You Built It…
Now What?

Optimizing Your Growing Environment

COLORADO AQUAPONICS

THE Aquaponic SOURCE™
Growing Fish and Plants Together

In this session we will discuss

- Source water and water quality
- Cycling and bacteria management
- Keeping fish healthy and happy
- Solids management and mineralization
- Selecting and growing abundant crops
- Pest prevention and recovery

Recirculating Systems

- Water is recirculated through the system over and over
- Water is typically not discharged (only tiny amounts)
- Bad bacteria can colonize quickly (there is not a complete soil or water ecosystem to keep it in check)
- Contaminants can build up over time
- Aquaponics is very difficult to disinfect if bad bacteria or contaminants are introduced
- Sterilization is impossible with bacteria and fish

Start with the right water

Have your source water tested using water standards, bacteria/biological elements and heavy metals

Is your water source free of contaminants?

- E Coli, heavy metals, pesticides, radon, arsenic, chlorine/chloramine, fluoride, other pollutants
- Rain water and surface water are questionable???

Most appropriate water options

- Municipal water – must remove chlorine/chloramine
- Well water – may need to remove bacteria or metals

HydroLogic Source Water Filters

DO NOT allow to freeze, use a water meter, change filter cartridges when specified, do not exceed flowrate

Hooks to garden hose
8,000 gallon limit

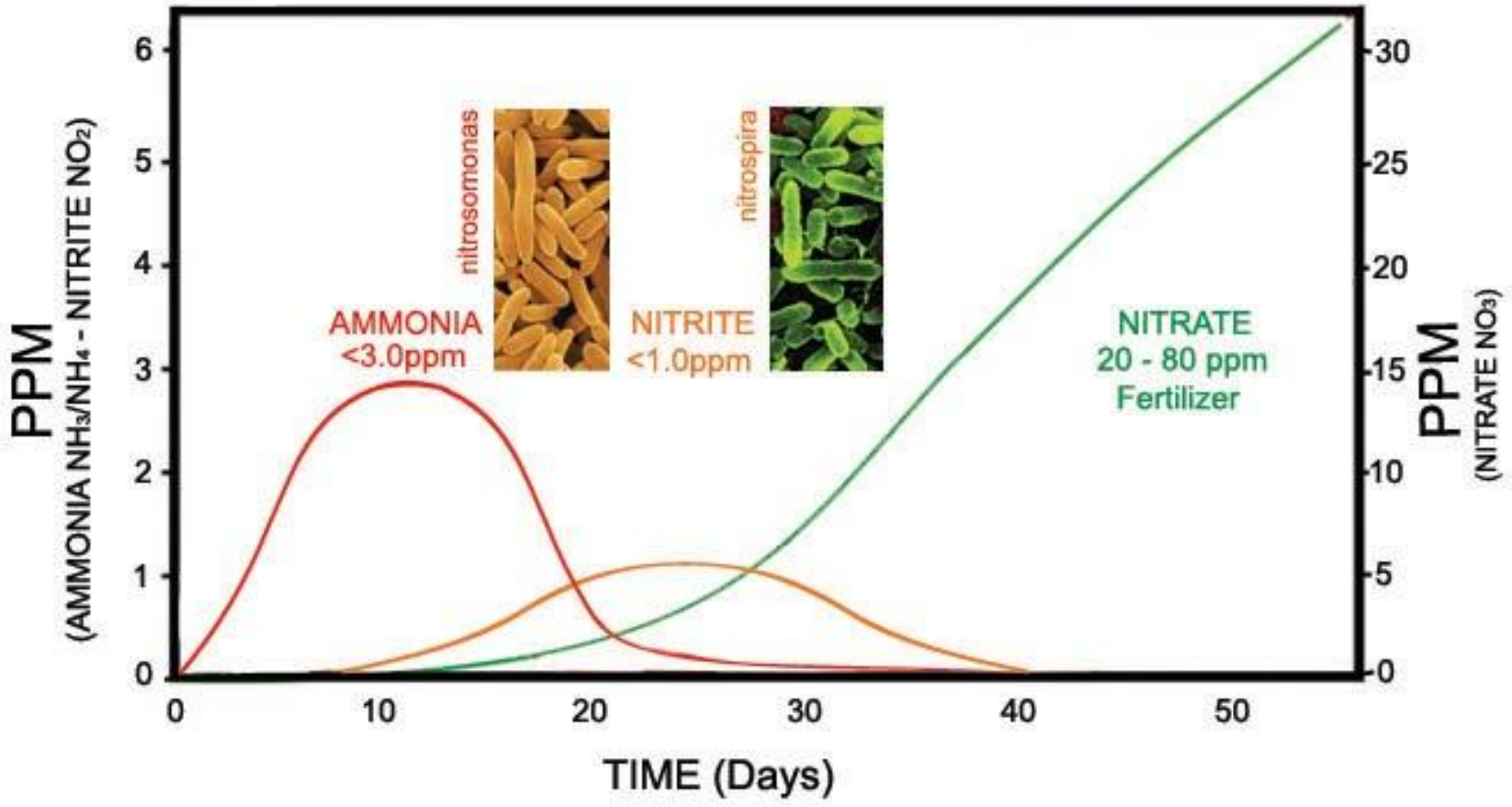
SmallBoy KDF
6,000 gallon limit
1GPM, 60 GPH
5 Microns

TallBoy KDF
15,000 gallon limit
2GPM, 120 GPH

Being a Bacteria Farmer

- Bacteria need a happy place to call home
- They are born, eat, poop, reproduce and die
- They live in a slimy mucus biofilm on many surfaces
- Must be adequately populated to maintain proper nitrification for your fish load and feed rate
- Nitrifying bacteria perform the nitrification cycle
- Nitrification happens in every water way of the world
- ***Nitrification in aquaponics mimics a natural ecosystem***

Nitrification Cycle



When cycling with fish perform 1/3 water change when ammonia or nitrite exceeds safe levels

Fishless Cycling

Follow these steps to start the nitrification cycle

- Fill the system and recirculate water
- Allow water to reach desired temp 77-86°F (25-30°C) ideal for bacteria to colonize
- Add nitrifying bacteria to biological filter
- Add an amount of ammonia to reach 2ppm
- Test water and record pH, ammonia, nitrite, nitrate
- Add ammonia and bacteria throughout cycling process
- Cycling may take between 20 – 45 days depending on bacteria, temperature, ammonia source, pH, etc.

Fishless Cycling

- ***Nitrifying bacteria supplement***
- ***AquaCycle Fish-less Cycling Kit***
- ***Liquid Ammonia*** (AKA Clear Ammonia, Pure Ammonia, 100% Ammonia, or Pure Ammonium Hydroxide)
- ***Ammonium Chloride*** (crystallized ammonia)
- ***Human Urine*** (AKA “Humonia” or “PeePonics”)
- Other sources

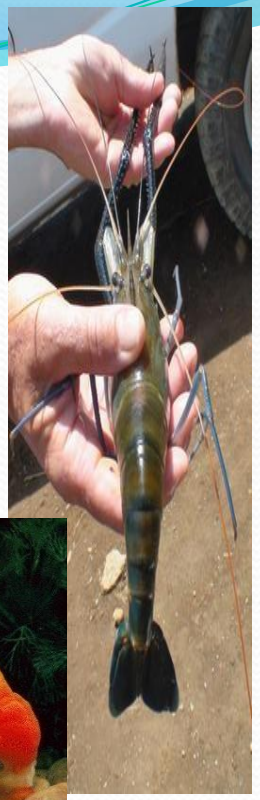
Bad Bacteria in Aquaponics

If bad bacteria are introduced by humans, animals, fish, planting media, source water or equipment, they are likely to proliferate and be difficult to detect or element, resulting in food safety issues!

- Fish do not produce pathogenic eColi or Salmonella
- Aquaponics is the perfect environment for bacteria (and other biological or microbial life cycle)
- Because Aquaponics is in a controlled environment, there is not a complete "food web"
- Bio-security and appropriate farm practices essential

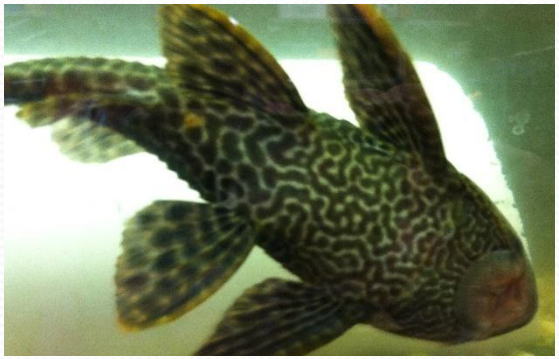
Now…The Fish

- Aquarium Fish
- Tilapia
- Yellow Perch
- Trout
- Catfish
- Bass
- Bluegill
- Carp
- Koi
- Goldfish
- Freshwater Prawns



Selecting Fish Species

- Edible vs ornamental
- Grow out time
- Temperature needs
- System size and location
- Ammonia and solids production
- Ability to integrate with other fish
- Permitted species
- Supplier availability, cost
- Consumer acceptance



Acclimating

Moving fish from transport into quarantine

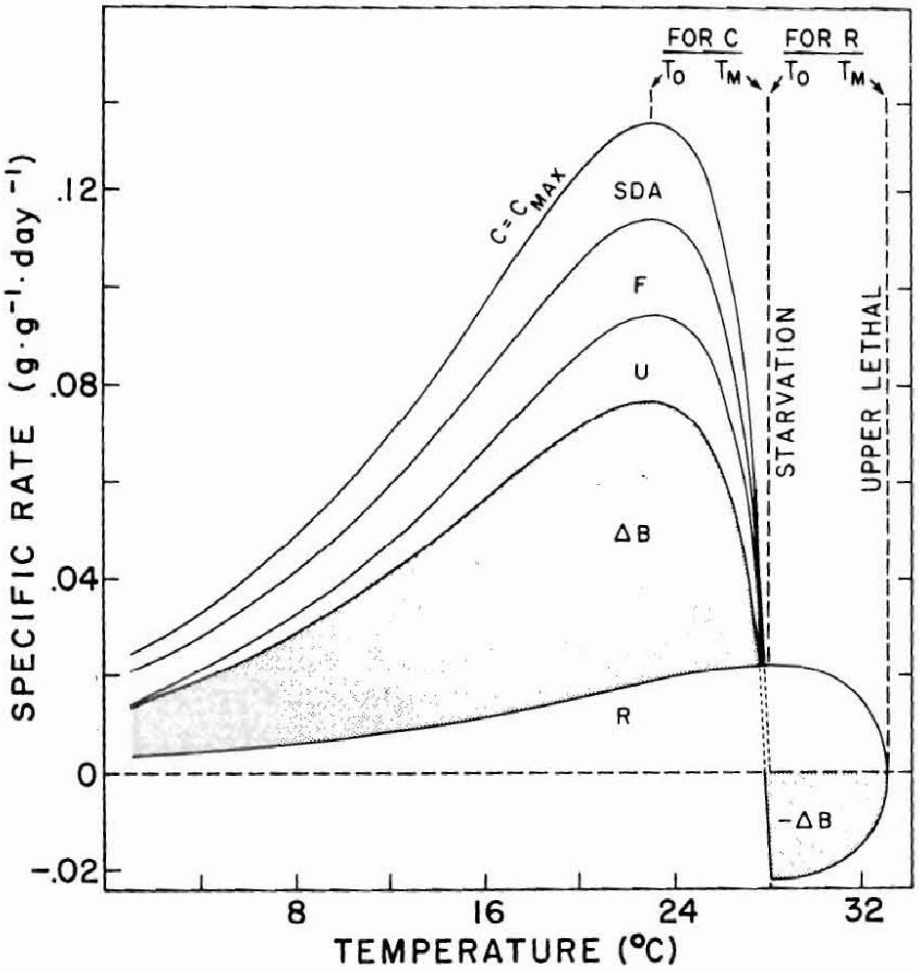
- Keep temperature within 2° delta
- Keep pH variance .2 - .4 between transport and system water
- Ammonia can build up in transport
- Maintain oxygen or aeration at all times
- Avoid putting water or nets from vendor into Aquaponic system, quarantine less of a problem

Maintain High Water Quality

- Temperature – stay within appropriate range for species
- Dissolved Oxygen (3 to 7 mg/l depending on species)
  DO levels decline shortly after feedings
- pH 7-8, avoid drastic pH changes
- < 3ppm Ammonia and <.5 Nitrites
- Ammonia production is directly related to feeding rates, quality of feed, fish size and temperature
- Ammonia generally peaks 4 to 6 hours following feedings
- Reduce or stop feeding if water quality falls below acceptable levels

Temperature and growth rate

- CMAX= Max. feeding rate
- SDA = Digestion (specific dynamic action)
- F = Feces, urine production (egestion)
- U = Ammonia production (excretion)
- ΔB = Change in fish weight
- **Opt. coolwater temp. = 23 C (73 F)**
- R = Respiration
- Max. = 28 C (82 F; starvation)
- **Coldwater fish = 14-16 C (57-61 F)**
- **Warmwater fish = 28-30 C (82-86 F)**



Bill Manci – Fisheries Technology Associates
www.ftai.com

Important Fish Facts

- 50% of fish waste is in the form of ammonia released through urine, fecal matter and gills
- Ammonia and Nitrites are deadly to fish
- Chlorine and Chloramine must be removed from water
- Dead fish don't float (right away), first they sink
- Sick fish should be removed from the tank immediately, and disposed of in the most humane way possible
- Breeding may take place in the tank
- Different fish species can cohabitate in the same tank

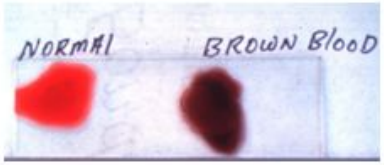
Fish Feeding

- On average, fish eat about 1.5 to 2% of their body weight daily depending on age, size
- Feed high quality food with the proper protein, carbohydrates, and fats for the age and species of fish
- Feed measured amount 3 - 4 times a day
- Feeding rates will vary with fish size, water temperature, light levels, breeding behavior, and water quality, and any stress conditions
- Fish feed is available in conventional and organic
- Choose pellet size appropriate to age of fish

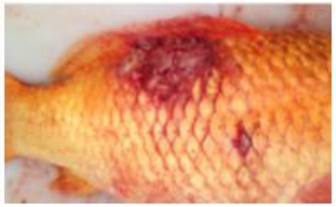
Fish Feeding

- Scoop out any uneaten feed after 20 minutes, don't overfeed, it wastes food and impacts biofilter
- Automatic feeders can clog or dump, neither is good
- Personally feed your fish to observe health and activity
- Tilapia may mouth breath at surface "piping" aids in digestion and allows them to bring in more oxygen
- Supplement with alternate feeds – insects, vegetables scraps, sun-dried duckweed (none are considered complete foods in a recirculating system)

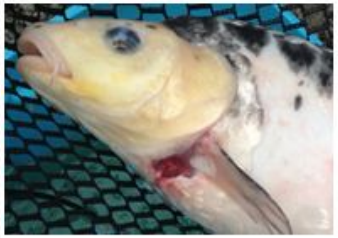













Check the internet for specific disease images and symptoms, consult a aquaculture veterinarian for proper identification

Integrated Fish Health Management

- **Prevention** – biosecurity, water quality, low stress
- **Removal** – move sick fish to quarantine, remove dead fish immediately
- **Identification** – determine disease, virus or cause of sickness or mortality
- **Treatment** – determine best mode of treatment **in quarantine**, ensure it is appropriate for edible fish
  - Increased temp, salt bath, medicated feed, MinnFinn
  - FDA approved listing for aquaculture pharmaceuticals
- **Documentation** – keep records of fish disease, death

Don’t Stress the Fish

- Water quality and flow
- Proper temperature
- Dissolved Oxygen
- Proper feed quality and quantity, FCR
- Stocking density
- Light & shade
- Adequate filtration
- Pest, disease and predator prevention
- Transport, handling, shelter, reproduction

Solids Filtration

- Two Basic types of filtration
  - Mechanical Filtration – Removal of fish solids, uneaten feed, mineralized break down of dissolved solids
  - Biological filtration – conversion of ammonia to nitrate

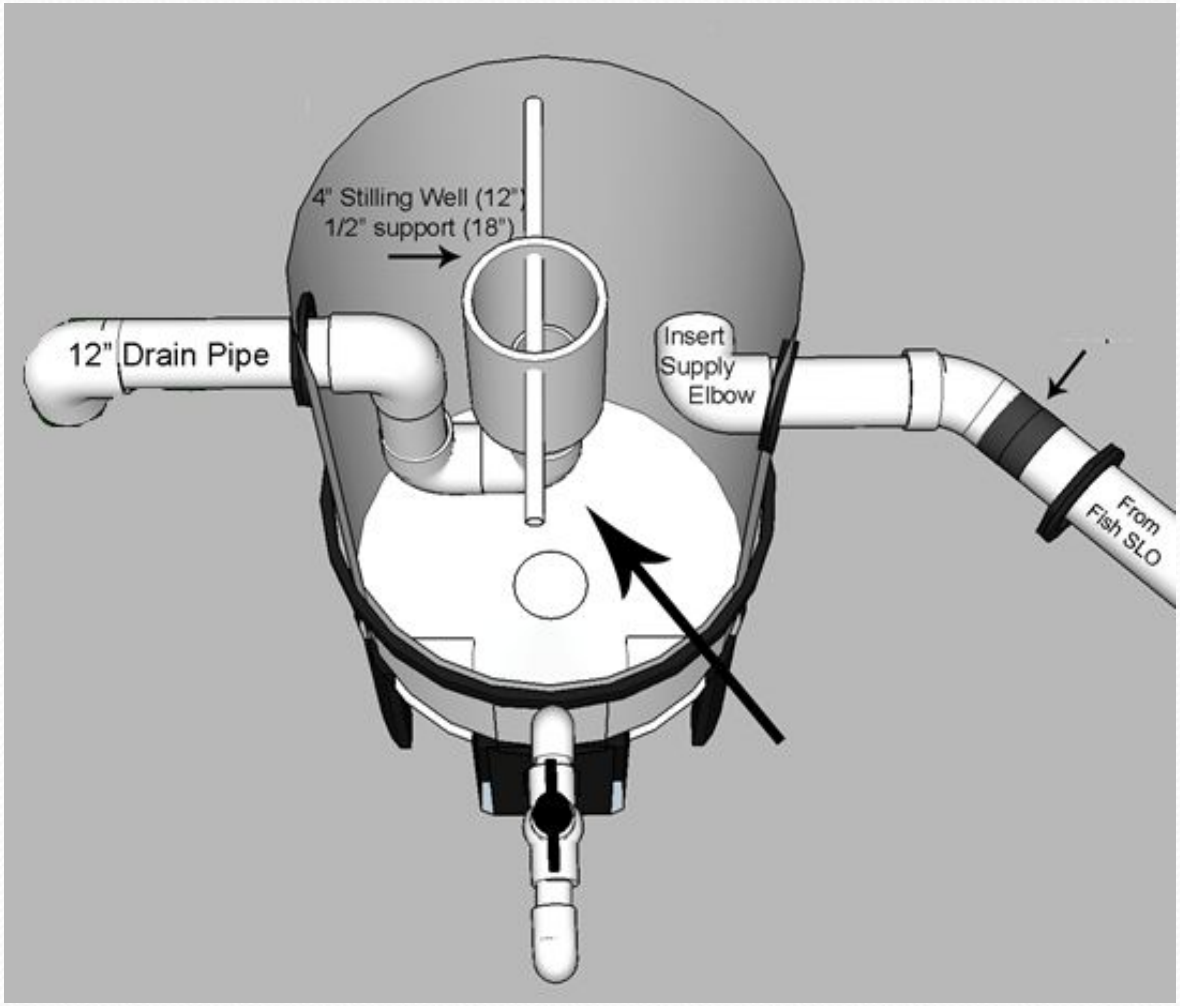
- When do I need filtration?
  - When (and ideally before) your media beds are getting overwhelmed with fish solids
  - When you are running deep water culture or NFT based systems – fine plant roots can get clogged with solids

Heterotrophic and Anaerobic Bacteria

- Consume organic compounds (plant material, uneaten feed, algae, feces) and carbon
- They grow faster than autotrophic bacteria
- Heterotrophic bacteria consume oxygen and space which out populates autotrophic nitrifying bacteria
- Anaerobic bacteria thrive with low/no oxygen
- Signification build up of solid waste encourages increased heterotrophic and anaerobic bacteria populations and can result in Denitrification

Spiral Flow Filter (clarifier)

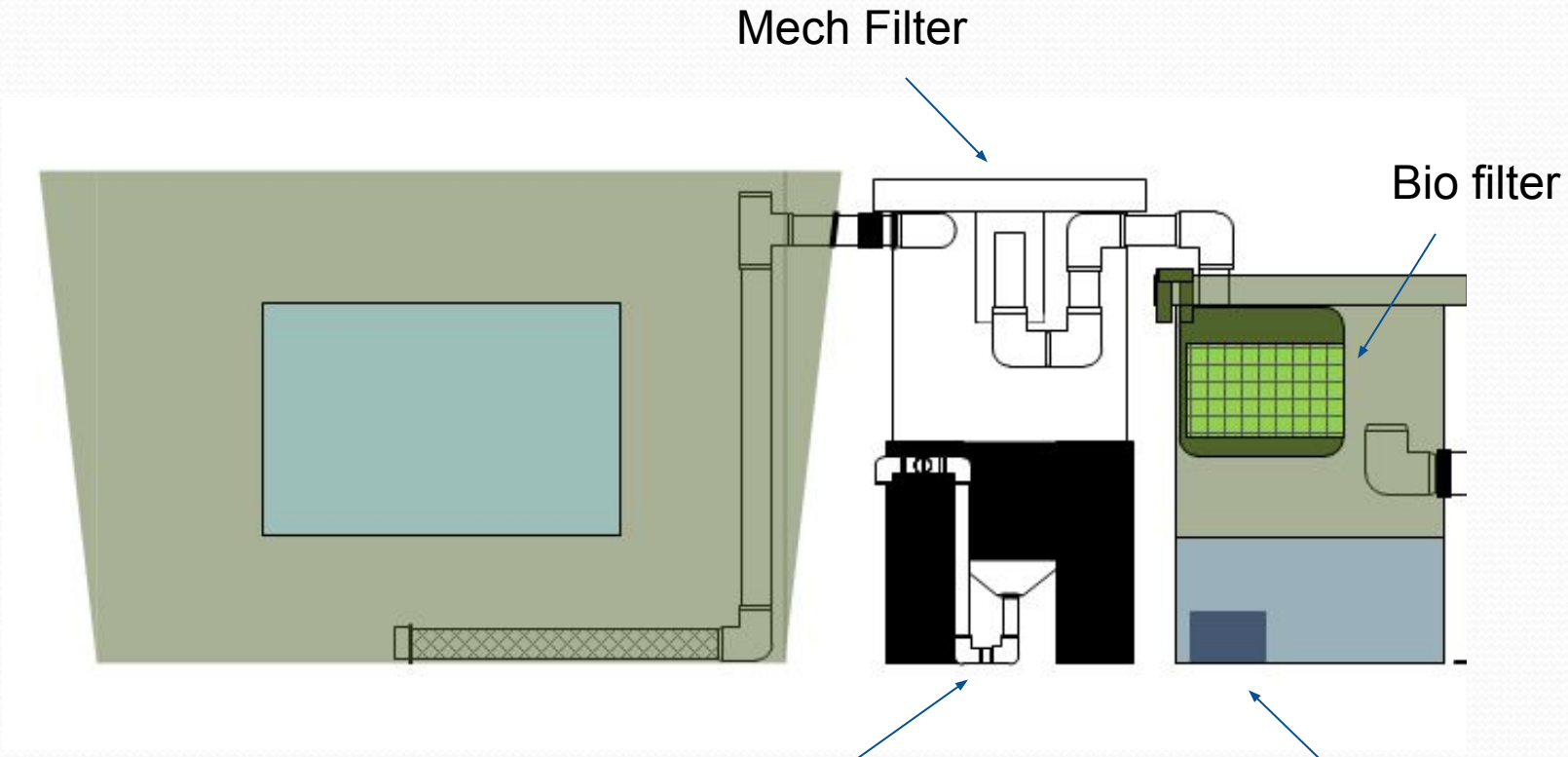
- Installed after fish tank and before grow beds or bio filter
- Solids collect at bottom and can easily be removed
- Clarified water passes on to next stage



Biological Filter

- High surface area for bacteria to colonize
- Important to remove solids before biofilter for best performance
- Worms can be added to break down some solids
- Over time solids accumulation will need to be flushed out

Filtration System Overview



What's in Aquaponic Water?

- Ammonia from fish gills and urine
- Uneaten feed or dissolved feed that escapes tank
- Fish feces – fish species have different fecal profiles
- Biofilm – coagulation of microbes which adhere to surfaces
- Biofloc – protein rich aggregate of organic material, bacteria, dead organisms, fecal pellets
- Plant debris – roots, leaves, decaying plant matter, grow media
- Adjusters and amendments – calcium, potassium, iron, etc.
- Minerals – from source water and nutrient additions
- Gases – oxygen, carbon dioxide, nitrogen, hydrogen sulfide

The Plants

- Lettuces
- Squash
- Zucchini
- Peppers
- Cucumbers
- Strawberries
- Peas & Beans
- Cooking Greens
- Most Herbs
- Tomatoes
- Melons
- Other plants

Why plants like Aquaponics?

- Nutrients constantly provided
- Warm water bathing the roots
- Don't have to search for water or food
- Less effort needed in putting out roots
- All the energy goes into growing UP not DOWN
- No weed competition

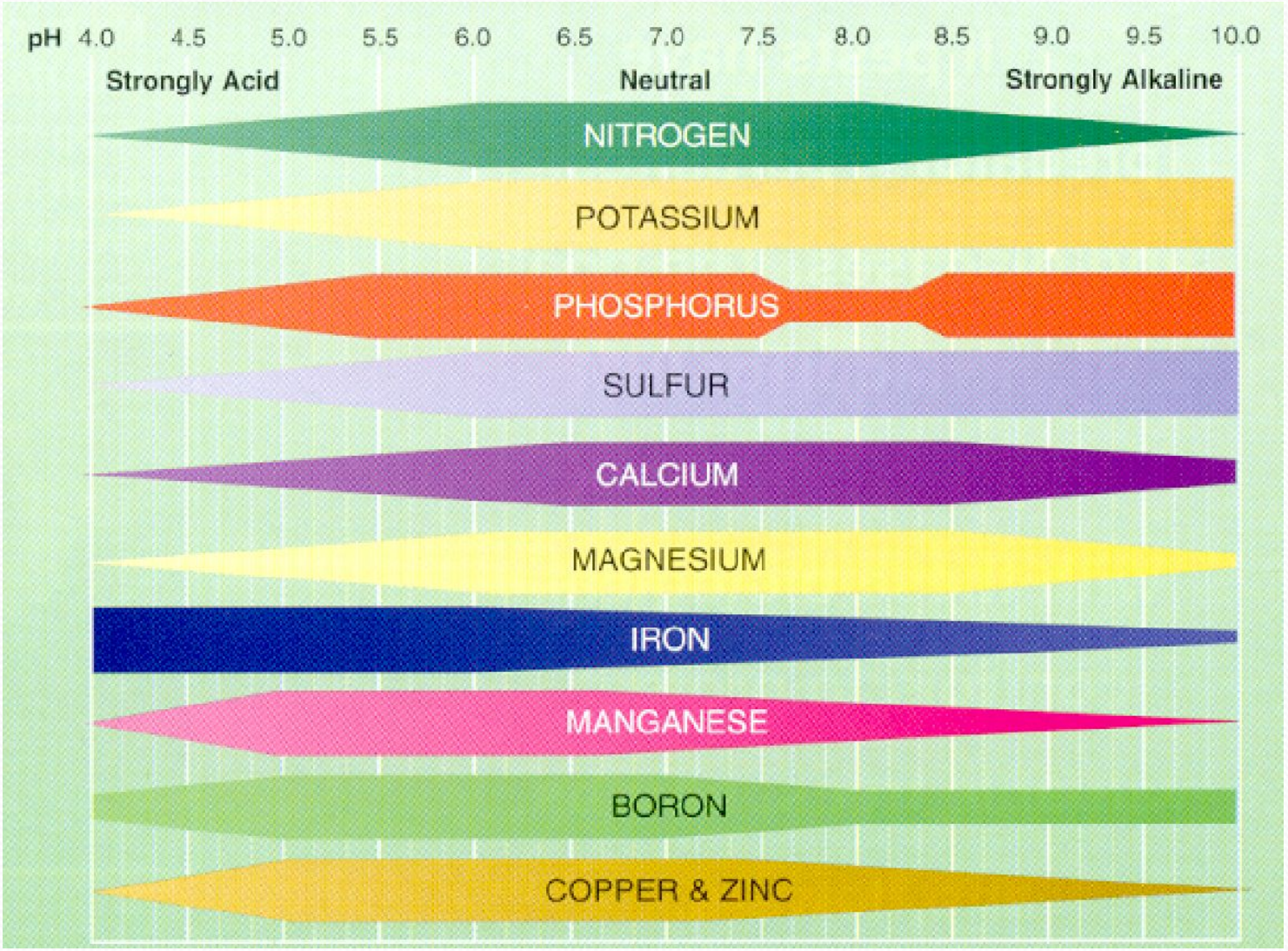
What things might influence plant growth in Aquaponics?

- Density and size of fish population
- Temperature of water and flow rate
- Temperature of air and ventilation (air exchange)
- Availability of beneficial bacteria and nitrates
- Amount of plants in the system
- Media present in system
- Available light, light spectrum, day length
- pH, nutrient availability and potential blocks
- Pest control

Getting Plants into the System

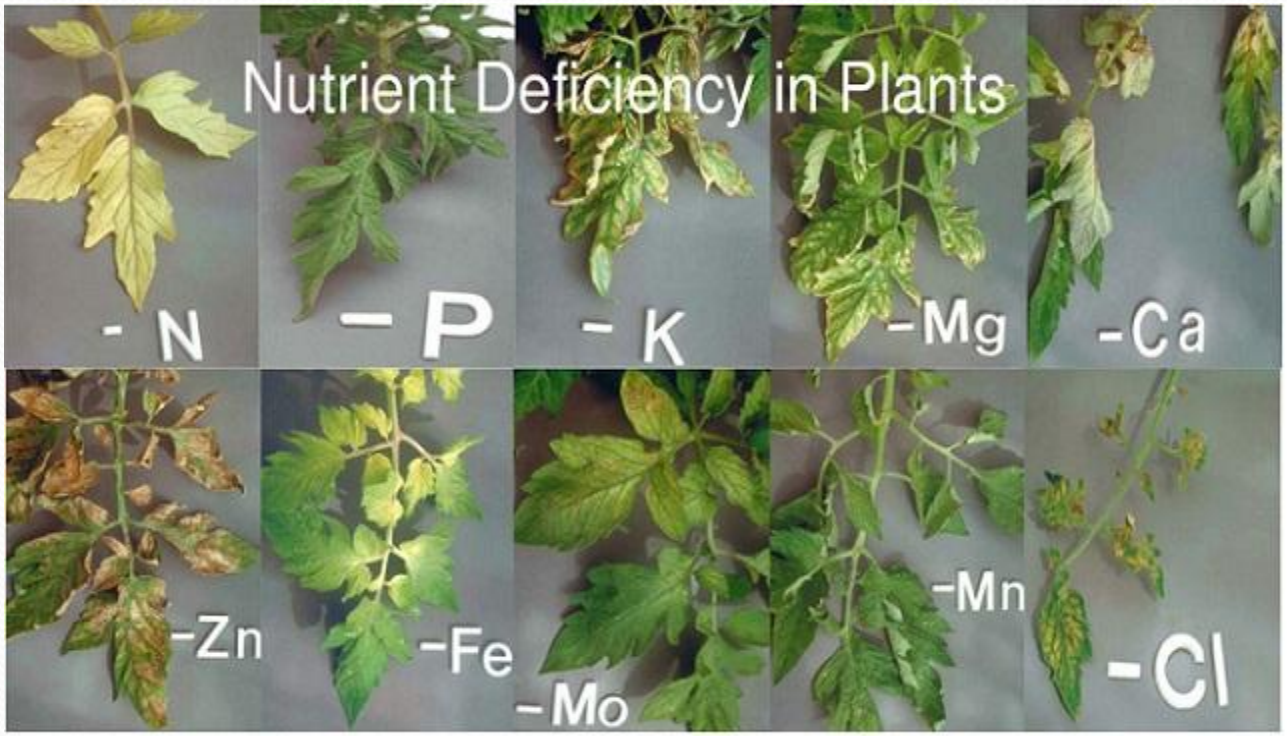
- Start seedlings from seed
- Take cuttings from “mother” plants (cloning)
- Buy plants (remove soil)

pH and Nutrient Availability



Nutrient Deficiencies

- Visually identify using color, texture, spots, splotches, deformity, slow growth, etc.
- Check old growth and new growth for differences
- Troubleshoot possible causes and take action



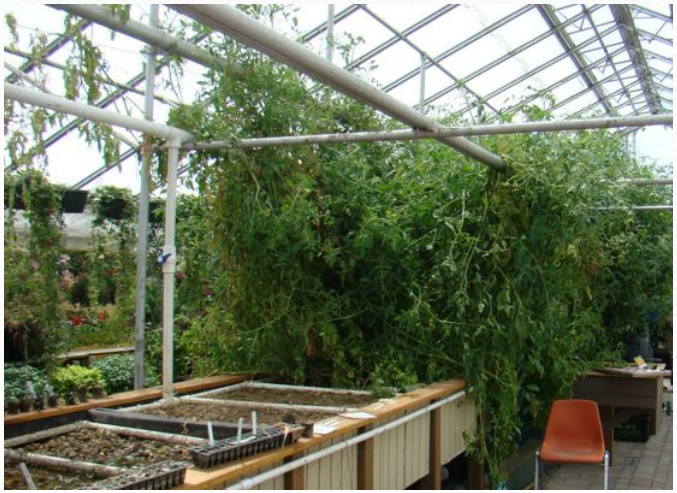
Nutrient Supplementation

- Aquaponics generally requires inputs of:
  - Fish Food
  - pH buffering – K and Ca
  - Iron supplementation
  - Trace minerals if needed

- Decoupled systems allow for more controls around plant nutrients
- Microdosing can provide more precise nutrients to flowering/fruiting crops without diluting into entire system

Fruit Crops Require Maintenance

- Vine management
- Pruning suckers
- Lower nitrogen needs after vegetative growth
- Longer time before producing crop
- Different nutrient needs for flowering and fruiting
- Pest and disease management
- Pollination is necessary



Pests - You Will Have Them

Integrated Pest Management (IPM)

1. Prevention – Keep them out, grow healthy plants
2. Monitor and Identify Pests – what is stressing the plants, what type of pest is involved
3. Set Action Thresholds – determine when/what
4. Control – take measures to remove pests, keep on top of scheduled regiment until control is complete
5. Keep Records – for health and food safety (it's the law)

Pest Remedies

Always ensure fish and bacteria safe, organic doesn't always guarantee its safe

- Vinegar and water
- Olive oil, peppermint oil
- Dr. Brommer's Castille soap
- Azatrol, Azaduractin (*Neem Tree*)
- BT, BTi and other bacterial agents
- Serenade (*Bacillus subtilis)*
- Hydrated Lime (slugs)

Do Not use anything with Copper or Pyrethrum

Consider Other Pests

- Vertebrates– birds, cats, dogs, rodents, raccoons, squirrels, reptiles, frogs, bears, moose, deer
  - Food safety issues
  - This includes pets!
- Snails and scuds in the water
  - Food safety issues
  - Keep raft beds clean
- Algae, duckweed, invasive plants, consider them weeds
- People….

The More You Know, The More You Grow

Create, Innovate, Educate, Integrate, Connect, Evolve

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