



NATIONAL AQUACULTURE
TRAINING INSTITUTE

Intensive Production of Ornamental Fish in Recirculating Aquaculture Systems

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Intensive Production of Ornamental fish

- There are around 100's of millions of ornamental fish sold around the world each year, with more than 80% of these farm produced.
- Successful production of ornamental fish (like all aquaculture ventures) is dependant on a range of factors, the most important being:
 - Climate – are temperatures suitable?
 - Quality and quantity of water available – pH, GH, minerals?
 - Land availability, topography, geology and soil type
 - Infrastructure including access to markets (airports, roads), utilities (electricity, gas etc) – can I access what I need?
 - Availability of skilled and unskilled labour
- So where and how are ornamental fish farmed?



Industry Culture Practices

- Production techniques vary considerably with species, and region – predominantly Asia
- Most production of ornamentals is undertaken in small fertilised ponds (generally less than 50 m²), with larger ponds sometimes being used.





Intensive Production

- Western countries with unsuitable climate, glass aquaria or recirculating systems are used to maintain appropriate environmental conditions.
- This generally means heating and light through artificial means.....EXPENSIVE
- Therefore need for intensive production
 - intensity increases so do yields and a greater financial return per unit volume.



Industry Culture practices

- We are now seeing an emerging trend towards RAS for both ponds and large outdoor tanks throughout Asia
- Due to higher yields and better quality control.



What are RAS?

- Recirculating Aquaculture Systems (RAS) are culture systems that reuse water more than once after some form of treatment
- Provide the necessary environment for the growth or holding of the culture species.
- The most fundamental problem faced in a recirculating system is the maintenance of suitable water quality and the removal of waste products generated by the culture species in an **economical manner**.
- Economics very important – many RAS operations have failed due to high capital and operating costs!



The wastes that RAS need to process are: faecal material, ammonia, urea, CO₂ and other metabolic wastes).

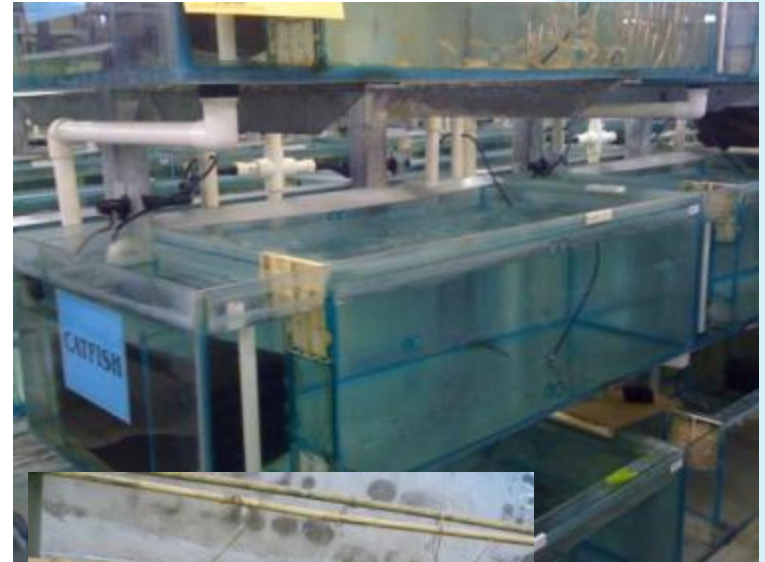
What are RAS?

- Fish wastes have a negative impact on the water quality, with an increase in;
 - turbidity and suspended solids, increased bacterial load
 - CO₂ levels, ammonia, nitrite, nitrate, and a range of other compounds.
- RAS use a range of physical, chemical and biological processes must be undertaken in order to maintain a suitable environment for the culture species.
- While it is technically possible to design a system where all waste products are removed, such a system would be uneconomical.
- Design and operation of a recirculating system is therefore a trade-off between the level of capital and operating investment, and the level of environmental control needed.



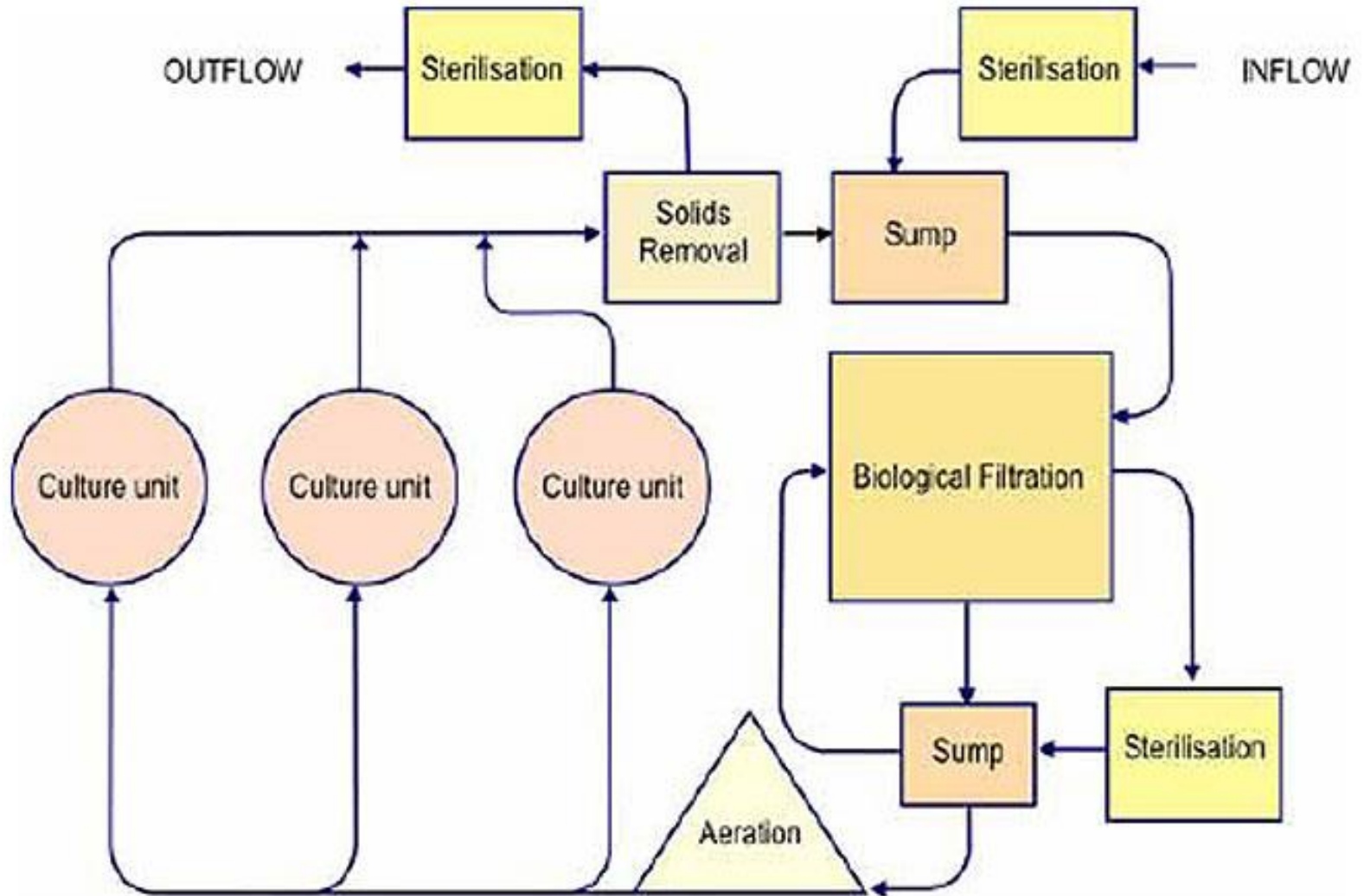
Basic components of RAS

- The most basic requirements of a recirculating system are a holding tank for growing and/or holding fish, some form of filtration to maintain water quality, and a pump to recirculate water.
- An example of a simple recirculating system is a glass aquarium or larger tank with an internal filter
- Commercial RAS can be much more complicated





A highly intensive Food-fish RAS

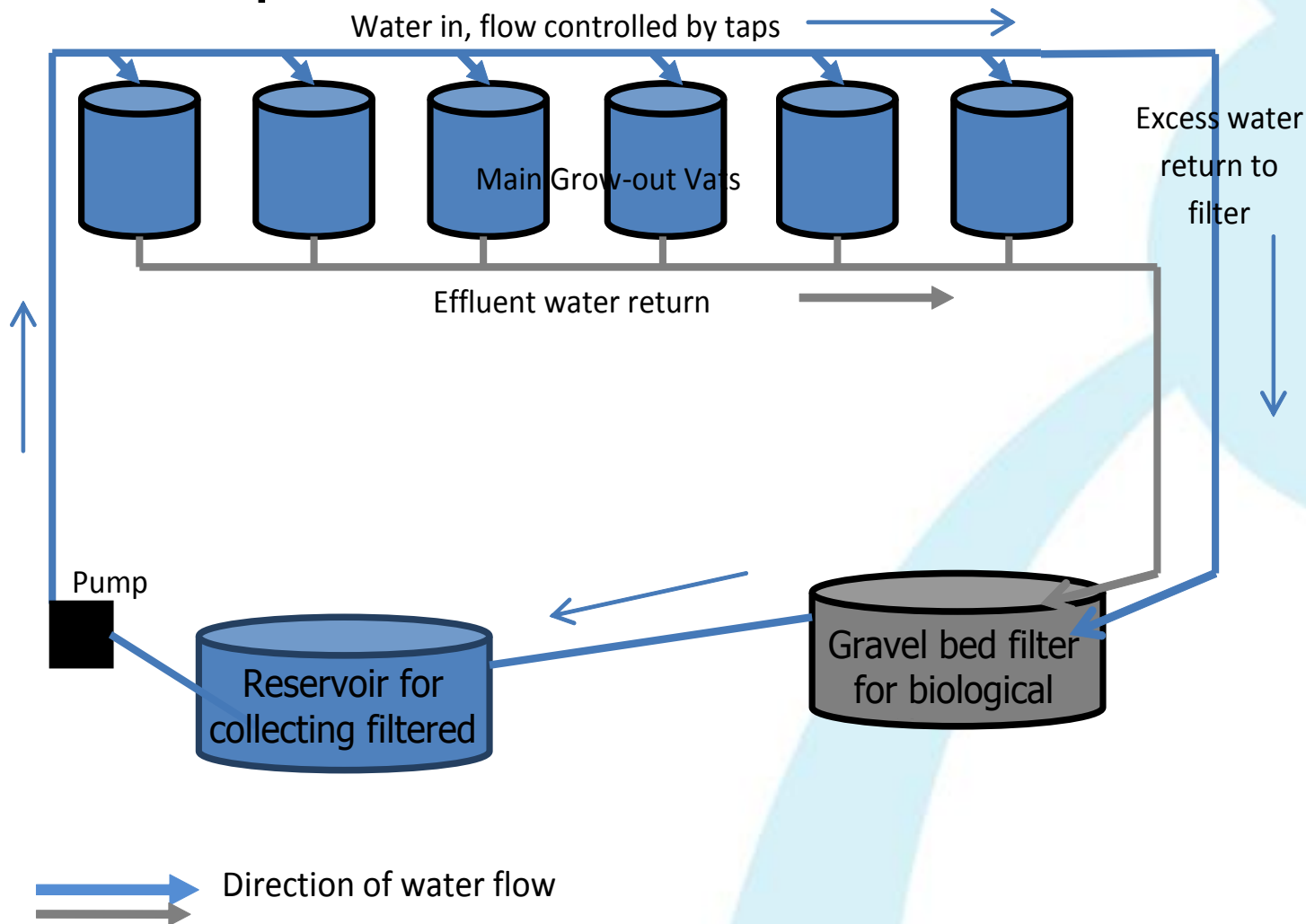




- The problem with large commercial RAS for ornamentals:
 - Very expensive to construct and operate
 - Stocking density for ornamental fish generally lower than that of food fish, therefore yields are comparatively low affecting economics of production



A more practical RAS for Ornamentals



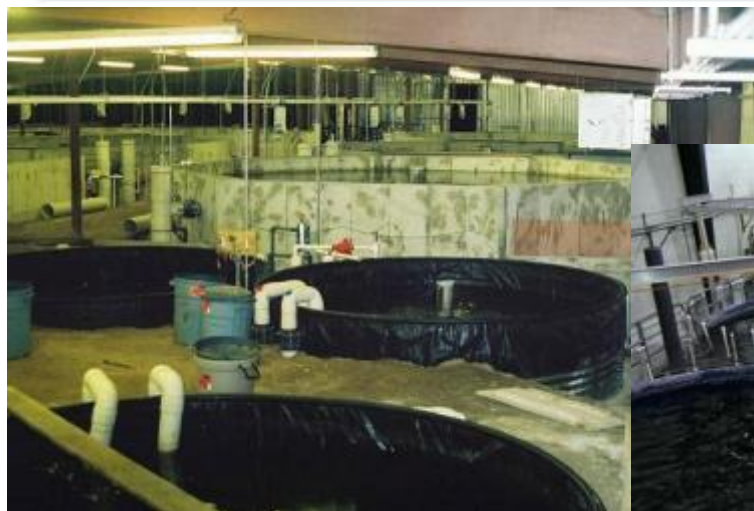
- RAS for ornamental fish, do not have to be as high tech as for food fish
 - Cheap, readily available materials can be used to reduce construction costs
 - In tropical climates, operating costs are reduced because heating is not needed
 - Major advantage is they allow greater control over the growing environment which means faster growth rates and improved survival



Holding/culture tanks

- These provide space for the fish to be held in a range of shapes, sizes and construction methods are used.
- However, round tanks are generally used as they are self-cleaning; due to the circular water flow, uneaten food and faeces is pushed to the centre of the tanks where it passes out through a central drainpipe.

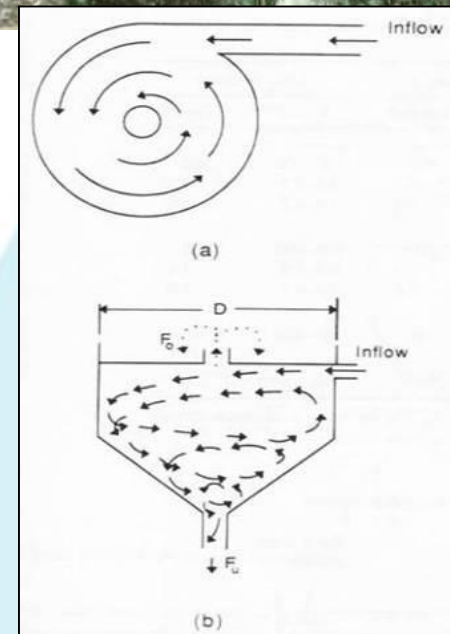






Solids filter

- Used to remove solids from tank effluent water – important to maintain low levels of bacteria and water clarity
- Types of solids filters used are:
 - 1. Settlement or sedimentation systems (large scale, pond systems),
 - 2. Mechanical filtration (filter wool, filter mats, screens),
 - 3. Chemical adsorption (activated carbon, protein skimmer).





Solids Filters

- Larger pond or recirculating systems may use more than one method of filtration to remove solids from a system
 - eg. screen filters may be used to pre-filter water before passing through a sand filter
- What-ever filter system used – must be washed regularly to remove the debris.



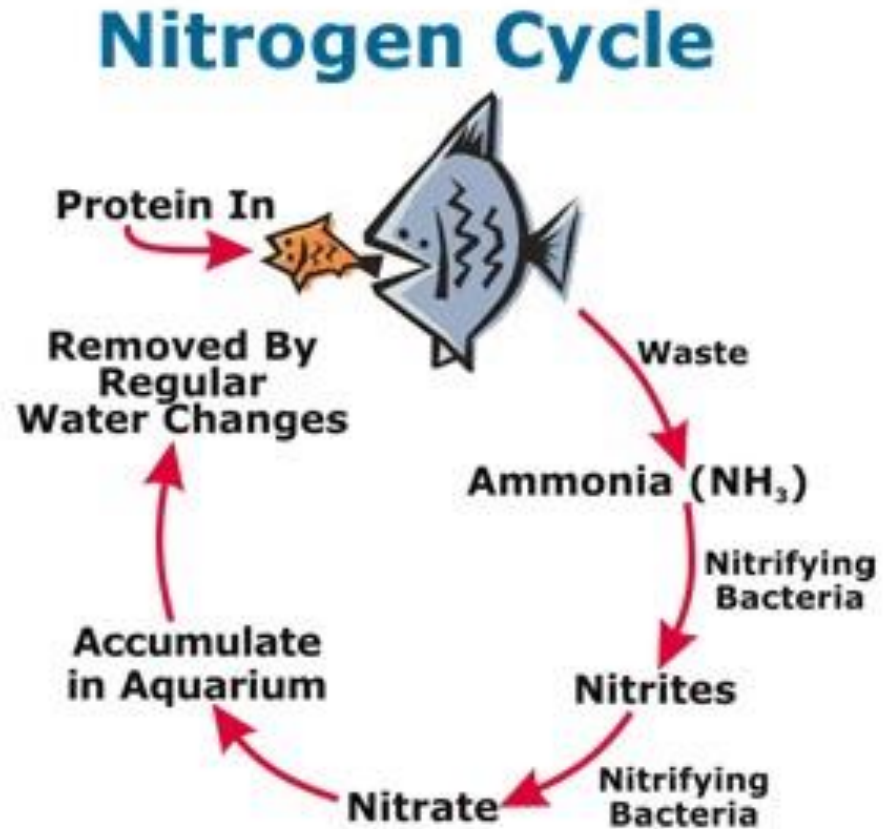


Biological filter

- A biological filter (biofilter) relies on bacteria to convert ammonia into nitrate via a two step process called nitrification.
- The biofilter provides a substrate (gravel, bioballs, sponge etc.) for bacteria to colonise and contact with the water to be processed
 - larger surface area = larger bacterial population = greater the nitrification capacity = better water quality & more fish
- A biofilter is an organism in its own right and needs to be maintained, operators need to consider nutrition, water quality, general environment.

Nitrification

- Nitrification is performed by two groups of aerobic bacteria in a two stage process:
 - *Nitrosomonas* spp. (NH_4 to NO_2) and
 - *Nitrobacter* spp. & *Nitrospira* spp. (NO_2 to NO_3^-)
- The nitrification As the process is aerobic, oxygen and continual water movement is essential



Types of Biofilters

- There are many different types and variations of biofilters, can be classified into the following types:
 - Submerged, Trickle, Fluidised bed



Sump/reservoir

- This increases the volume of water in the system – generally point where water is exchanged
- can be used to facilitate water quality control and acts as a collection point for the pump to recirculate water.



Pump & aeration

- Some form of pump is needed to recirculate the water through the culture system and aeration is needed to maintain suitable DO levels.
- In a simple system an airlift pump might provide enough water circulation
- Larger more intensive systems require an electrical pump
- Pump should be a low energy pump – although generally more expensive than a standard pump the operating costs are generally much lower



Additional equipment

- This may include disinfection systems such as Ultra-violet sterilisers and ozonators for disinfection of water to control micro-organisms,



Large scale ornamental RAS





Low cost RAS



Management of systems

- Regular water quality checks – especially for new systems
 - **pH**, general hardness and mineral content
 - **nitrogenous wastes – ammonia, nitrite.**
 - **dissolved oxygen – important to maintain water movement**
- Daily/regular siphoning of tanks
- Prophylactic treatment of parasites
- Sequential rearing - minimises biomass and shock-load of systems
- Polyculture - generally stock catfish sp. with other fish in nursery and growout systems

Stocking Densities

- Capital costs vary with the densities of fish and the type of equipment/systems employed in the production of fish.
- Some species require superior water quality conditions to others, and consequently, more expensive filtration equipment is required
- Stocking density varies with life stage and species of fish. For example Salmonid smolt are stocked at 1-3kg/m³, grown out at 10-40kg/m³ plus
- Stocking rates for ornamental are normally much lower 0.1 to 1kg/m³ but intensive systems can get to 3 kg/m³
- The following table indicates the commonly used culture systems for the various species groups and stocking densities.

Species	Commonly used culture systems	Stocking densities
Bubble nest breeders	Indoor tanks, ponds for growout	1 to 8 fish per Litre
Barbs	Indoor tanks, ponds for growout	1 to 10 fish per Litre
Catfish	Indoor tanks, ponds for growout	0.1 to 2 fish per litre
Cichlids	Indoor tanks and recirculating systems	0.1 to 2 fish per litre
Livebearers	Recirculating systems, outdoor tanks and ponds	1 to 20 fish per litre
Tetras	Indoor tanks, ponds for growout	1 to 20 fish per litre

Feeding

- A good quality artificial pellet is best for use in RAS to help maintain good water quality
 - Protein level is generally 40% or higher
 - Pellets need some form of pigment
 - Should have good vitamin levels (Vitamin B and C important)
 - Supplemental feeding of livefeeds can help improve growth and colour/quality of fish
- Natural pigment blends such as capsicum extract (produces red colours) or marigold extract (produces yellow/orange colours) can also be used. These are mixed at 0.1 - 0.5% into feeds.
- Good colouration is the key to production of high quality fish.

Pelleted Feeds

- **Formulated diets** can be provided in a range of sizes, types and shapes:
 - Pellets, powders (crumbles) or **emulsions** (usually fed to live food species to boost their nutritional value for the culture species) to match the mouth size of the predator species;
 - Discs, hexagons, biscuits, 'spaghetti' rings;
 - Floating, slow sinking, sinking;
 - Soft pellets (mimic natural feeds) or hard pellets.

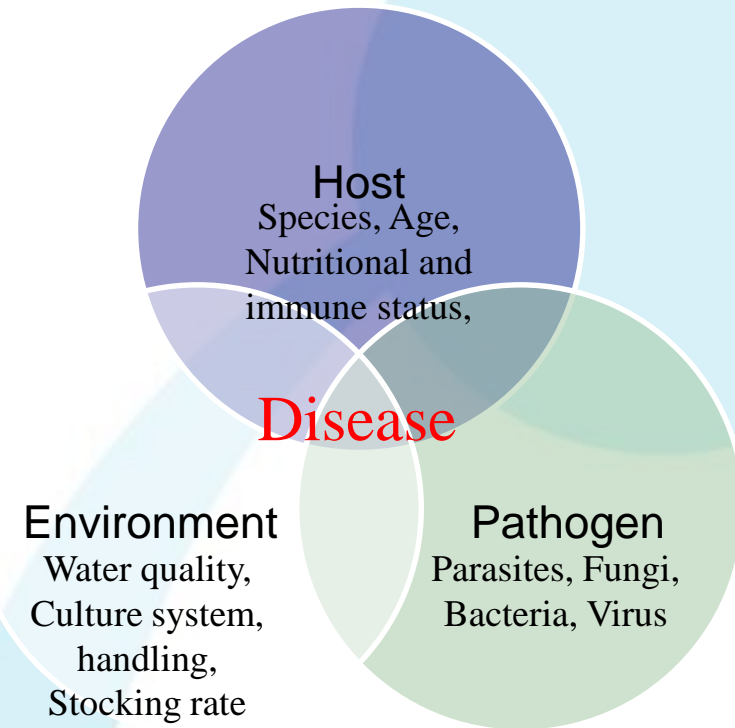


Species	Estimated time to produce market sized fish	Expected Survival (Egg to market size)	Comment
Anabantids	12 – 16 weeks	70	High mortality common around day 10-14 when inflating labyrinth organ
Barbs	14 – 16 weeks	80	Size grading important to prevent aggressive behaviour
Catfish	16 – 20 weeks	75	Often grown with other species to clean tanks
Cichlids	16 – 20 weeks	85	Can become aggressive as they age
Livebearers	14 – 20 weeks	90	Removing females at early age can assist in growing better quality male fish
Tetras	12 – 20 weeks	70	Fast growing at high density



Stress and disease

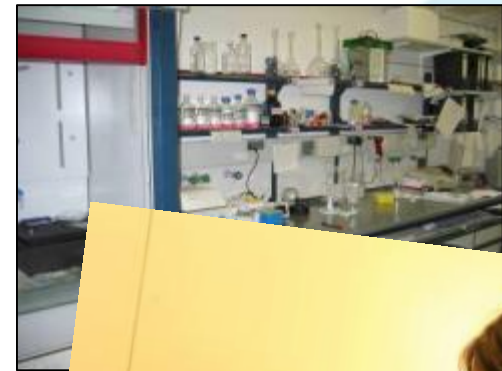
- Disease control is essential in RAS
- Stress and disease are inter-related, control of these factors is important for health of fish.
- Stress causes physiological changes that compromise immunity and leaves the fish more susceptible to disease.
- Maintaining optimal conditions and good hygiene is essential





Disease Detection

- in-house ability to diagnose at least routine disease issues - essential in controlling spread of disease
- Parasites are easily diagnosed with a microscope, recommended to have this
- Diagnosis of bacterial and viral would generally involve sending samples to a laboratory
- Government surveillance
 - Important to be involved
 - Valid health certificate – what is the implication to the export country if fish are found to carry disease in certified disease free fish?



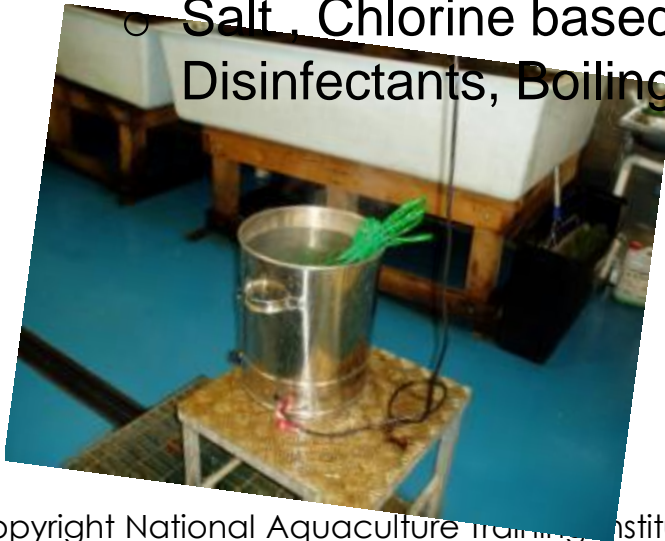
Facility Hygiene

- Good hygiene practices are essential in preventing disease
 - Avoid using equipment from other farms, unless properly cleaned
 - using separate equipment in different parts of the facility also reduces risk
- Staff or visitors can easily spread disease
 - Footbaths and washing hands can reduce this risk
- Always work from clean to dirty
- For farm – cleanest and strictest hygiene should be for hatchery – eggs / larvae most susceptible to disease
 - Should have separate equipment / workforce



Facility Hygiene

- Ensure all equipment is cleaned and disinfected properly after use e.g.
 - Wash thoroughly, remove all mud/dirt/debris first
 - There are many choices of disinfection but the effectiveness can vary
 - Drying and exposure to sunlight
 - Salt . Chlorine based products, Disinfectants, Boiling



Summary

- RAS is relatively new technology for ornamental fish production
- Increased capital and operating costs are off set by better control over production and higher yields
- System design and operation does not need to be complicated
- Hygiene and disease control are important to reduce mortality – once in RAS disease is difficult to eradicate

The end – Thankyou!

- Any questions?
- I can be contacted on email:

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