**Sunbeam Learnings**

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**SOP for Weekly Water Testing**

1. Sample collection by each section. Collect 3 from anyof the tanks under their section. If mixed fish - only under the same species like cichlids and lilys.
2. Perform in-situ and ex-situ tests.
3. Record results on water testing form.

**Theory on Weekly Water Testing**

Purpose of water testing and collection is to ensure optimal water condition for the fishes. We are to perform our husbandry well as to indicate that we have done our part. So whenever there is a complaint, we can always use the record keeping as a guide and safety line to note any mistakes that could have been made.

**SOP for Weekly RAS Water Testing**

1. Water samples will be collected once every week.
2. To be collected from eg row 91 & 92, 1 cup.
3. Once collected, gown PPE - Gloves and goggles.
4. Perform necessary Tests - In-situ. Salinity, TDS, pH, Temperature, DO.
5. Followed by Ex-situ. GH, KH, NH4+NH3, NO3, NO2.
6. Once completed, record down on the weekly water quality record form which will be documented.
7. If results are in the range from 5-5-6.7 based on our husbandry, it is good.
8. However if they are not, corrective action will be we will monitor and change water in % accordingly like increasing water content to dilute or add sodium bicarbonate.
9. Perform housekeeping.

**Theory on Weekly RAS Water Testing**

RAS stands for Recirculating Aquaculture System. The purpose of water testing and collection is to ensure optimal water conditions. Our husbandry is to be at peak condition so whenever there is a complaint, there may be no worries on our side as we had to check thoroughly. This system is almost similar to the function of a hydroponics system however they go through a semi-permeable membrane that can filter out and chemically react in the pump chamber, allowing it to produce new fresh water. The RAS system is connected in two rows with 1 RAS membrane. All water will be recycled. The feces produced by fishes that reside on the bottom of the partitioned glass side will naturally flow down and back to the ras system to be filtered and cleaned through a semipermeable membrane and then recycled back to all the tanks.

Some setback of using RAS is that once one tank is contaminated, the potential of introducing the same type of danger to other tanks is highly likely. Hence, species like the lily are not able to use the RAS system due to the high frequent water change and unstable salt concentration that they need as well as they carry high amounts of viruses. Water change frequency depends on ammonia products hence lily’s only twice a week as not high protein = less ammonia. For  Koi fish, 3  times as they produce more protein.

1. We will perform the test to see if it may affect the new shipment drastically. Reason being is that RAS is a connected system hence if water is not good, it will affect the new arrival of fishes.
2. Proper PPE is a must as it is part of the safety protocol.
3. Test is to perform as part of an indication to note our performance in husbandry. We are to prevent any unwanted incidents that can cause fatality to the fishes.
4. In-situ and Ex-situ is only a term used to identify whether it is a test via chemical reaction or water parameters.
5. Record keeping
6. NIL
7. This is a protocol we must follow and monitor closely to prevent any death of fishes. Medicine may be used to raise effectiveness. Active ingredients would be Malachite Green and Formaldehyde.
8. NIL

**SOP for In-situ Tests**

1. Using the water parameter, open the cover and remove the pH buffer from the device and screw a reading cage onto the reader.
2. Rinse the reader with water and switch on.
3. Soak it into the sample and press ‘measure’
4. Wait for about 4-5mins for the reading to stabilise then record down the results.
5. Once done, rinse with water and place it into the sample (if any) and remove the reading cage and place the cover back and perform the necessary housekeeping.

|  |  |
| --- | --- |
| **Type of Test** | **Unit** |
| Total Dissolved Solids | parts per million (ppm) |
| Dissolved Oxygen | parts per million (ppm) |
| Salinity | part per thousand (ppt) |
| Temperature | Degree Celsius |
| pH | No unit measurement |

**SOP for Ex-situ Tests**

1. Ammonia - Rinse the sample cell and pour 5ml of sample into the cell.
2. Add the reagent 6 times using the 3 reagents given. Swirl and wait for 5 mins for the reaction to complete.
3. Using the reference chart, match the correct colour and record the concentration of the colour.

1. Nitrate - Rinse the sample cell and pour 10ml of sample into the cell.
2. Add the reagent 6 times using the 2 reagents given in order. Pour 1 full scoop of the dry chemical reagent and shake till most of it has been dissolved. Drop the last reagent 6 times.
3. Swirl and wait for 5 mins for the reaction to complete.
4. Using the reference chart, match the correct colour and record the concentration of the colour.

1. Nitrite - Rinse the sample cell and pour 5ml of sample into the cell.
2. Add the reagent 5 times using the 2 reagents given. Swirl and wait for 5 mins for the reaction to complete.
3. Using the reference chart, match the correct colour and record the concentration of the colour.

1. KH - Rinse the sample cell and pour 5ml of sample into the cell.
2. Add the reagent till colour change is seen. Final colour should be yellowish-orange.
3. Record the amount of times reagent has dropped.

1. GH - Rinse the sample cell and pour 5ml of sample into the cell.
2. Add the reagent till colour change is seen. Final colour should be yellowish-green.
3. Record the amount of times reagent has dropped.

|  |  |
| --- | --- |
| **Type of Test** | **Units** |
| Ammonia | mg/L |
| Nitrate | mg/L |
| Nitrite | mg/L |
| KH | mg/L |
| GH | degree of General Hardness (dGH) |

**Theory on various tests**

Tests are performed to ensure husbandry are at optimal standard and not to have any mishaps and incidents happening to the fishes.

Total Dissolved Solids are performed to ensure that fishes are healthy and at optimal growth. For freshwater fishes, they are prone to fatal death as the dissolved solids are a prime cause as it would affect the stock density in the fish tanks. High TDS can cause an overgrowth of algae and how this works is since algae requires carbon dioxide, the production of algae increases which will then increase in alkalinity through the bicarbonate ions in water. A stable TDS level would be 350ppm - 400pm.

Henceforth, we introduce a water system that can aid in filtering the materials that cause such obstacles, the protein skimmer. The buildup of ammonia products and other bio wastes is collected through the filter to filter out the proteins. Clean water is then produced. Fresh and aquatic fishes normally do not produce as much as the seawater and marine fishes as not only does the fish increase protein products but from the water itself as its highly natural. We import seawater as we wish to receive most of its nutrients and try to keep it natural. If we were to recreate our own seawater, we would not be able to fully extort the full content and not only would it not be accurate, the cost production will be too high.

Testing of dissolved oxygen would be simply to indicate if there is enough aeration in the water. Since Singapore is a warm and humid country, warm water is not able to sustain high amounts of DO. Lack of oxygen would kill the fish through falling respiration and reduce good microbial activities in water however it varies from fish sizes. DO can also decrease overnight as when food is given in the afternoon and not consumed, the food will absorb the DO. Additionally, when aeration is introduced by the aerator, low production of oxygen is taken as plants would not be able to photosynthesise to produce the required amount of oxygen due to the lack of sunlight. Aerators are where pump natural air from the outside into the water through a gas inlet.

Two types of aeration can be found in the tank. A much smaller pore and one that is connected to the weighted sponge holder. These different pore sizes produce different pore air bubbles. The smaller the bubble, the better as it produces a more quantified amount, though covering less space, it has higher production of oxygen. Similar concept to a cube of sugar or broken sugar. Results will be faster from broken sugar as it dissolves faster.

Knowing how different fish react to different water properties, they are bound to be sensitive. For salinity, it differs as we categorise them under saltwater and seawater fishes. Lily’s are saltwater fishes and only require little amount whereas clown fishes are sea fishes. Salinity level is important as if there were to be out of the fish’s desired level, it can cause physical damage to their body. High salinity can also cause high stress and excrete mucus like liquid which is the hypotonic urine like humans to expel the excess. However, this case does not apply to marine fishes. Instead, they lose water and gain salt osmotic concentration to increase salt. A salinity level should be 35ppt.

Temperature wise is important, especially specific species. For example, shrimps at 23 degrees will be the most optimal range for their growth and this is  to prevent physical damage as they disintegrate easily with heat hence when collecting dead fishes, they will be noted as missing. Other fishes like Koi would be better under 24 degrees to reduce stress which can lower mucus produced by them and slows growth of other bacterias that are not needed. Low temperature can cause thermal stress behaviour which includes loss of equilibrium and sudden violent spasm. A cole shock that can slip the fish into coma when the central nervous system ceases to function.

pH is the most crucial part which can be quite dangerous to fishes. Not all fishes are adaptable and can result in death. Most fishes prefer a pH of 6-8. Measurement and monitoring of pH is difficult as a lot of factors fall on it like temperature, hardness of water, TDS and more. Gills, fins and tails are prone to temperature and pH. Hence, checking pH is important. If the water is too acidic, we can increase pH by dilution, however, the water change can inflict stress which is already stressful for the fishes as they are facing burns from the acidity of water. Instead, we use coral chips. These chips are made of calcium carbonate which acts as a buffer capacity to increase the pH.

Ammonia is the most common occurrence in a tank. The common test that is related to almost every other test. Ammonia is released from waste products of the fishes so when high density of fishes are found in a tank or when too much feed is given without proper diet, high ammonia levels will occur. When high ammonia levels are present, it can burn the fish's tail and when it is not treated, it can be chipped off causing more damage like lesions and abrasions to the tail, and in prolonged exposure, fatal death can take place by bacteria or fungus growing on it.

Additionally, fish waste breaks into nitrates which tend to lower pH. It burns with poison and choke and suffocate by the gills. All these result in an increase of respiration and stress in fish which can have a psychological effect on fish. Normally seawater would have a higher concentration of ammonia as more proteins are found than fresh water.

When an ammonia test is performed, it titrates the total concentration of TAN which means Total Ammonia Nitrogen. Hence, we will only be able to derive the concentration of ammonia through using the TAN calculator. To calculate, it needs reference to the amount of total ammonia, salinity, pH and temperature. TAN can also be inspected visually especially when there is an incoming shipment. Cloudy/Dark shade indicates high TAN. Possibility of this is caused by not fasting the fish for at least 2 days or late purchase order.

As many would have already known, nitrogen is very common and can be found in water. Nitrogen fixation will occur and produce the necessary reaction from nitrifying bacteria like nitrosomonas bacteria to form nitrite then denitrifying bacteria to form nitrobacter bacteria to form nitrate. To decrease the potential hazard of producing bad bacteria, we can introduce live rocks as they have bacterial properties that are beneficial and not just for aesthetics. They can culture good bacteria to mitigate the bad ones which can lower sickness in fish. This can create a good environment for the fishes to live in.

Nitrate has been found to be more toxic in salt water than in fresh water. It is reasonable to

assume that very high levels of nitrate cause stress and greater susceptibility to disease in marine aquariums since nitrate levels in the oceans are almost zero. Nitrite proves toxic because it breaks down the red blood cells and oxidises the iron in the haemoglobin into a stable state called methaemoglobin, which has no oxygen-carrying capacity. This process has the effect of turning the gills and blood brown.) The ability to convert methemoglobin back into haemoglobin determines how resistant a particular fish is to high nitrite levels.

Water hardness, generally referred to as analysis of water with part concerned on total dissolved salt content. KH refers to total hardness which relates well with TDS and water polarity. Temporary hardness is found as well and refers to total content of the major portion from calcium and magnesium salts. Hard water tends to have more salt than soft water. GH is the general hardness refers to total content of salts like hydroxides, bicarbonate and carbonates. KH and GH is generally to sit well with the environment to produce better growth.

Water hardness is dependent on alkalinity levels and amount of salt present. High salt content equates to hard water making non hard water fishes affected by it, resulting in decrease of blood calcium level however for hard water fishes have the ability to cope as they can excrete calcium hormone called calcitonin. Factors include osmosis pressure as non hard water fishes do not take in salt content very well. Hard water fish osmoregulatory systems can have reduced workload replacing ions from blood if in soft water.

**SOP for Dead Fish**

1. Collection of dead fish is to be done at the start of work - 9am
2. Use a reused plastic bag to collect the dead fish.
3. Label the bag with your section (F3) and date of collection.
4. Using the trolley used to push around, place the bag in an empty container.
5. Salt water and fish net should be soaked before every collection for a tank. Use the fish net to collect the dead fish.
6. Proceed to collect the dead fish. Lookout for any floating or sinked dead fish and place them in the labelled plastic.
7. Collect for section F3 - Row 45, 57-60, 92-98 and 111-114. Once done, take a picture of collected dead fish and send to the lab contact.
8. Tanks which have 5 or more dead fish, we should write the quantity of fish dead on the tank card. Summary of dead fish should be written as well stating the tank no., type and size of fish, supplier, date of arrival, no. of dead fish, problem with fish. We should state the problem like listless, gills, rotten, whitespot etc.

**Theory on Dead Fish**

Dead fishes are normally caused by sickness, lack of oxygen, high toxicity levels from ammonia, nitrite and total hardness of water. Other factors include improper husbandry, high dosage of medicine and more. Collection of dead fish is performed to ensure no residual clumps or bodily parts cause high debris in water. If dead fishes are not collected for a long period of time, they will decay and cause water in the tank to be contaminated by indirectly harming them.

**Theory on Ocean Acidification**

Ocean acidification starts with the presence of carbon dioxide and water which forms carbonated water - the prime cause. Knowing that water is at around a pH of 7 when it mixes with carbon dioxide, it will decrease the pH based on the amount of carbon dioxide present in the water. When carbonated water is formed, it ionizes and becomes carbonic acid. Hence the term, acid in it, we will have a pH of around 3. What threat it poses now is that it will be too acidic for most fishes to live in, making it inhabitable. From carbonic acid, it can quickly dissociate to become bicarbonate where it loses one of its hydrogen ions which can dissociate again to become carbonate where we lose the remaining three hydrogen ions. Hence, as it dissociates further, pH will increase. Bicarbonate stands at around a pH of 7.5 and carbonate at around 11.

If the water becomes too acidic, metabolism and immune response in fishes will deteriorate over time. As coral chips in water tanks are found to be made of calcium carbonate, they aid in increasing the pH to stabilize the water and have air pockets to start nitrification. They are used as buffers and are to be changed over time. Typically ¾ bag of coral chips will suffice to increase alkalinity but too much of it can be quite bad too. However when in the ocean, when there is an equal amount of bicarbonates and carbonates, it will be difficult for living organisms like the coral reefs and tetrapods to produce their shells in water as they require carbonate. If carbonate decreases, its shell would dissipate and dissolve as bicarbonate is competing against the free hydrogen present in water.

Other factors include temperature, respiration level, and stock density of the tank. The high temperature would aid pH to increase and when there is high stock density - where fish activity and the count are high, more carbon dioxide is produced making more carbonic acid. This is why we do not overstock in one tank. If pH is found to be high in the tank, we can use sodium bicarbonate which can have an instant effect to increase pH. Acting as a neutralizer to buffer back to the desired range. We can use water plants and have more coral chips but it will take a longer time if ever an incident were to happen - which it did to the cichlids. Before the arrival of cichlids, we are to add sodium bicarbonate whenever we change as it will be more stable with the coral chips.

In summary, ways to increase pH are to lower the stock density in water, monitor temperature, and add relevant amounts of coral chips. Since controlling temperature in the ocean is difficult, materials from substrates like chalk and groundwater in the ocean can aid in increasing pH and making a habitable environment. Monitoring carbon dioxide levels is complex which is why these 3 chemical compounds, they can have reversible reactions in water.

The equations are as follows.

[H2O + CO2 ] → H2CO3 **⇌** HCO3-}**⇌** CO3^2-

CaCO3 + H2CO3 →  Ca(HCO3)2

**Theory on Uses of Medicines and Types of Diseases/Infections**

Bacteria can be found anywhere and if not treated, they can harm living organisms. Below are some medicines used to treat bacteria and prevent overgrowth and/or maintain healthy growth levels in the water.

Lice are found to usually grow on walls and glasses of tanks. Common occurrences would also be on fishtails, sometimes the back of the body, and a head area especially goldfishes and Koifish. Lice will naturally start growing when dormant eggs from parasites lay their eggs to potentially grow throughout.

Treatment for lice would be chemically treated with Dimillin. Works by interfering with the development of a new chitin exoskeleton on lice (beginning stage) and their larvae. The exoskeleton is required to shed its bodily coverage every several times so when the next cycle is fed, the structure of the newly formed exoskeleton is not properly formed thus causing the larvae to die. The dosage should be about 0.03mg/L and the next dosage should only be given after 10-14 days from the day of use.

Alternative to use of medicine would be to use UltraViolet light. The recommended power source would be 60 watts. This is to not kill most of the good bacteria but mostly the bad ones. We can also manually scrub the tanks to remove the eggs which is why this is used as preventive maintenance but this will not remove 100% of the lice. Some suggestions I made were to use the disinfectant for sponges in the washing machine to water bath the tank to get rid of the dormant/eggs of the bad bacteria to prevent the growth of lice. It was mentioned that it can be done however the maintenance and timespan would use a lot of resources and besides, the PUB water supply contains chloramine so it would have already killed most of the dormant eggs and parasites.

We were supposed to disinfect the tank but because they lack manpower, they took the alternative, which is tap water that runs throughout like RAS. It contains a small ounce of chlorine which is at an acceptable range of below 0.1ppm-0.3ppm. We do not use sodium thiosulphate or any other water agents as the cost will be high.

CuSO4 treats fishes to different parasites. These parasites mainly cause flukes on the gills and skin of fish. However, some cons of using copper solutions cause depletion of oxygen levels, especially in copper-sensitive fishes (like invertebrates). It could also potentially kill beneficial bacteria. The recommended dosage would be < 1g of CuSO4. Hence, the dosage should be once/per week to avoid low oxygen.

Ammonia levels can tend to get high in packing water and if it is not treated, fishes may face ammonia burns while leading to loss of scales and an increase in stress level. Hence, we often use ammonia reducers/removers which aid in reducing heat and irritation on scales of fish. When fishes are stressed, they tend to release mucus-like substances from their gills which is why we would use silver pro.

Because of the mucus, oxygen may be low and increased physiological stress, this can lead to having listless - staying in one spot or fighting against each other for oxygen which is why we use a silver pro. This can reduce abrasions among themselves and can even help during transportation as transport may not be smooth sailing, making fishes bump into each other.

White spots are a common occurrence in fish in both freshwater and seawater. Freshwater white spots are commonly caused by ichthyophitirius multifiliis - a parasite that is highly contagious in water. For seawater white spots are cryptocaryon triptans - a species of ciliates that can be fatal if left untreated.

Fortunately, the treatment is widely available and the medicine would be to use OT. We could also salt bath the fish to treat the fish for white spots in the 30s. OT stands for oxytetracycline. They are used to treat bacterial infections and are most effective for common carps. It can also be used as an antibiotic.

Salt bathing fishes are quite commonly used before treating fish with any medication to reduce dosage and intake. They are normally used to treat white spots, black spots, and fungus which are all stress causes to fish. These stressors cause black marks on the scales of fish. The fungus starts from lesions and is infected by bacteria to grow which increases the chances of not healing.

Flukes are also common in fishes like goldfish and Koi fish. They are parasites that are caused by poor water conditions making fish reduce their immune system to fight off any parasites hence being more susceptible to infections. From there, parasites feed on fish skin to lay eggs and reproduce, especially when in warm temperatures. They are affected by infected gills and skin which can potentially suffocate the fish if the growth of eggs is too big for them. A way to treat flukes is by using a prime ingredient called formalin. It contains antibacterial and antifungal properties to fight off and is most effective against fungal infection and external parasites of fish.

Some special diseases that only affect Koi fishes are called KHV - a viral disease commonly found in carps that are highly contagious and affects gills with color patches like brown/white, rough patches on the skin, and sloughing mucus. It cannot be treated and in the most common case, it would be culled to prevent overspreading. KHV can be detected through PCR (Polymerase Chain Reaction) and Serology testing. If the fish house is found to be tested positive for KHV in carps, NEA will take the necessary actions to prevent any more spreads of the virus and may need to suspend the fish house.

Acriflavine (A) is also used to treat a variety of ailments from bacterial/fungal infections to disinfecting open wounds in fish. It acts like a lotion, a topical antiseptic solution for minor wounds, burns, and infected skin. However, this may cause itchiness and painful burns upon contact.

The main purpose of FMG (Formaline Malachite Green and Methylene Blue) is purely to treat the external parasitic infection on fish commonly on koi fungus infections. It is a strong mixture that should only be applied after every week to prevent overdose.

**SOP for Tank Cleaning for lily’s**

1. Before tank cleaning, ensure tank cards are removed and passed to the lab manager for fish count and checks. Leftover fishes who are sick/damaged/listless/dead are to be cull/removed/moved/disposed into a bag or container. Labelled with supplier, date and section.
2. Take a picture of the bag and send it to the lab contact. Lab manager will reduce/increase order for the next batch of arrival depending on situations.
3. Starting tank cleaning, place the sponge that is used in the tank on the top left or right side of the tank to indicate to be cleaned. Catappa leaves are to be disposed of in a bag. Sponge can be removed once cleaning starts and weighted holder can be reused.
4. Prepare items used for cleaning - Scoop, brush, long brush, fish net.
5. Open outlet valve to drain out the water and use the long brush to scrub the resided ammonia faeces on the partitioned glass as the water drains out. Close the inlet water valve to prevent water from entering.
6. Once most of the water is drained, scrub using the scrubber with the leftover water on all four sides and base of the tank.
7. Once done, use the scooper to scoop out the excess water and wastes to remove and ensure most of it is removed.
8. After cleaning is done, age the water. Prepare by opening the inlet water valve and close the drain valve so the water fills up.
9. Replace the dirty sponge with a new sponge that has been disinfected and place it with the weighted holder - connect the air inlet tube into the weighted holder. Place a new pair of catappa leaves as well.
10. Lastly, place a QT holder - Quarantine.

**Theory on Tank Cleaning for Lily’s**

Lily’s are a type of ornamental fish, part of section F3, which are fishes I take care of. Tank cleaning is important as it can clean off many parasites and bacteria that remain in the tank. This is to prevent the harmful organisms from destabilizing the water that will be used for the new incoming fishes. Leftover fishes are removed as we do not want to mix with the new or previous incoming as part of the audit as it may cause a mixup in stock count and microbiological incident. We do not want to introduce a set of organisms that can be harmful, which could result in having more DOA of fishes - combining new and old.

Tank cards are used as part of stock count and data for audit. Pictures sent to the lab for the manager are also part of an audit which aids in what orders should be placed for the next incoming. Placing used sponges on top as an indicator is a good practice as it is efficient and can tell which tanks are to be cleaned. As for catappa leaf being disposed of, we do not want to reuse it again to prevent cross contamination as well. Feces and waste will naturally reside on the side partition glass in the tank as the outlet water valve to drain are located on that end. With the help of a partial vacuum, feces are bound to reside on the side. We will need to scrub as the wastes can get stuck or are too sticky and sticks well to the bottom of the tank. Scrubbing the 4 sides and bottom is also a preventive method for the microbiological growth of organisms such as lice. Lice is a prime example as they cause itchiness to the fish which can potentially cause a loss in color and pigment of the fish's color as ornamental fish are hard to take care of. We also want to eliminate most parasites like Ichthyophthirius multifiliis caused by a protozoan which can cause the freshwater fishes to suffocate if the growth of parasites is strong where it takes effect on the gills of fish.

To further minimize growth, we should always remove the excess water as this will help in the prevention of mixing of new and old water. The diluted concentration of water will be better and have a much better chance of reducing DOA. After the main cleaning is done, we should age the water as this is crucial for the fish. The purpose of aging water would be to increase stability in temperature and remove potential chlorine residue that may be present through manual removal. Other factors include dissolved gases which can occur when high-pressure water flows into the tank. Dissolved gases like carbon dioxide affect the pH range which can be lethal to the fish. High carbon dioxide means higher pH. As water is being aged the day before shipment incoming, we should replace new sponges with clean ones which have been disinfected with a disinfectant. The disinfectant used is environmentally friendly and biodegradable for aquaculture biosecurity. Requires a low dosage and is potent against viruses, bacteria, and fungus which is safe for bacteria culturing after usage. The weighted holder is paired with the disinfected sponge as a support system to ensure it reaches the bottom of the tank which will then be connected to an air inlet tube to introduce aeration.

The use of catappa leaves is primarily a factor and part to ensure the healthy growth of Lily. They are often used in fish tanks to release/excrete necessary compounds that can benefit the fish and make out a certain type of water. The main function of the leaf is to soften the water as lily are sensitive to hard/salty/brackish water. Lily carries a ton of viruses and bacteria hence a good use of leaves can help mitigate the number of parasites and protozoans that can cause damage to the lilies. Catappa leaves aid in lowering the pH level, reduce stress, and have antibacterial and antifungal properties which is a much healthier way than using chemical concentrated kits which are not environmentally friendly. How this works is with the help of some chemical compounds that are present in the leaf. For example, tannins are excreted out from the leaves themselves. Though it causes discoloration of the tank water, it is very beneficial. It carries bioloads which is the breakdown of the organic materials which will then cause a buildup of detritus thus causing various things to happen in the water.

Lastly, placing a QT card holder is a practice to indicate that the tank is under quarantine as it is a new shipment. Fishes are to be quarantined as they could carry potential viruses and may be sick so if there were to be a new order, we should not be taken from the newly arrived fishes. This is to reduce sickness of the fish and prevent any fatality when we ship new fish.

**F3 Packing Water**

Packing water is supplied by PUB and is normally separated into 5 sections. They are contained in silos as storage containment units. The 5 types of silos are catered for water used to like -

Leaf water - Cattappa leaves are stored in a filter mesh, acting like teabags to secrete out the necessary compounds in the leaf to make leaf water.

Fresh Water -Dechlorinated

Salt Water - 1% salt

Sea Water - 35% salt

Water - Contains chlorine

Leaf water is primarily used for freshwater fishes and is normally diluted with 1% salt to soften water hardness. Fresh water is supplied for all uses. From all water in tanks, packing water for exports, filtered drinkable water, and more. Saltwater is catered for freshwater fishes. Seawater is mainly for marine fishes in the marine fish house. With all the main components being water - the water is supplied by PUB and since PUB is known to remove contaminants in water using chlorine, it is not available to use as chlorine may still be present in water. Hence, we will need to perform Reverse Osmosis.

Reverse Osmosis is a systematic filtration setup where it purifies water through a semi-permeable membrane that separates ions. Pressure is applied to overcome osmotic pressure thus filtering the contaminants. A specially designed RO system at Sunbeam contains carbon to filter out chlorine ions as the small amount of chlorine can kill fish in water. This can also alter the taste and odor of water. Carbon filtration can remove byproducts but not inorganic compounds and requires frequent water changes. Another method of chlorine removal is through sunbathing under the sun for 3 days (depending on the water level of the tank). This will allow water to stabilize and remove unwanted gases through evaporation.

However, for seawater, we would import as the contents of minerals are not 100% the same as mimicked ones. We cannot replicate the same level of natural minerals in imported ones. Replicating is also difficult as cost production will be high and it may pose a certain level of safety for the fish.

When packing for fish, we are to use packing water for specific species of fish. There are 10 separate tanks, each with different types of water contents ranging from medications in water, soft/hard water, soft+medicated treated water, and more. This is because we want to ensure the best when customers receive their fish all in good condition. We are to also fast the fish 2-3 days before exporting them to prevent ammonia levels from rising from the waste products.

Packing water is part of trial and error and we will best see fit if this method works for a certain type of fish. This can act as part of improvement for better packing in the future. Packing can also be draining as some fishes would take quite a while to acclimate to the water and would require special medications in water. Some fish would need to be salt bath first before adding the packing water. The sad part is when the customer wants to cancel, we will need to repeat the steps which reduces the manpower.

We do export international shipments and most fish can be packed for long travel of <36 hours. If a shipment is longer, we would normally use a tranquilizer and sedatives to put it to sleep first to reduce its stress level and so the metabolism does not spike up which is a good practice so oxygen in the bag will not be consumed too much. The ammonia reducer used can not last for the whole shipment.

Some packing can be different. For example, shrimps will need a green net packed inside the bag as shrimps need something to sit or hold onto while in the bag. For cichlids more than 6.5cm in length, we will need to double bag to prevent the plastic from bursting - same for fishes that can have sharp spikes on its body. For cichlids less than 3.5cm in length, we will need to place plastic strips to prevent them from fighting in the bag, creating more sections and space for them.

I had a thought where if we could introduce aeration in packing water before being packed. However, it would not be advisable as the aeration used may contain unwanted gases as the aerator is located outside of the fish house supporting other numerous fish house rows through the air inlet pipe. Thus, we would use 100% pure oxygen, and it is much higher.

**Relevant Information and Facts**

Sizes of tanks vary and in tier level of 3 and 4, depending on whether it is a RAS system or not. The size would stand at 120cm L, 33cm H and 59cm B. Giving a volume of 233640cm3/233.64L.

Sections are also split into 5, covering different species. Sections are B1, A9, B4, F3, B5 - BETTA fish section separated in containers as they fight in the same tank. BETTA fish also have multiple coloured species as they have continuous different breeding hence coming up colours with neon, galaxy, pink, purple and more which are expensive.

Some marine fish, especially hard live coral will take 1 hr to fully acclimate to the tank by drips. They are extremely sensitive to changes in water. If an order is given for export and packed by us, we can reuse the same water.

Introduction to hydroponics in the RAS system have been done before and the project was removed due to the high maintenance cost. Due to low manpower and high monitoring, it leads to an increase of workload and risk of algae bloom rising. Harvesting of overgrown plants is also difficult. Some suggestions made by me would be to settle or lower the plants when shift is about to end or when collecting dead fish as that would slow the rate of growth and also increase O2 level during the night provided that there is sufficient sunlight before it goes dark for the plant to photosynthesise. In fact, we can also use slow growing plants as they require little maintenance.

Feed given in codes - SSS/BS/DF. Brand by aquarium munster, Dr balseer in different flavor like regular, acai and some others. Different protein levels and contents for different stages of life for fish. As they grow older, less protein is needed.

**SOP for Friday Incoming Shipment**

1. Receive packing list from Lab Manager
2. Prepare tanks for placement of fish (done on Thursdays)
3. Arrival of fish. Sort fishes by supplier and type and to be allocated to clean available tanks
4. Open newly arrived fish shipment and collect fish water sample - one from each supplier
5. Fill and sort tank cards
6. Update DOA (Die on arrival) on packing list.
7. Submit packing list document to lab manager.

**Theory on Friday Incoming Shipment**

1. Packing list acts as a necessary document which is part of auditing for the near future. It is used as a guideline on which incoming shipment will arrive on the day of import.
2. Tanks are to be prepared on Thursdays and filled with dechlorinated water to age the water before the day of shipment. By ageing the water, dissolved gases have time to dissolve off and water temperature can be stabilised to desired range.
3. We would need to sort according to category and type of fish (eg lily’s, koi fish) to better organise the sections. This will ease future process orders and fishes to catch as the allocation is well organised.
4. This is part of preventive action and check and a procedure needed to act as an evidence under the DOA (Die on arrival) document. This will allow us to show evidence if the DOA of fish is high. It is also part of good husbandry practices as this would allow us to detect any potential hazards that may be present in water of fish or fish itself - a weekly water testing. If an event happens like high ammonia burn, we can contact the supplier straight away.
5. Once completion of opening the fish bags and transfer to tanks, we will write the necessary information on tank cards which consist of section, tank number, name/size of fish, date arrived, supplier, food needed and how many times a day
6. Two copies of the packing list will be given, one for DOA and the other for allocation of tanks as a reference guide. One will be identified with which section you belong to - which will be used for results of water tests and DOA management which will be sent to the DOA management. The other would be for LAB USE - Used for allocation of tanks.
7. BOTH packing list with section and Lab use identified will have to be submitted to the lab manager for record and documentation purposes.

**SOP for Documentation on DOA Incoming Shipment Report**

1. 2 packing list form will be given
2. One for LAB - for allocation of tanks and the other Section - Results of water tests and DOA management
3. Complete and fill in the necessary information - for Section, ensure whether any DOA/a tick/sickness/wrong order etc. For LAB - The right tests have been performed and indication of results - in-situ and ex-situ.
4. Open the clean scanner app and take all documents submitted.
5. Do the necessary cropping and save as - Date of shipment, Supplier and REPORT
6. Once saved, proceed to share the document in the WhatsApp group chat - #DOA Management.
7. From there, Nicole will do the necessary checks.

**Theory on Documentation on DOA Incoming Shipment Report**

Not much to explain as these are strictly for documentation purposes. Should there be an audit, this will be one of the criteria and if there is a lawsuit or complaint filed, this will act as evidence and supporting role.

**SOP for Handling Customer Complaints**

1. In the event of a complaint - Trial and Error, shipment will arrive.
2. Unpack and separate the fish.
3. Fishes are to be packed in 4 sets of 3 bags labelled with C/T1/T2/T3 LABEL T - Treatment/Test, LABEL C - Control
4. Determination of outcome. Checking on fish after 24 hours. If in good condition, will send out the current packing method and return back fishes - provided they are not dead.
5. If fishes are still not good, monitor and wait for 41 hours (in total). If it is good, we will send it out.
6. Lastly 65 hours in total, if good, send out.
7. If not good after a total of 65 hours - replacement will be made for fishes immediately.
8. In the period of the trial and error method, if the method seems to work, implementation of the new method will start usually after 2-3 weeks of complaint.

**Theory on Handling Customer Complaints**

Handling complaints will only happen if there is a problem when customers find high DOA, water being very cloudy/unclear/foggy/smelly, fishes that are not up to standard. These problems occur when there may be a flaw in the packing water when used during the packing or a slight chance of improper husbandry in the fishhouse. Normally, we would focus on the packing water as we want the customers to feel the highest standards of husbandry when they receive their imports. Packing water is where we use different medicines, leaves and more to ensure the packing water is most suitable for the ornamental fishes. There are a total of 10 tanks with different purposes for different packing methods. 

1. Filter and sort
2. To be bagged
3. C - Control which is the original packing water that was used on the fishes. T1/T2/T3 would be any of the 10 tanks we want to use and experiment on to find which is the most suitable. Say for example T1 would be leaf water, T2 with medicine, T3 with leaf water plus medicine.
4. NIL
5. NIL
6. NIL
7. We would normally send out extra but rarely there is ever a case where we reach over 65 hours.
8. This is to ensure our service remains at a certain standard and the packing water would be at an optimum throughout the delivery process so the fish will not be damaged.

**SOP for Updating MP**

1. Select maintain - MPD
2. Select F Type: CW or F1 or Fresh
3. Stamp Mass Price Stamper on MPD paper.
4. Filter out codes by given stamp (eg 19000 - 19999) - refer to PAPER
5. Refer to the indicated paper about what needs to be changed.
6. CREATE TABLE

MP -  What needs to be changed to

Delete - Press side of code and press delete

Change - Go to code and change MP according to given instructions on paper

Add - Done the last as easiest. Go to the very bottom of the list and key in the given code and MP then press F1. If the type if F1, key ‘F1’ under the column ‘Type’.

1. Once done, select ‘Save’ once. Once you see a print icon above that has turned bold, save is completed.
2. On stamped paper, write down, ‘Done by: NAME’ ‘DATE of MP’ and time completed.
3. Staple all MPD papers and proceed to print by selecting ‘scan and sent’. Followed by ‘Address book’ then under ‘ABC’, select ‘C’.
4. Select ‘Cannon Scan’ and press the start button. Give the printed and MP documents to Jess

**Theory on Updating MP**

MP is used for categorising the type of fish by codes. This is to update any future references for PO (Purchase Order) from the account number of a buyer.