients will provide food for the rest of the food web.

Start the skimmer. Starting the skimmer at this point helps manage any excess organics that might otherwise build up from the newly added rock. It may take a while to stabilize the skimmer. It may create some microbubbles for a while. It might also do nothing. Either is ok for now. Both issues will resolve themselves. The goal is to get the skimmer running so it can operate as needed.

Set the water level at the intersection of the skimmer's neck and the bottom of the collection cup. You can adjust that level as needed over time to produce a moderately wet, foam that then breaks down into a thick, dark liquid.

A word about the skimmer in this process… As the balance of nutrient users and producers change, the need for skimming changes. Skimmers work by removing SOME organics from the water column. When the balance is tilted toward nutrient users, more organics need to be available so less skimming is needed. If the balance is tilted the other way, there will be an excess of organics in the water column and more skimming is needed. In this process, the skimmer is not the primary provision for managing dissolved organic compounds. It simply provides some export to establish an additional, and somewhat controllable, nutrient pathway.

You may find that you don't want to run the skimmer all the time once the tank is mature. In that case you can put it on a timer. To do this, it is important to have a skimmer that maintains its level adjustment when being cycled on and off. External, recirculating skimmers seem to be return to a preset level than internal models. I've discovered is that an external skimmer can fit in the skimmer bay of most sumps with little modification. This provides protection from overflow.

Turn on the display tank lights. There is no need to start with high intensity lighting right now. If possible, set intensity level just high enough to encourage Coralline Algae growth in the display tank. Run the lights for about 8 hours per day for now. If possible, run only the blue portion of the lights and set the lights to ramp up and down over the time period selected. These steps will discourage microalgae growth while the tank stabilizes.

Check the live rock and sand for pests. Take some time to check out the live rock. While undesirable hitchhikers should not be a big problem, removing any you can find now is better than waiting until they reproduce and become a problem. Look at the rock at night with a red light. Identify the critters you see moving around. Remove the ones that might be harmful. There is a lot of good information on the internet to help you identify these critters, determine if they are undesirable, and how to trap, kill, or otherwise remove them. Do not use any potions or chemicals to rid the tank of creatures you find. If you can't remove or trap them, we'll add critters to deal with them later.

Add some hearty, nonaggressive fish. Cardinals and Dartfish are good candidates for this addition. Unless you intend to have an aggressive tank, avoid Damsels and Clownfish for now. I know, Clownfish are very desirable. You need to wait though. They are just too aggressive and territorial to be the first fish in the tank. Please note that we are not "Cycling" the tank with these fish. Ammonia will not rise when that are introduced.

So, why is ammonia not a problem at this stage? The live rock in the system has more than enough nitrifying and denitrifying bacteria to support a fair number of nutrient producers (fish and invertebrates), as well as that generated by die off in the live rock itself. However, let's keep it reasonable. The goal here is to provide some ammonia input to start nutrient processing pathways but not to provide so much that nitrates start to rise too quickly.

Feed lightly and only once per day for a week or so. While I wouldn't expect you to count them, target about 5 or 6 Mysis or Brine Shrimp for each fish per day. This provides a controlled input of ammonia to

feed organisms in the live rock and spur more bacterial growth. Increase feeding after about a week. Avoid flake and pellet food for now to limit phosphate levels.

A word about quarantining fish and reducing pathogens… There are many valid arguments on both sides of this subject. I know of hobbyists that have successful tanks without ever quarantining a fish and others who have wiped out whole tanks because they didn't quarantine one fish. I've also lost a lot of fish in the quarantine process and still had fish get sick and die after being quarantined.

Personally, I prefer to purchase quarantined fish from trusted vendors and put them directly in the tank. You can find these suppliers on the internet. It does cost a little more and takes time to receive your order. Some preplanning is required.

I will not say that I think that the suppliers' quarantine processes ensure you get fish that are completely free of pathogens. I do think that the time period required for their quarantine process helps ensure that, among other things, the fish is acclimated to captivity, eating, and were not somehow injured in capture.

The fish that survive the quarantine process time period are not likely to die when exposed to pathogens when they are in an established, stable environment. I don't think this is an immunity issue though. I believe these fishes are healthy enough to survive the exposure until other organisms in the system reduce the pathogens to tolerable levels.

Once again, the creatures and organisms we added with the introduction of the live rock will help in that regard. Tiny filter feeders capture bacteria and the free-swimming stage of parasites. This decreases the potential for pathogens to reproduce to a point where they can overwhelm even healthy fish and cause an outbreak to occur. The premium live rock, corals, and clams we add later will further reduce the population of pathogens.

Diatoms: Diatoms will probably pop up in the next week or two. They are easy to wipe off. The phase will pass quickly.

MILESTONE 2: At this point, we have established the basic building blocks of the nutrient pathways and started some nutrient input. There is live rock, rubble rock, and live sand in the system, the skimmer is running, the lights are on at low levels, and there are healthy fish in the system. Diatoms may have popped up, are still present, but are no longer an issue.

PHASE 3: ESTABLISH BASE NUTRIENT LEVELS and ADD MORE LIFE

If the prior steps have been performed correctly, nitrate and phosphate will probably not be detectible. The presence of a detectable level of nitrate and phosphate are needed to ensure the processes we are trying to establish are not restricted. They also deter some very undesirable microbes. Eventually, the tank's inhabitants will provide them for us, but it may take a while. Until then, we'll have to add them directly.

Start testing to determine nitrate and phosphate levels. The nitrate level target is about 5 to 10 ppm. Add Sodium Nitrate stock solution to bring nitrate into range. The phosphate level target is about .03 to .05 ppm. Add Trisodium Phosphate stock solution to bring phosphate into range. Don't read this as any

sort of “magic number” or “magic ratio” of nitrogen to phosphate. As long as there are detectable levels of each, and nitrates are higher than phosphates, all is good. You may find that it is initially hard too raise phosphate. This might be due some binding to the substrate. Don’t sweat this issue. Simply add enough to raise and maintain the phosphate level near the target.

You can buy these solutions at your local pet store. They are rather dilute and expensive. DIY solutions are easy to make and inexpensive. Recipes can be found on the internet. There are calculators on the internet that tell you how much to add, but I prefer to add nitrate and phosphate solutions a little at a time and wait at least an hour before retesting.

If you find that nutrient levels are elevated above the target level, simply note it and continue. Additional provisions will quickly be added help control these levels.

Add More Life. This step adds more nutrient users in preparation for the nutrient producers soon to be added.

Add some “Premium Live Rock”. Now that the system can support it, adding premium live rock with most of its accompanying life is an excellent way to increase diversity. Pull of plants and debris and prepare the rock per the suppliers’ directions. Place the rock directly in the refugium, and don’t forget to place the rubble from the shipping boxes in the overflow partition. You can put the premium rock in the display tank, but you will sacrifice some of the cryptic sponges and other life that are light sensitive or prone to being eaten by the tank’s inhabitants.

Let’s talk about quarantining or dipping corals. Regardless where we purchase our corals, we should assume they, or the substrate that they are mounted to, carry pests. We’ll add some critters to help control these pests later, but it would be best to keep them out of our tank altogether. Some quarantine corals just like fish. I also remove frag plugs when I can. These often carry pests even when the corals themselves don’t. I think “dipping” corals prior to putting them in the tank sufficient. This involves placing the corals in a bath containing substances toxic to their pests just prior to placing them in the tank. There are many products that work just fine for this process. Instructions for dipping corals are available on the internet, and the process is easy to perform.

Add some soft corals like Toadstools, Leathers, and Zoanthids in the display tank. These are nutrient reducing organisms. They can be added all at once. Have a ball! Remember though, you’ll be adding the cool stuff later and these types of corals can grow ad spread. Consider where you want those to be placed. This is generally low in the water column, and in the corners and back of the tank.

Increase display tank lights. The corals you have added are photosynthetic but don’t require a lot of light. They may require more than your initial setting. Raise the lights a little at a time to the point that corals respond positively. Increase the lighting to 12 hours. If pest algae or bacteria starts to show up, reduce the light accordingly. Using only the blue end of the lighting’s spectrum will reduce the likelihood of encouraging algae while supporting coral well.

Add more fish and increase feeding. These are nutrient producing organisms. At this point, try to add fish that that also serve to eat algae, detritus, or corals pests.

Here are a few fish to consider adding.

1. Blue Sapphire Damsels (Springeri, Springers) - These guys eat common SPS Coral Pest, aren't bad looking, and are fairly nonaggressive. Adding roughly 1 per 50 gallons works well.
2. Lawnmower or Eyelash Blenny – This fish eats gobs of detritus and algae – One per tank.
3. Flasher and Fairy Wrasses – These guys eat Bristle Worms and other pests, don't require a sand bed, and are not as likely to bother clean-up crew members as the larger Wrasses.
4. Bristletooth Tangs - These are great algae pickers.

There are other fish that can help with pests, but may also pick on corals or other beneficial invertebrates. You should consider the potential downside before putting them in the tank. These include Wrasses in the Halichoeres family like Melanurus and Coris Wrasses. Rabbitfish, Filefish, most Butterflyfish, and Dwarf Angelfish will all graze on things we don't want then to bother. I would say there is one exception to this recommendation… Copperband Butterflies can do well in reef tanks, look great, and can help with pests like Aiptasia Anemones. They are sensitive, picky eaters, are hard to acclimate to captivity, and may pick at some corals just a little. I always have one in my tanks though. Finally, Hawkfish will probably eat any shrimp you might want to put in the tank and then sit on a rock and stare at you as if to ask "Is that all".

Introduce a Clean-up Crew. In addition to the creatures that came with the live rock and sand, adding snails and crabs can help to keep a lid on algae and other pests, but avoid those that get large. I like Trochus Snails to help with algae, an Emerald Crab or two to pick off Bubble Algae, and a few Bumble Bee snails will guard against Vermetid snails.

I would also add some Peppermint Shrimp at this point. They munch of pest anemones that might pop up in the live rock, for the most part don't bother anything else, and will eat other food when the anemones are not present. Get them from a reputable supplier to ensure you get the ones that actually eat the pesky anemones. Several different species are available that look very much alike but only a couple actually do the job. These guys will do the job all by themselves or simply hold the fort until we put in a Copperband Butterfly later in the process.

The one thing to remember is that the clean-up crew only helps. The reefer is the best clean-up crew member.

Begin Dosing an Organic Carbon Rich Source.

First, let's differentiate "Organic Carbon" from "Inorganic Carbon". It is a pretty simple thing…

Inorganic carbon is mined or extracted from substances taken from the earth. Think of things like coal and oil and the products that are produced from them like gasoline and even the Granulated Activated Carbon we use in our filtration.

Organic Carbon is produced by living organisms. It is part of the DNA that defines every organism in the system. It makes up all living tissues, and is present in carbohydrates, fats, alcohols, acids, sugar, and a host of byproducts of the biological processes that occurs in the nutrient pathways and food web. It is a component of the food we feed. In one form or another, it is food for everything in the system. Organic carbon is very important.

Reef tank systems are generally low in available organic carbon because its input is limited to the food we feed and the output of the photosynthesis process. Additionally, the organisms populate the system to use all that is available. We increased feeding in the last step to provide more organic carbon. However, there is a limit to how much food, with all of the nutrients it contains, can be added.

Adding a carbon source is intended to provide extra carbon to the system without adding additional nutrients. The free carbon encourages the growth of bacteria that then become food for, and provide carbon and nutrients to, other organisms in the system. This provides another nutrient pathway and becomes part of the food web.

We will use household white vinegar (5% acetic acid) for our carbon source. It is inexpensive, easy to obtain, a weaker carbon source than others so its exact dosage is less critical, and for some reason, it seems to be less likely to encourage Cyanobacteria.

It is possible to dose too much of the carbon source. Adding too much carbon too quickly will encourage unwanted organisms, particularly Cyanobacteria. Overdosing the carbon source will cause bacterial blooms that will cloud the water, result in slimy mats of bacterial mulm, and most importantly, rob dissolved oxygen from the water. We will start low and go slow to ensure this doesn't happen.

The bacteria that use the carbon we add also use nitrate in their growth process. This provides us with a way to measure how much carbon to use. We'll watch nitrate levels and reduce the carbon dose when nitrate begins to fall faster than normal. Also, there must be detectible phosphate in the system for this process to work.

Dose 1.5 ml per 10 gallons per day to start. Increase the dose by 1.5 ml per 10 gallons per day each week until nitrate starts to fall during your weekly testing. At that point, cut the dose in half. This is the maintenance dose that will be administered daily. Remember that you are also probably adding nitrate solutions to keep nitrates at a certain level. The change we are looking for here could also be that you have to start adding more of the solution to maintain your target level.

Watch for cloudy water or a clear to pinkish slim building up on hard surfaces near the water's surface. These conditions are mostly harmless, but are indicators of overdosing of the carbon source. Reduce the dose by half until the conditions resolve themselves. After that, start raising the dose and continue as above.

The pH of this acid solution is low. Dosing the daily quantity in small increments ensures you don't drop the pH of the system. It is possible to dose this solution manually. However, it is wiser to set up a dosing pump to do the job. Set one of the dosing pumps to deliver the established dose spread out throughout the lighted portion of the day. We choose the lighted portion of the day because the carbon dosing process uses some oxygen that is in excess during that time period.

As organisms are added or they increase in population, imbalances between nutrient users and producers will occur. This may drive nitrate and phosphate levels up. Since carbon dosing reduces nutrients, we could be tempted to use the carbon dosing to control the rise. As a matter of fact, this was the original goal of the process when it was developed. This is not the intention of the carbon dosing activity for us though. Additional vinegar added to the system will negatively impact it in the long term. We'll talk about balancing nutrient users and producers and how to cope with rising nutrient levels later. In the meantime, let's keep our dose of vinegar at the established level.

Cyanobacteria and hair algae will probably start making an appearance.

While we have done all we can to prevent it, these pests will pop up from time to time. You'll see them in small spots on the sand or rocks. We've made is very hard for them to get a foothold or spread rapidly, but they will try. This is where another rule comes into play…

Chemical products advertised to solve problems simply don't work.

These products: 1) Do not work; 2) Solve one problem but affect a nutrient pathway that causes other problems; or 3) Simply cover up the symptoms until the actual problem gets bad enough to cause something worse to happen.

Don't panic when these pests show up. The system will keep them from getting out of control. This is where things often go wrong. We start to see small outbreaks of these pest organisms. In our panic, we start adding all sorts of filter media and magic elixirs that are advertised to stop the growth of these pests. This action interrupts the nutrient pathways and slows or even stops the progress of the system. This unintentionally gives the pests more opportunity to grow. We try something else to stop the pest organisms' progress and things get worse. The cycle continues and the tank starts to fail. Vigilance and elbow grease should be the only things required to keep pest organisms from getting out of hand when the system is young. Quickly dispatch pests with stiff brushes, a little vacuuming, and slowing growth by temporarily reducing light. A toothbrush, one made for dentures, a set of stiff bristled bottle brushes, a Turkey Baster, and a small siphon type vacuum will be your best friends in this phase.

MILESTONE 3: Fish and corals are doing well in the display tank; Refugiums and Overflow Partitions have live rock rubble in them; Nitrates and Phosphate levels are roughly in target range; Some clean-up crew members have been added; a maintenance level of a carbon source is being dosed, and while not problematic, removal of a little Cyanobacteria or algae is required from time to time.

PHASE 4: START MAINTAINING the SYSTEM

From here out, we are required to perform all sorts of tasks for maintenance purposes. I like to think about the performance of these tasks as a whole as "maintaining stability". In addition to establishing mature nutrient processing pathways and food webs, stability is required to create an amazing tank. Stability applies to everything that comprises the environment that supports the tank's organisms: organic and inorganic nutrient levels; water chemistry i.e. salinity, alkalinity, calcium, and magnesium levels; light intensity and duration; temperature; water flow direction and duration; and food availability.

MAINTAINING THE SYSTEM IS THE HOBBY. I'll even venture to say that successful reefers like doing maintenance. No matter how well we have set up our system, it will fail unless you maintain it. Here a possible maintenance schedule.

DAILY MAINTENANCE

- Feed small portions of varying high protein, low phosphate foods. Small quantities fed a few times a day are better.
  - Fresh or frozen foods are a great choice
  - Fresh, live clams provide some gut bacteria as well as a high protein source
  - Frozen Shrimp, Clams Squid, Mysis and Spirulina loaded Brine Shrimp are great staples
  - Nori based foods are great for Tangs and other herbivores
  - Flakes, pellets, or other dried or prepared foods can be used sparingly when necessary
    - Nori and Flakes are usually lower in protein but have high phosphate levels
    - While not normally desired, they can be used where low phosphate is an issue
- Observe the system
  - Check operation of equipment and make necessary adjustments or repairs
  - Observe condition of fish and corals
  - Look for and immediately dispatch pest algae and bacterial outbreaks and other pests like Vermetid snails and Aiptasia anemones.
- Check Sump Level & REPAIR/ADJUST AUTOMATIC TOP SYSTEM AS NEEDED

TWO to THREE TIMES PER WEEK

- Clean glass
  - It is normal for a green or brown film to develop on the glass that has to be cleaned every few days. Simply wipe it off. An inexpensive "MAG FLOAT" is a great device for removing this film.
- Target feed as needed
  - Only target feed corals that need it. Most corals are photosynthetic and don't need to be fed. Overfeeding is common when trying to target feed so be careful.
- Dump/clean skimmer cup

WEEKLY

- Blow detritus and excess biofilm from rocks with a Turkey Baster or power head
- Carefully scrub problems areas with an appropriate brush.
- **ADD DIY "CORAL SNOW" SOLUTION**
  This homemade solution clears the water and deters Cyanobacteria. It binds and removes excess organic matter that might encourage it. It also helps establish other strains of heterotrophic bacteria on the systems surfaces that are not already coated with another bacteria or Coralline algae.
  - This is a solution of 10 TBSP of calcium carbonate powder and 900 ml of RODI water that is prepared earlier and stored until needed.

        - This solution acts as a "Flocculant". It binds with organic matter. It is then be removed by filter socks and skimmer.
    - Mix 20 ml of this solution with 5 ml of Brightwell's MicroBacter 7 (or similar) per 50 gallons and allow to rest for about 5 minutes. For example a 100 gallon system would get a dose of 40ml of the calcium carbonate solution mixed with 10 ml of Microbacter 7.
        - MicroBacter7 is a product that I believe contains heterotrophic bacteria that digest organic matter. There are other products that perform the same function that could be substituted.
    - Stop all pumps and add the Calcium Carbonate/MicroBacter 7 mixture
        - The water will be noticeably cloudy
    - After one hour, start all the pumps except the return pump.
    - After another hour, start the return pump.
        - The water will clear in a couple of hours.

The calcium carbonate powder solution can be used by itself to create super clear water anytime you are not happy with the tank's water clarity. It is hard to overdose this product. Only mix in the MicroBacter 7 once per week though.

- Do 15% water change
    - These water changes are intended to <u>help</u> keep the water chemistry from changing too quickly.
        - Removes <u>some</u> organic compounds that aren't removed by the skimmer.
            - These are excess because they aren't being used by the nutrient processing pathways
        - Removes <u>some</u> built up ions.
        - Helps replenish minor trace elements.
- Test Salinity
    - Adjust as necessary
- Test Nitrate and Phosphate
    - Add Stock solutions to adjust if readings are lower than target,
        - The goal is to establish a balance of nutrient producers, nutrient users, and nutrient input so that they don't have to be added. We also have to do this without driving nutrients high enough to cause problems. If you have to add nutrients using the stock solutions it is time to feed more and/or add more nutrient producers. If nutrients levels are rising or already higher than desired, add more nutrient users and/or reduce feeding. In some systems, the processes work well enough that there is always a need to add a little of the stock solutions to be added.

      Note: When seeking to add extra nutrients by feeding, adequate of nutrient users must be present to break the food down to its base nutrients in a manner that maintains the current nutrient pathways. Food fed in excess of that will simply decompose and add nutrients and dissolved organic carbon that might not be addressed adequately current nutrient processing pathways.

- Test Alkalinity, Calcium, and Magnesium
    - When Coralline Algae starts to grow, these levels may start to drop.
    - We'll add solutions to maintain their levels until a little later when we will automate the task. These solutions are available commercially or can be mixed from simple products or chemicals. Recipes and instructions are available on the internet.

- Check the ATO storage vessel and fill when needed. You will learn how often the vessel need filling and won't have to check it so often.
- Check and clean skimmer and system pumps as needed
- Wipe off/clean the ATO water level sensor

MILESTONE 4: The system's parameters are stable, a maintenance schedule has been established, plans, equipment, and supplies are in place so that the schedule can be followed and maintenance can be performed on time and effectively.

PHASE 5: EXPAND FOOD WEB and NUTRIENT PATHWAYS

Establishing a sustainable food web and increasing nutrient pathways in the system is very important to its maturity process. We have established some of the basic building blocks. Now we need to add a little more diversity to close the loop.

Add more life to the Refugium(s) and Display Tank. Note: The Refugium(s) are "Cryptic". No lighting is necessary. Sponges, tube worms, and other Cryptic life perform the function of binding and re-mineralizing nutrients and adding particulate organic material to the food web. The display tank develops cryptic zones under the rocks and in the rocks' nooks and crannies. These places are a great place for Copepods and Arthropods to grow and propagate. Some are likely already present.

Start adding "Bugs". Add live Copepods and Arthropods to the Refugium and display tank. This will establish more diverse colonies that serve multiple purposes. They munch on microalgae and detritus and are a thread in the food web. These organisms are available via the internet. Be advised, you will be disappointed when you receive these products. There does not appear to be a lot of life in the packages. There is more than it appears though. They multiply quickly. The goal is just to seed them in the system. Simply turn off all the pumps and add them to the refugium(s). Give them an hour or so to find a home and then turn the pumps back on.

Start adding Phytoplankton. Live is best. If necessary, freeze-dried will do. This performs two functions. It feeds copepods, clams and some corals and, if live, binds inorganic nitrate and phosphate for export or binding in other organisms' tissues. It may also provide some additional organic carbon input. Add it by hand, two or three times per week. If you miss a day every once in a while, it is no big deal. Don't add more to make up for missed doses.

CAUTION: Whether culturing live phytoplankton, purchasing it, or using freeze dried, start with small amounts and ramp the amount added to the tank slowly. Quantities required depend on phytoplankton density and users in the system. The goal is to feed just enough that all of that added is either consumed or exported by the skimmer. Excessive amounts can drive organic carbon levels too high and make the system vulnerable to pest bacteria. It can also drive phosphate levels up due to the fertilizer used for its culturing.

Add more corals and a Clam if tests are in range. Add more soft corals, LPS, or possibly an easy to keep SPS coral, like Montipora species, to add more nutrient users and to check the system to see if it will support more sensitive corals. Clams are a great addition. They can filter fine particulate organic matter and help balance nutrients.

MILESTONE 5: The tank is now well established. It already has a fish population and quite a few corals. It is stable, but still somewhat immature. It still needs a lot of input from you. You are testing weekly for nitrate and phosphate and possibly adding nitrate and phosphate stock solutions. Nitrate and phosphate are being maintained in range. You are testing weekly for alkalinity, calcium, and magnesium and may be adding solutions to maintain their levels. You are adding some form of phytoplankton. Coralline algae growth is visible and pest algae, while possibly still present, is not a struggle to keep in check. You are likely cleaning the glass every few days.

At this point, the game changes. Now we are stocking the reef in a way that maintains the balance of net nutrient users and producers and nutrient input. You will also start supplementing water chemistry to account for the demand created by these new occupants. Always consider adding groups of corals and other net nutrient users and allow them to get established prior to adding new fish. All this must be done while managing water chemistry to meet the increased demand.

PHASE 6: STOCK and MANAGE the SYSTEM

Increase fish feeding. Feeding on the heavy side is a key to maintaining this system. The intent of feeding fish heavily is to increase ammonia and dissolved organic carbon production required to satisfy the needs of the organisms in the system.

Monitor the tank for lack of organic carbon. As you stock the system, you may find that the system is begging for more organic carbon input. This condition is indicated by a lack of film growing on the glass, a reduction in skimmer output, less than normal polyp extension/expansion for soft and LPS corals, and/or lack of color of SPS corals.

When these conditions are noted, proceed carefully. If you can, simply add more nutrient producers and increase feedings. If that isn't possible, carefully add amino acids, proteins, carbohydrates, or etc. to provide the organic carbon the system needs. Carefully dose these by hand when needed. I prefer to use Red Sea's Reef Energy AB+ solution. These substances are carbon rich and can be easily overdosed. Watch for rapid film growth on glass, cloudy water or slime caused by bacterial blooms, Cyanobacteria to pop up, or nutrient level trends to change. Like phytoplankton, this is a start low and increase slowly situation.

Start Managing Major Elements - Calcium, Alkalinity, and Magnesium

A word about alkalinity… We have established a low nutrient system. Hard corals, and other organisms that grow using a calcification process, seem to respond better when the alkalinity level is maintained at the lower end of the acceptable range. For this process an alkalinity of 7 to 9 dKh is preferrable. The exact number within this range is not important. It is important that the level is very stable.

Warning: Changing alkalinity more than .5 dKh per day should be avoided once sensitive corals are in the system. In addition, allowing alkalinity to swing up and down within the acceptable range will harm them. Try to establish a level that is stable within .1 or .2 dKh per day. Calcium and magnesium levels can be raised faster, but still controlled to keep it reasonably stable.

Demand for calcium, magnesium and carbonate (alkalinity) will build quickly from this point forward. It is best to install the equipment now to ensure its function is available as the demand increases. It also allows for the learning curve associated with operating the system.

A relatively new method of efficiently adding these elements has emerged. It uses a Tropic Marin product called "All for Reef". This product adds balanced amounts of calcium, alkalinity, and magnesium, as well as some valuable trace elements using just one solution. A measured amount of the solution is added daily to keep alkalinity in the desired range. The calcium, magnesium, and trace element levels should stay fairly stable. Don't expect this product to work without monitoring and occasional adjustment of one or more of the parameters.

Testing calcium, alkalinity and magnesium will still be required as part of weekly maintenance. Before you start using the All for Reef product, you will need to establish acceptable calcium, alkalinity, and magnesium levels. So, grab some test kits and get your parameters in the following ranges:

1. Alkalinity – 7 to 9 dKh;
2. Calcium – 400 to 450 ppm; and
3. Magnesium – 1300 to 1350 ppm.

Once the parameters are established, start adding the All for Reef product per the manufacturer's directions. It will take a while to get the dosage correct for the current conditions. You won't need much at first as most of the demand is simply the Coralline growth. You will have to make adjustments as demand increases. Weekly testing will tell you when it is time to make an adjustment.

Adding the product manually is possible, but spreading the dose over a 24 hour period helps maintain stability. A 2nd dosing pump for this task is a good idea.

Weekly maintenance will now involve testing the parameters above, using the calcium, alkalinity, and magnesium solutions to reestablish the proper ranges, and adjusting daily dosage of the All for Reef product to better maintain the levels.

Let's talk about pH… I don't test for pH, but I know you will at some point. This parameter is a function of the available carbon dioxide in the atmosphere around the display tank and the alkalinity of the water in it. The pH changes depending on how carbon dioxide is being used by the photosynthesis process and, to a lesser extent, other processes. This makes the pH rise when the lights are on and fall when they are off. I would suggest that we not worry about pH levels as long as other parameters are in range the range of 7.8 to 8.4 and stable. I'd also suggest that your test method is flawed if you see a higher or lower number.

Add more life. This following process is repeated until the tank is stocked to your liking. Nutrient users or nutrient producers are also added to adjust nutrient testing trends. Feeding is increased accordingly.

Add a group of corals, clams, etc. (Net Nutrient Users) all at once. Add more sensitive SPS Coral Frags when tank becomes stable enough. Stability of salinity, temperature, alkalinity, flow, and light are critical for some SPS corals. These are the corals that will be the show stoppers of your tank. Spending money to buy high quality, larger sized, tank raised frags is recommended.

Add some more fish (Net Nutrient Producers). Add these on a steady basis. Add in small increments depending on size. Add maybe one bigger fish or a few smaller ones.

Take a fresh look at your water change schedule. At this point, water changes can be reduced and performed less frequently. You will get a feel for when to do small water changes as you progress. Until then, I'd shoot for an average of 5-10% per week.

MILESTONE 6: There are a lot of fish, corals, and maybe some clams in the tank; corals are growing; pest organisms are almost nonexistent; cleaning the glass is required but not a big job; inorganic nitrate and phosphate are stable at low but detectible levels; and Coralline is growing and is kind of becoming a pain in the butt. You are dosing phytoplankton, All-for-Reef, adjusting alkalinity, calcium, and magnesium, and possibly nitrate or phosphate with stock solutions. Copepods, tube worms, sponges, and other life is evident in the display tank, refugium, and overflow weirs. You are maintaining stable alkalinity, calcium, and magnesium levels. You are dosing small amounts of organic carbon and may be adding small amounts of a carbon rich product.

At this point, I think we can consider the system to be established. Congratulations. Now you just need to continue to manage the nutrient pathways, food web, and water chemistry to ensure everything continues to thrive as the tank matures and you add even more life.

This system is set up to maintain a very dense population of corals and fish. It will always require great care and disciplined maintenance practices, but you will be able to enjoy a healthy, colorful, fast growing reef that is full of heathy fish for a very, very long time.

You will now need to learn how to prune or "Frag" corals to keep them from getting out of hand, and how to supplement your reef expenses by selling the excess growth to your reef buddies.